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Screen time behaviors and caffeine intake in U.S. children

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NA conceptualized the study, SF carried out statistical analysis and assisted formulate the tables, NA drafted the manuscript; SQ provided input on interpretation of findings and

discussion. All authors (NA, SF, SQ) reviewed and provided critical input on the final draft of the manuscript and approve its submission to the journal.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the CDC.

ABSTRACT

Background: Screen time (ST) behaviors, e.g., television (TV) watching and computer use, among youth are associated with unhealthy eating, and these patterns track over time. This is the first report relating ST behaviors with caffeine intake in a nationally representative sample of U.S. children.

Methods: Data on 3421 children (ages 6-11 years) from National Health and Nutrition Examination Survey (NHANES) 2007-2012 were used. Time spent on TV watching and computer use was determined using questionnaires. Dietary intake was assessed using 24-hour recall by trained interviewers. Caffeine intake (mg) was estimated by using updated food and nutrient databases. Caffeine consumption was examined in relation to time spent (≥2 versus <2 hours/day) on ST behaviors.

Results: Children who watched TV ≥2 hours/day had significantly higher (~45% more) caffeine intake.

Conclusion: TV watching associated positively with caffeine intake in school-aged children, suggesting a need to modify these behaviors from early childhood.

INTRODUCTION

Excessive screen time (ST) and use of caffeinated products among youth are subjects of public health concern. ST behaviors include watching television (TV) and using computers or other electronic media.[1] ST behaviors have been related to increased cardiometabolic risk, shorter sleep and unhealthy eating habits in youth.[2-4] Positive associations between ST and consumption of caffeinated foods and beverages have been described in national samples of school-aged children primarily in a few countries in Europe.[2] To our knowledge, the association of ST behaviors with quantitative estimates of caffeine intake has not been previously examined. Furthermore, eating habits form early in childhood, and both eating patterns and ST can track into adolescence and later ages, impacting long-term health.[1-4] Thus, we report for the first time, the association of ST behaviors with caffeine intake in a nationally representative sample of U.S. school-aged children.

METHODS

Data

NHANES is a series of large, complex, stratified, multistage probability surveys of the U.S. population, conducted by the National Center for Health Statistics (NCHS) of the CDC.[5] Participants are administered an in-home interview, followed by a visit to a mobile examination center (MEC) that includes physical examinations and dietary interviews. The NHANES protocol is approved by the NCHS Research Ethics Review board. Cross-sectional data from NHANES cycles (2007–2008, 2009–2010 and 2010–2012), where information was available on ST behaviors and caffeine intake for 6-11 year old survey participants (SP), were used. Unweighted exam response rate for NHANES 2007-12 was 74.1 (range 69.5-75.4). Written parental informed consent and child assent were obtained for all children ages 6-11 years.

Screen-time behaviors. Data on ST behaviors, including TV watching and computer use, were collected by asking: “Over the past 30 days, on average how many hours per day did SP sit and watch TV or videos”, and “Over the past 30 days, on average how many hours per day did SP use a computer or play computer games outside of work or school”. Proxies (generally a parent) provided responses ranging from none, <1, 1, 2, 3, 4, or ≥5 hours. Total ST was computed by

summing TV watching and computer use time (<1 was coded as 0.5); these questions are designed to be mutually exclusive, but there are possible limitations when summing the responses (rounding up or down). All ST variables were dichotomized to <2 or ≥2 hours.[2]

Caffeine intake. The type and quantity of all foods and beverages consumed in the 24-hour period the day preceding the MEC visit were collected by trained interviewers using a standardized computer-assisted dietary interview system (USDA's Automated Multiple-Pass Method).[5] For beverages that may be caffeinated (e.g., soda, coffee, tea, and energy drinks) additional questions were asked to determine caffeine content. Proxies, generally parents, assisted with the dietary interviews. NHANES caffeine intake data are computed using USDA's Food and Nutrient Database for Dietary Studies that is updated for each survey cycle to reflect current market supply.[5]

Statistical analysis

Statistical analysis were conducted with STATA 13. Caffeine intake displayed a skewed distribution; these data were logarithmically transformed to test hypotheses.[5]

Day 1 dietary sample weights that account for differential selection probability, nonresponse, noncoverage, and complex sample design were applied. Weighted, untransformed estimates of the 25th, 50th (median), 75th, 90th, and 95th percentiles for caffeine intake and proportions of caffeine consumers on a given day were estimated[5]. Hypotheses concerning caffeine intake (mg) in relation to ST variables were tested using weighted means of the log-transformed variable (α=0.05).[5]

RESULTS

Overall, 73.7, 63.4, and 19.2% children spent ≥2 hours/day on total ST, TV watching, and computer use, respectively. Seventy-four percent reported consuming caffeine on a given day. A greater proportion of children who watched ≥2 hours TV/day consumed caffeine (75.2%) versus

those who watched less TV (70.3%) (p=0.05). The proportion of caffeine consumption by computer use and total ST did not differ significantly.

Caffeine intake in relation to ST behaviors is presented for all children and for caffeine-consumers only in Tables 1 and 2, respectively. The median intake of children who watched TV ≥2 hours/day was 44% higher versus those who watched TV <2 hours/day (p<0.05) (**Table 1**). Although caffeine intake was higher among children with ≥2 hours/day of computer use or total ST, these differences were not statistically significant. (Table 1). When analyses were restricted to caffeine-consumers only (Table 2), children who watched TV ≥2 hours/day had 46% higher median caffeine intake than those who watched less TV (p<0.05). As for all children, caffeine intake among caffeine-consumers was higher for those with ≥2 hours/day of computer use or total ST, but were not statistically significant (**Table 2**).

DISCUSSION

A positive association between ST behaviors and consumption of caffeinated foods (sodas, candy/choclate, "junk food" inlcluding chocolate) has been reported in nationally representative samples of children in European countries and in small cross-sectional studies.[2,3] To our knowledge, this is the first report relating ST behaviors with quantitatively estimated caffeine intake, in a nationally representative sample of U.S. children.

Total ST (≥2 hours/day) and caffeine consumption were reported by proxies (generally a parent) for 73.7 and 73.5% children, respectively; this is consistent with previous limited literature in nationally representative samples of U.S. children.[1,5] Although in the current study, the median caffeine intake on a given day among 6-11 year old U.S. children was small, some children consumed large and potentially detrimental amounts.[5] Furthermore, caffeine intake increases with age[5] and eating habits formed in childhood can continue into adolescence and adulthood suggesting the need to monitor this behavior into adolescence and later years.

In the current study, children who watched TV ≥2 hours/day had significantly greater caffeine intake than those who watched less TV. This finding is consistent with increased odds of soda ("soft drinks") consumption by 6-9 year olds who watched TV ≥2 hours/day in 5 European countries.[2] Eating patterns and ST behaviors can differ across countries; our findings of a

positive association between TV watching and caffeine intake corroborate the findings noted in European countries and extend them to U.S. children. Children who watch more TV are more likely to have shorter sleep, experience fatigue and higher exposure to food-related advertising, and have unhealthy eating habits[2,3]; these factors could motivate higher intake of caffeinated foods and explain the association between TV watching and caffeine intake noted in the current study. It is important to note that our findings are based on self-reported crosssectional data and do not allow drawing causal inferences. Future research could examine the association of ST behaviors with caffeine intake upon adjusting for demographic and lifestyle covariates, and describe usual caffeine intakes and sources among youth.

In conclusion, this study describes for the first time a positive association of ST behaviors, notably TV watching, with caffeine intake among 6-11 year old U.S. children. The findings highlight the need for continued monitoring of ST and caffeine intake behaviors in youth and for examining their correlates to inform nutrition and health policies.

WHAT IS ALREADY KNOWN ON THIS TOPIC

There are suggestons that ST and eating habits form in childhood and track into later ages.

ST behaviors (TV and computer-use) are associated with adverse health outcomes and unhealthy eating.

Few national-level studies have examined the association of ST with consumption of caffeinated foods (e.g., soda, chocolate) in European children.

WHAT THIS STUDY ADDS

This study is first to relate ST behaviors with quantitatively-estimated caffeine intake in a nationally representative sample of 6-11 year old U.S. children.

TV watching was associated with higher caffeine intake on a given day among all and caffeineconsuming children.

ST and caffeine intake in youth need to be monitored.

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Table 1. Caffeine intake (mg) on a given day for all children (ages 6-11 years) overall and by screen time variables*

	n†	Median	25th percentile	75th percentile	90th percentile	95 percentile	*p* value‡
All	3421	4.4	0.0	24.6	58.6	85.8	
Total screen time							NS
<2 hours	807	3.7	0.0	16.0	42.5	69.1	
≥2 hours	2,474	4.7	0.0	28.2	62.0	94.9	
Television watching							0.02
<2 hours	1,138	3.4	0	15.5	43.7	81.3	
≥2 hours	2,143	4.9	1.0	30.2	62.3	93.6	
Computer use							NS
<2 hours	2,605	4.3	0.0	23.2	55.5	82.5	
≥2 hours	678	4.8	0.0	31.1	84.6	119.0	

* Medians and percentiles were calculated from untransformed weighted data; 5th and 10th percentiles are not presented and were essentially equal to zero because of a high proportion of children who did not consume any caffeine.

† Unweighted n

‡ All statistical tests were performed on log-transformed means

Table 2. Caffeine intake (mg) on a given day for caffeine-consumers (ages 6-11 years) overall and by screen time variables*

	n†	Median	25th percentile	75th percentile	90th percentile	95 percentile	*p* value‡
All	2425	10.2	3.1	38.2	73.2	112.1	
Total screen time							NS
<2 hours	559	8.2	2.8	30.4	56.7	84.4	
≥2 hours	1760	11.6	3.3	41.3	79.7	116.0	
Television watching							0.04
<2 hours	781	8.3	2.8	31.1	64.6	96.9	
≥2 hours	1538	12.1	3.3	42.3	76.0	115.9	
Computer use							NS
<2 hours	1866	9.9	3.0	36.6	66.9	96.6	
≥2 hours	454	12.3	3.9	45.1	98.2	128.2	

* Medians and percentiles were calculated from untransformed weighted data; 5th and 10th percentiles are not presented and were essentially equal to zero because of a high proportion of children who did not consume any caffeine.

† Unweighted n

‡ All statistical tests were performed on log-transformed means

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Screen time behaviors and caffeine intake in U.S. children: Findings from the cross-sectional National Health and Nutrition Examination Survey (NHANES)

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NA conceptualized the study design with input from SF and SQ. SF carried out data analysis, and all authors (NA, SF, and SQ) were involved in the interpretation of the findings.

NA wrote the first draft of the manuscript; all authors provided critical input in further drafting, revising and reviewing the manuscript as well as approving the final manuscript.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the CDC.

ABSTRACT

Background: Screen time (ST) behaviors, e.g., television (TV) watching and computer use, among youth are associated with unhealthy eating, and these patterns track over time. A positive association between ST and TV watching with consumption of caffeinated foods and beverages has been described in national samples of children in a few European countries. The association of ST behaviors with caffeine intake has not been previously reported. We examined whether ST behaviors were associated with caffeine intake on a given day (% consumers, and amount consumed) in a nationally representative sample of U.S. children.

Methods: Data on 3421 children (ages 6-11 years) from the cross-sectional National Health and Nutrition Examination Survey (NHANES) 2007-2012 were used. Time spent on TV watching and computer use was determined using questionnaires. Dietary intake was assessed using 24-hour recall by trained interviewers. Caffeine intake (mg) was estimated by using updated food and nutrient databases. Caffeine consumption was examined in relation to time spent (≥2 versus <2 hours/day) on ST behaviors.

Results: Children who watched TV ≥2 hours/day had significantly higher (~45% more) caffeine intake. Total screen time or computer use were not associated with caffeine consumption in school-aged children.

Conclusion: TV watching was positively associated with caffeine intake in school-aged children, suggesting the need for continued monitoring of ST and caffeine intake behaviors in children and adolescents as well as examining the correlates of these behaviors to inform nutrition and health policies.

INTRODUCTION

Excessive screen time (ST) and use of caffeinated products among youth are subjects of public health concern. ST behaviors include watching television (TV) and using computers or other electronic media.[1] ST behaviors have been related to increased cardio-metabolic risk, shorter sleep and unhealthy eating habits in youth.[2-6] Positive associations between ST and consumption of caffeinated foods and beverages have been described in national samples of school-aged children primarily in a few European countries.[2] To our knowledge, the association of ST behaviors with quantitative estimates of caffeine intake has not been previously examined. Furthermore, eating habits form early in childhood, and both eating patterns and ST can track into adolescence and later ages, impacting long-term health.[1-3, 7, 8] Thus, the purpose of this study was to examine the association of ST behaviors with caffeine intake in a nationally representative sample of U.S. school-aged children. We tested the hypothesis that there was no association between ST behaviors and caffeine consumption (i.e., proportion of children who consumed caffeine, and amount of caffeine consumed on a given day).

METHODS

Data

NHANES is a series of large, complex, stratified, multistage probability surveys of the U.S. population, conducted by the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention (CDC).[9] NHANES is designed to assess the health and nutritional status of adults and children in the United States and has been collecting these comprehensive data continuously since 1999. Briefly, participants are administered an in-home interview, followed by a visit to a mobile examination center (MEC) that includes a physical examination and dietary interviews. The NHANES protocol is approved by the NCHS Research Ethics Review board. Cross-sectional data were also collected on ST behaviors on 6-11 year old survey participants (SP) in certain NHANES cycles (2007–2008, 2009–2010 and 2010–2012). These data, along with detailed methods of collection, and questionnaires used, are publically available on the NHANES website (https://www.cdc.gov/nchs/nhanes/index.htm).

Written parental informed consent and child assent were obtained for all children ages 6-11 years. Unweighted exam response rate (%) for NHANES 2007-12 was 74.1 (range: 69.5-75.4). The analytic sample consisted of NHANES participants aged 6–11 years (n=3,421) with data on ST behaviors and dietary intake, and whose dietary recall data were considered 'reliable' in terms of the quality and completeness of the recall (https://wwwn.cdc.gov/Nchs/Nhanes/2011-2012/DR1TOT_G.htm).

Screen-time behaviors. Data on ST behaviors, including TV watching and computer use, were collected by asking: "Over the past 30 days, on average how many hours per day did SP sit and watch TV or videos", and "Over the past 30 days, on average how many hours per day did SP use a computer or play computer games outside of work or school". These questions are similar to those used in other validated surveys such as the CDC's Youth Risk Behaviors Surveillance System and other studies.[10-12] Proxies (generally a parent) provided responses ranging from none, <1, 1, 2, 3, 4, or ≥5 hours. Total ST was computed by summing TV watching and computer use time (<1 was coded as 0.5); these questions are designed to be mutually exclusive, but there are possible limitations when summing the responses (rounding up or down). All ST variables were dichotomized to <2 or ≥2 hours, considering recommendations to limit ST to < 1 to 2 hours per day,[6, 13] as used in other studies examining eating habits and ST behaviors in children.[2, 14, 15]

Caffeine intake. The type and quantity of all foods and beverages consumed in the 24-hour period preceding the MEC visit were collected by trained interviewers using a standardized computer-assisted dietary interview system i.e., Automated Multiple-Pass Method (AMPM) of the United States Department of Agriculture (USDA).[9, 16] The methodology used for determination of caffeine intake has been described in detail in previous NHANES analyses.[17-19] Briefly, the AMPM includes a multiple pass format interview, standardized probes, and memory cues to help respondents remember and describe food and beverage consumption.[16] For beverages that may be caffeinated (e.g., soda, coffee, tea, and energy drinks) additional questions were asked to determine caffeine content.[18] Proxies, generally parents, assisted with the dietary interviews. NHANES caffeine intake data are computed using USDA's Food and Nutrient Database for Dietary Studies, which is updated for each survey cycle to reflect current market supply.[9, 17]

Statistical analysis

Statistical analyses were conducted with STATA 13. Caffeine intake displayed a skewed distribution; thus these data were logarithmically transformed to test hypotheses.[18]

Day 1 dietary sample weights that account for differential selection probability, nonresponse, noncoverage, and complex sample design were applied. Weighted, untransformed estimates of the 25th, 50th (median), 75th , 90th, and 95th percentiles for caffeine intake and proportions of caffeine consumers on a given day were estimated.[18] Hypotheses concerning caffeine intake (mg) in relation to ST variables were tested using weighted means of the log-transformed variable (α=0.05).[18]

RESULTS

Overall, 73.7, 63.4, and 19.2% children spent ≥2 hours/day on total ST, TV watching, and computer use, respectively. Seventy-four percent reported consuming caffeine on a given day. A trend of a greater proportion of children who watched ≥2 hours TV/day consuming caffeine (75.2%) versus those who watched less TV (70.3%) was noted that approached significance (p=0.05). The proportion of caffeine consumption by computer use and total ST did not differ significantly (data not shown).

Caffeine intake in relation to ST behaviors is presented for all children and for caffeine-consumers only in Tables 1 and 2, respectively. The median caffeine intake of children who watched TV ≥2 hours/day was 44% higher versus those who watched TV <2 hours/day (p<0.05); median (95% CI) on a given day were 4.9 (0-93.6) and 3.4 (0-81.3) mg, respectively (**Table 1**). Although caffeine intake was higher among children with ≥2 hours/day of computer use or total ST, these differences were not statistically significant (Table 1). When analyses were restricted to caffeine-consumers only (**Table 2**), children who watched TV ≥2 hours/day had 46% higher median caffeine intake than those who watched less TV (p<0.05); median (95% CI) were 12.1 (0-115.9) and 8.3 (0-96.9) mg, respectively. As for all children, caffeine intake among caffeine-consumers was higher for those with ≥2 hours/day of computer use or total ST, but was not statistically significant (**Table 2**).

DISCUSSION

A positive association between ST behaviors and consumption of caffeinated foods (including sodas, candy, and chocolate) has been reported in nationally representative samples of children in few European countries and in Iran, and in small cross-sectional studies.[2, 3, 14] To our knowledge, the association of ST behaviors with quantitatively estimated caffeine intake in a nationally representative sample of U.S. children has not been previously examined. Thus, the findings of this study add to the limited literature on caffeine consumption and screen time behaviors in children.

Total ST (≥2 hours/day) and caffeine consumption were reported by proxies (generally a parent) for 73.7 and 73.5% children, respectively; this is consistent with previous limited literature in nationally representative samples of U.S. children.[1, 17] Although in the current study, the median caffeine intake on a given day among 6-11 year old U.S. children was small, some children consumed large and potentially detrimental amounts.[17, 18] Furthermore, caffeine intake increases with age[17-19] and eating habits formed in childhood can continue into adolescence and adulthood[8] suggesting the need to monitor this behavior into adolescence and later years.

In the current study, children who watched TV ≥2 hours/day had significantly greater caffeine intake than those who watched less TV. These findings are consistent with increased odds of soda ("soft drinks") consumption by 6-9 year olds who watched TV ≥2 hours/day in five European countries.[2] Eating patterns and ST behaviors can differ across countries; our findings of a positive association between TV watching and caffeine intake corroborate the findings noted in European countries[2] and extend them to U.S. children. Children who watch more TV may have shorter sleep, experience fatigue and higher exposure to food-related advertising, and may have unhealthy eating habits;[2, 3, 6] these factors could motivate higher intake of caffeinated foods and/or beverages. Alternatively, it is also possible that caffeine consumption increases wakefulness and decreases time spent asleep, which could in turn be spent as watching TV.[5, 20] Interestingly, in a study in Belgium, soda consumption in early adolescence predicted screen time (TV and computer use) in early adulthood among girls.[7]

Our findings have limitations. They are based on cross-sectional data relying on reports of time spent on ST behaviors and dietary intake based on a 24-hour recall that could be subjected to recall bias. However, these techniques used in large-scale surveys and epidemiological studies are considered adequate to describe large-group level means and examine group level associations.[9, 21] The cross-sectional nature of NHANES data do not allow determination of the directionality of the association noted between TV watching and caffeine intake, or to draw any causal inferences. Future research could examine the association of ST behaviors with caffeine intake using more objective measures of total ST as well, upon adjusting for demographic and lifestyle covariates, and describe usual caffeine intakes and sources among youth.

In conclusion, this study describes for the first time a positive association of ST behaviors, notably TV watching, with caffeine intake among a nationally representative sample of 6-11 year old U.S. children. The findings highlight the need for continued monitoring of ST and caffeine intake behaviors in youth and for examining their correlates to inform nutrition and health policies.

WHAT IS ALREADY KNOWN ON THIS TOPIC

There are suggestions that ST and eating habits form in childhood and track into later ages.

ST behaviors (TV and computer-use) are associated with adverse health outcomes and unhealthy eating.

Few national-level studies have examined the association of ST with consumption of caffeinated foods (e.g., soda, chocolate) in European children.

WHAT THIS STUDY ADDS

This study relates ST behaviors with quantitatively-estimated caffeine intake in a nationally representative sample of 6-11 year old U.S. children.

TV watching was associated with higher caffeine intake on a given day among all children and among those consuming caffeine.

ST and caffeine intake in youth need to be monitored.

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<2 hours	2,605	4.3	0.0	23.2	55.5	82.5	
≥2 hours	678	4.8	0.0	31.1	84.6	119.0	

* Medians and percentiles were calculated from untransformed weighted data; 5th and 10th percentiles are not presented and were essentially equal to zero because of a high proportion of children who did not consume any caffeine.

† Unweighted n

‡ All statistical tests were performed on log-transformed means

Table 2. Caffeine intake (mg) on a given day for caffeine-consumers (ages 6-11 years) overall and by screen time variables*

	n†	Median	25th percentile	75th percentile	90th percentile	95 percentile	*p* value‡
All	2425	10.2	3.1	38.2	73.2	112.1	
Total screen time							NS
<2 hours	559	8.2	2.8	30.4	56.7	84.4	
≥2 hours	1760	11.6	3.3	41.3	79.7	116.0	
Television watching							0.04
<2 hours	781	8.3	2.8	31.1	64.6	96.9	
≥2 hours	1538	12.1	3.3	42.3	76.0	115.9	
Computer use							NS
<2 hours	1866	9.9	3.0	36.6	66.9	96.6	
≥2 hours	454	12.3	3.9	45.1	98.2	128.2	

* Medians and percentiles were calculated from untransformed weighted data; 5th and 10th percentiles are not presented and were essentially equal to zero because of a high proportion of children who did not consume any caffeine.

† Unweighted n

‡ All statistical tests were performed on log-transformed means