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Contemporary Screen Time Usage among Children 9–10-years-old is Associated with Higher BMI Percentile at One-Year Follow-Up: A Prospective Cohort Study

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Abstract

Objective: There is a paucity of prospective research exploring the relationship among contemporary screen time modalities (e.g., video streaming, video chatting, texting, and social networking) and body mass index (BMI) percentile. The objective of this study was to determine the prospective associations between screen time behaviors in a large, demographically diverse population-based cohort of 9–10-year-old children and BMI percentile at one-year follow-up.

Methods: We analyzed prospective cohort data from the Adolescent Brain Cognitive Development (ABCD) Study (N=11,066). Multiple linear regression analyses were conducted to estimate associations between baseline screen time behaviors (exposure) and BMI percentile at one-year follow-up, adjusting for race/ethnicity, sex, household income, parent education, depression, binge-eating disorder, and baseline BMI percentile.

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Authors Contributions

JMN, PI, JC, KPG, KBD, KTG conceived of the study. JMN and JC carried out the analysis. PI conducted the literature review. JMN, PI, JC, and KTG were involved with writing the paper. All authors were involved in critically revising the paper and had final approval of the submitted and published versions.

Conflict of interests

The authors have no conflict to declare.

Results: Each additional hour of total screen time per day was prospectively associated with 0.22 higher BMI percentile at one-year follow-up (95% CI 0.10–0.34) after adjusting for covariates. When examining specific screen time behaviors, each additional hour of texting (B=0.92, 95% CI 0.29–1.55), video chat (B=0.72, 95% CI 0.09–1.36), and video games (B=0.42, 95% CI 0.06–0.78) was significantly prospectively associated with higher BMI percentile.

Conclusions: Screen time is prospectively associated with a higher BMI percentile one year later among children 9–10 years old.

Keywords

Screen time; television; social media; smart phone; body mass index; weight; obesity; pediatrics; adolescents

Introduction

The number of children and adolescents presenting with obesity has significantly increased in recent years, with more than 13 million youth ages 2–19 in the U.S. having been affected by childhood obesity.[1] Understanding the modifiable factors associated with childhood obesity is key in providing tailored education, prevention, and interventions for youth and their families. Excessive screen time use (over two hours per day) is associated with greater sedentary time, less physical activity, and unhealthy eating behaviors, all of which may contribute to youth's risk for obesity.[2–4] The American Academy of Pediatrics has recommend limitations of technology usage in youth less than six years of age.[2] Studies initially targeted TV-watching and obesity,[4,5] with more recent inclusion of video games.[6] However, children across the nation are interacting with technology in rapidly evolving ways and technology is quickly emerging as the premier mode for youth to engage with their peers, family members, education, and entertainment.

Cross-sectional studies have demonstrated an association between screen time and higher BMI and obesity,[4,6–8] with larger studies focused on older adolescents and young adults.[9] The few prospective studies have been limited to relatively small sample sizes[10,11] and have not included large, diverse, and representative child populations in the U.S. Given that the biggest rise in obesity prevalence is seen in late childhood to early adolescence, research investigating BMI and screen time in younger adolescents is vital in identifying emerging trends in pediatric obesity.[12] Also, most of the existing literature pertains to undifferentiated total screen time or takes a narrower focus on television as the primary medium of media consumption.[4,5] Although youth interact with a diverse array of screens, there is sparse research exploring BMI's relationship to newer modalities such as texting, social networking, video chatting, and video streaming. The purpose of our study, therefore, is to determine prospective associations with several contemporary forms of screen time and BMI percentile in a large, diverse sample of American youth. We hypothesized that contemporary screen time modalities would be prospectively associated with a higher BMI percentile.

Methods

Study Population

The Adolescent Brain Cognitive Development (ABCD) Study, a large, diverse, and prospective cohort study of brain development and health across adolescence, provided data for this analysis. The sample consisted of 11,875 children recruited from 21 sites around the U.S. We analyzed data from the ABCD 3.0 release for the baseline (2016–2018, ages 9–10 years) and one-year follow-up (2017–2019, ages 10–11 years) assessments. Further details of the study sample, recruitment process, procedures, and measures have been previously reported.[13] Participants with missing data for baseline screen time (N=63) or BMI at one-year follow-up (N=752) were excluded, leaving a total of 11,066 in the cohort. We used single imputation by Gaussian normal regression for missing covariate data (N=1,016) based on other available sociodemographic data as we have done previously.[14] Centralized institutional review board (IRB) approval was obtained from the University of California, San Diego. Study sites obtained approval from their local IRBs. Caregivers provided written informed consent and each child provided written assent.

Measures

Exposures: Screen Time—Screen time was measured using the ABCD Youth Screen Time Survey. Children answered questions about typical hours per day spent on six different screen modalities (viewing/streaming television shows or movies, watching/streaming videos [e.g., YouTube], playing videogames, texting, video chatting [e.g., Skype, Facetime], and social networking [e.g., Facebook, Instagram, Twitter])[15] separately for weekdays and weekend days based on a previously validated measure.[16] Similar to a previous study investigating screen time exposure from the ABCD study, we calculated the weighted average participants' typical weekday and weekend screen time usage to obtain a typical week measure.[17] After obtaining this screen time total for each type of media, we reported the weighted average as a continuous variable.

Outcome: Body Mass Index (BMI) Percentile—BMI was calculated based on the average of two-to-three measured heights and weights (BMI = weight/height^2) by research staff and was converted into sex and age-specific percentiles in accordance with CDC growth curves and definitions.[18]

Covariates: Age, sex, race/ethnicity, household income, and highest parent education were based on parents' self-report. Major depressive disorder and binge-eating disorder were assessed using the Kiddie Schedule for Affective Disorders and Schizophrenia (KSADS-5) parent diagnostic interview.[19]

Statistical Analysis

Data analysis was performed in 2020 using Stata 15.1. Multiple linear regression analyses were conducted to estimate the association between baseline screen time (exposure variables, examined in separate models) and BMI percentile at one-year follow-up (outcome variable), adjusting for baseline BMI percentile only (model 1), as well as baseline BMI percentile, sex, race/ethnicity, household income, parent education, and site (model 2). Some

children within the sample were twins or siblings. Sensitivity analyses were conducted including only one sibling per family and findings did not differ; therefore, we present results from the full sample. We also analyzed BMI and BMI z-score as outcomes. We tested for effect modification of screen time by sex, but there was no evidence of effect modification (p for interaction>0.05). ABCD's pre-constructed propensity weights were applied based on the American Community Survey from the US Census.[20]

Results

Table 1 describes sociodemographic characteristics of the 11,066 participants included. The sample was balanced by sex (48.8% female) and racially and ethnically diverse (47.8% non-White). On average, youth reported 4.0 hours of screen time per day, with the most time spent watching/streaming television shows/movies (1.3 hours), playing video games (1.1 hours), and watching/streaming videos (1.1 hours) at baseline. Mean BMI percentile was 62.1 at baseline and 63.5 at one-year follow-up.

Table 2 shows linear regression analyses examining the prospective associations between baseline screen time and BMI percentile at one-year follow-up. In models adjusted for baseline BMI percentile only, all forms of screen time were associated with higher BMI percentile at one-year follow-up. In fully adjusted models, each additional hour of total screen time per day was prospectively associated with a 0.22 higher BMI percentile at one-year follow-up (95% CI 0.10–0.34). When examining specific screen time behaviors, each additional hour of texting (B=0.92, 95% CI 0.29–1.55), video chat (B=0.72, 95% CI 0.09–1.36), and video games (B=0.42, 95% CI 0.06–0.78) was significantly prospectively associated with a higher BMI, after adjusting for covariates.

Appendix A and B show sensitivity analyses with BMI and BMI z-score as outcomes, respectively. The findings are similar (all B coefficients with positive association), although the scales are different and some associations with individual screen time modalities are no longer statistically significant.

Discussion

In a population-based, demographically diverse cohort of 9–11-year-old children in the U.S., we found that greater screen time was prospectively associated with a higher BMI percentile one year later. When examining specific screen time behaviors, more time spent on texting, video chat, and video games was most strongly associated with a higher BMI percentile. Although texting and watching/streaming videos had the strongest associations with BMI, it should be noted that participants only reported an average of less than 15 minutes per day on these screen time modalities.

Our findings extend upon those of mostly cross-sectional studies in older adolescents or adults examining the relationship between screen time and BMI.[4,6–8] We add to the prior literature on screen time and BMI by reporting prospective associations from a large, demographically diverse cohort study of children in the U.S. and study contemporary forms of screen time, including texting, video chatting, and social networking.

Several mechanisms may contribute to the prospective association between screen time and higher BMI, including snacking, sedentary time, and physical inactivity. Youth may be more prone to snacking and overeating while distracted on screens, even in the absence of hunger.[8] Children may also be exposed to more food advertisements while on their screens,[21] thus influencing their eating behaviors. Screen time is mostly sedentary and may also displace time for physical activity.[22]

Despite the important findings of this study, limitations should be noted. Although we adjusted for several potential confounders, including baseline BMI percentile, there is the possibility of additional unmeasured confounders. Despite the use of a longitudinal cohort study, given the observational study design, we cannot definitively establish causality. Future research could examine the reverse relationship, which is whether baseline BMI percentile is prospectively associated with screen time at one-year follow-up. Although BMI percentiles are the standard of care in pediatric clinical practice,[18,23] there are limitations in the use of BMI percentile in longitudinal studies and at >97th percentile of BMI;[24,25] thus, we report BMI and BMI z-scores in supplemental appendices. Furthermore, effect sizes of the associations between screen time and BMI percentile were relatively small for one-year follow-up; however, cumulative exposure to screen time over decades may become more clinically significant later in the life course. In addition, screen time increases after ages 9–11 years, indicating that future research is needed to follow the ABCD cohort through later adolescence. While other reports have similarly found relatively low usage of social networking among pre-adolescents 8–12-years-old (16 minutes per day), adolescents 13–18-years-old report much higher usage of social networking (71 minutes per day).[26] Lastly, screen time measures were based on self-report, which could lead to reporting bias.

Findings from this study suggest that specific screen time behaviors should be targeted as part of childhood obesity prevention efforts. Today's youth are increasingly engaging in screen time for social and educational purposes, which has been exacerbated by the COVID-19 pandemic.[27] This has led to a rapid rise in overall screen time use that can have detrimental effects. Guidance for children, parents, clinicians, and policymakers regarding appropriate screen time usage is needed to ensure the health and well-being of young people.[27] Health care providers should assess for excess screen time usage and weight changes, especially during the pandemic, and advise about potential risks associated with excessive sedentary screen time. Professional organizations, such as the American Academy of Pediatrics should provide further specific guidance for families regarding screen time usage and strategies to prevent weight gain related to excessive screen time usage.[2]

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1.

Sociodemographic, screen time, and anthropometric characteristics of 11,066 Adolescent Brain Cognitive Development (ABCD) Study participants

Sociodemographic characteristics (baseline)	Mean (SD) / %
Age (years)	9.9 (0.6)
Sex (%)	
Female	48.8%
Male	51.2%
Race/ethnicity	
White	52.2%
Latino / Hispanic	20.0%
Black	17.3%
Asian	5.5%
Native American	3.2%
Other	1.9%
Household income	
Less than $25,000	18.7%
$25,000 through $49,999	20.4%
$50,000 through $74,999	17.5%
$75,000 through $99,999	13.4%
$100,000 through $199,999	22.6%
$200,000 and greater	7.4%
Parent with college education or more	79.7%
Major depressive disorder	0.2%
Binge-eating disorder	0.7%
Screen time variables (hours per day, baseline)	
Total screen time	3.99 (3.16)
Television shows/movies	1.31 (1.31)
Videos (e.g. YouTube)	1.05 (1.18)
Video games	1.06 (1.13)
Texting	0.24 (0.56)
Video chat	0.21 (0.52)
Social networking	0.13 (0.45)

Anthropometrics	
BMI percentile, baseline	62.1 (30.7)
BMI z-score, baseline	0.43 (1.49)
BMI (kg/m^2), baseline	19.02 (4.30)
BMI category, baseline	
Underweight (BMI<5th percentile)	3.9%
Normal weight (5th percentile ≤ BMI < 85th percentile)	62.5%
Overweight (85th percentile ≤ BMI < 95th percentile)	15.9%
Obese (BMI > 95th percentile)	17.8%
BMI percentile, one-year follow-up	63.5 (30.5)
BMI z-score, one-year follow-up	0.48 (1.54)
BMI (kg/m^2), one-year follow-up	20.02 (4.77)
BMI category, one-year follow-up	
Underweight (BMI<5th percentile)	3.8%
Normal weight (5th percentile ≤ BMI < 85th percentile)	60.8%
Overweight (85th percentile ≤ BMI < 95th percentile)	16.6%
Obese (BMI > 95th percentile)	18.9%

Legend: ABCD propensity weights were applied based on the American Community Survey from the US Census. SD = standard deviation

Table 2.

Prospective associations between baseline screen time and body mass index (BMI) percentile at one-year follow-up in the Adolescent Brain Cognitive Development Study

	BMI percentile at follow-up, adjusted for baseline BMI percentile only		BMI percentile at follow-up, fully adjusted[a]	
	B (95% CI)	p	B (95% CI)	p
Total screen time	**0.29 (0.18 – 0.40)**	**<0.001**	**0.22 (0.10 – 0.34)**	**<0.001**
Television	**0.46 (0.15 – 0.76)**	**0.003**	**0.32 (0.02 – 0.62)**	**0.039**
Videos (YouTube)	**0.58 (0.29 – 0.87)**	**<0.001**	**0.36 (0.06 – 0.67)**	**0.019**
Video games	**0.53 (0.20 – 0.86)**	**0.001**	**0.42 (0.06 – 0.78)**	**0.021**
Texting	**1.25 (0.62 – 1.87)**	**<0.001**	**0.92 (0.29 – 1.55)**	**0.004**
Video chat	**0.98 (0.34 – 1.61)**	**0.003**	**0.72 (0.09 – 1.36)**	**0.025**
Social networking	**1.04 (0.29 – 1.80)**	**0.007**	0.67 (−0.07 – 1.41)	0.075

Legend:

Bold indicates p<0.05. The B coefficient in the cells represents abbreviated output from a series of linear regression models with BMI percentile as the dependent variable and screen time as the independent variable. Thus, the table represents the outputs from fourteen regression models in total. ABCD propensity weights were applied based on the American Community Survey from the US Census.

[a]Covariates: race/ethnicity, sex, household income, parent education, depression, binge-eating disorder, site, and baseline BMI percentile.