Characteristics of Screen Media Use Associated With Higher BMI in Young Adolescents

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KEY WORDS

obesity, adolescents, television, video games, computer, ecological momentary assessment

ABBREVIATIONS

EMA—ecological momentary assessment
MYME—Measuring Youth Media Exposure
PDA—personal digital assistant
TUD—time-use diary

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WHAT'S KNOWN ON THIS SUBJECT: Rates of screen media use have risen in parallel with rates of obesity among young people. Identifying the specific characteristics of media use that are associated with obesity can help elucidate the explanatory processes and inform effective interventions.

WHAT THIS STUDY ADDS: This study examines the associations between BMI and characteristics of media use including the type of device, duration of use, and attention to the medium. The more that participants paid primary attention to television, the higher their BMI.

abstract

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OBJECTIVES: This study investigates how characteristics of young adolescents' screen media use are associated with their BMI. By examining relationships between BMI and both time spent using each of 3 screen media and level of attention allocated to use, we sought to contribute to the understanding of mechanisms linking media use and obesity.

METHODS: We measured heights and weights of 91 13- to 15-year-olds and calculated their BMIs. Over 1 week, participants completed a weekday and a Saturday 24-hour time-use diary in which they reported the amount of time they spent using TV, computers, and video games. Participants carried handheld computers and responded to 4 to 7 random signals per day by completing onscreen questionnaires reporting activities to which they were paying primary, secondary, and tertiary attention.

RESULTS: Higher proportions of primary attention to TV were positively associated with higher BMI. The difference between 25th and 75th percentiles of attention to TV corresponded to an estimated +2.4 BMI points. Time spent watching television was unrelated to BMI. Neither duration of use nor extent of attention paid to video games or computers was associated with BMI.

CONCLUSIONS: These findings support the notion that attention to TV is a key element of the increased obesity risk associated with TV viewing. Mechanisms may include the influence of TV commercials on preferences for energy-dense, nutritionally questionable foods and/or eating while distracted by TV. Interventions that interrupt these processes may be effective in decreasing obesity among screen media users. *Pediatrics* 2013;131:935–941

Over the past 3 decades, the prevalence of obesity among 12- to 19-year-olds has increased from 5% to 18%,[1] overtaking smoking as the leading avoidable cause of morbidity and mortality in the United States.[2,3] During this same period, children's and adolescents' lifestyles have changed, with dramatic increases in use of television, video games, and computers.[4,5] From 1999 to 2009, the average amount of time US 8- to 18-year-olds spent viewing TV content rose from 3 hours 45 minutes (3:45) to 4:30 a day, with the increase primarily being TV programs viewed on computers and other platforms.[5] Young people's use of interactive media increased at a faster rate, with daily computer use rising from 0:27 to 1:29 and video gaming from 0:26 to 1:13.[5] Young people's continued and increasing heavy use of screen media indicates that recommendations for reducing use largely go unheeded.

Multiple epidemiologic studies have associated duration of TV viewing with risk of overweight and obesity in children and adolescents.[6–13] Other studies have found associations only for certain ethnic or gender categories,[14] associations that disappeared when other variables were considered,[15] or no relationship at all.[16–18] Evidence of a link between computer use or video gaming and obesity risk is more limited.[13,15,18,19] Meta-analysis has shown a small positive significant association between TV screen time and body fatness, but no such association for computer/video games.[20]

Screen media use is neither a homogenous behavior nor purely health-negative, which may contribute to inconsistent research findings. Screen use is a complex experience, characterized by use of different stationary and mobile devices, multitasking with several media and activities simultaneously, and allocation of varying degrees of attention to each competing pursuit. By examining specific characteristics of young people's media use, we can focus on mechanisms that link it with obesity, thereby taking a critical step toward the development of effective interventions targeting changeable behaviors.

Several mechanisms explaining the link between screen media use and obesity have been proposed, including (1) exposure to food advertising increasing consumption of energy-dense, nutritionally questionable foods; (2) distracted eating while using screen media contributing to increased overall caloric intake; and (3) sedentary screen media use displacing strenuous physical activity.[21,22] The effects of TV advertising on food preferences and consumption have been repeatedly demonstrated,[21,23–25] and there is growing evidence that TV and other screen media use can result in distracted eating.[26–29] Despite face validity, screen media displacement of physical activity has little supporting evidence. A national survey found that the amount of strenuous physical activity did not vary between "heavy" and "light" TV viewers.[5] Randomized controlled interventions have demonstrated that reducing total screen time decreases adolescents' weight gain without increasing physical activity.[30,31] Such findings call into question the hypothesis that sedentary media use displaces more active pursuits.

In this study, we seek to understand mechanisms of obesity risk by examining characteristics of young adolescents' screen media use that may be associated with BMI, including the amount of time young people spend using TV, video games, and computers and the extent to which they allocate their primary attention to each.

METHODS

Participants and Recruitment

From January to November 2008, adolescents aged 13 to 15 years were recruited from public schools, after-school programs, and community programs in a small New England city. Data were collected during this same time period with the first participant beginning in mid-January and the final participant ending in mid-December. Parental consent was obtained and verified before each participant's enrollment. All materials and procedures were approved by the Committee on Clinical Investigation at Boston Children's Hospital.

Data Collection

To capture youth media use and exposures in mobile and multiscreen environments, we developed and piloted Measuring Youth Media Exposure (MYME), an intensive data collection methodology that integrates multiple validated media use assessment strategies including recall estimates, time-use diaries (TUDs), and ecological momentary assessment (EMA).[32] MYME collects (1) height/weight measurements and participant-completed health status and media use questionnaires,[33] followed by (2) 1 week of randomly signaled EMA questionnaires, and (3) participant-completed 24-hour TUDs on a random weekday and Saturday.[34]

To test the MYME method's reliability for the pilot, the data collection week was repeated twice with a 1-week interval. TUD reports from the 2 weeks of data collection revealed moderate and significant correlations between reports of week 1 (w1) and week 2 (w2) media use; nonsignificant paired t tests of TV, video game, and computer use indicated that time estimates for using each medium were similar for the 2 weeks. Average weekday use varied little between w1 and w2 for the following media: TV (w1, 2:46; w2, 2:30; $r = .30$, $P < .01$), video game (w1, 0:36; w2, 0:32; $r = .61$, $P < .001$), and computer use (w1, 0:57; w2, 0:52; $r = .22$; $P = .05$).[35] Because MYME produced stable estimates, and to be consistent with

subsequent waves of data collection, we analyzed w1 data unless participants experienced technical problems or had incomplete data. For these 5 participants, w2 data were used.

BMI Assessment

Researchers measured and weighed participants without shoes and coats, entering heights measured with a single standardized Seca stadiometer into a single Detecto 750 scale that calculated participants' weight and BMI (in kg/m^2).

EMA

Participants carried Palm personal digital assistants (PDAs) running CERTAS software (PICS, Reston, VA) that signaled them at random intervals of no less than 30 minutes during their self-identified waking, nonschool hours. Depending on their unique schedules and signal randomization, participants received 4 to 7 signals a day. When signaled, participants completed a 1- to 4-minute (determined by skip patterns) on-screen questionnaire about their current location, companionship, activities, media use, attention, and affective states. If participants did not respond, the PDA would provide up to 2 reminder signals, 5 minutes apart, before closing access to the questionnaire. We evaluated sampling density in a pilot study and found that the 19 participants responded to a high percentage of signals (83%, on average).[34] To eliminate potential bias of participants with low response rates, participants who did not respond to an average of at least 1 signal each day were excluded from the analyses. The final analytic sample responded to an average of slightly >4 signals a day (see Table 1) at a response rate of 66%, within the range of response rates reported in other EMA studies with adolescents (52%–80%).[36,37]

TUD

The TUD format was adapted from one established in previous research that successfully measured young people's activities, including media use.[38,39] At the end of a randomly selected weekday and Saturday of their assessment week, participants documented their activities in 96 fifteen-minute time blocks. For each, participants responded in free text to "What were you doing?" and were instructed to "place an X below each type of media you were using." Columns available included TV, video games, computer, music, and print. Data from pencil-and-paper TUDs were cleaned and entered into an electronic database by using SPSS 19 (IBM SPSS Statistics, IBM Corporation, Armonk, NY). Participants who did not return 2 completed TUDs for their assessment week were excluded from the analytic sample.

Participant Compensation

Over 2 weeks of data collection, participants could be compensated up to $140 on a prepaid bank card if they completed all 4 TUDs, responded to ≥70% of EMA signals, and completed all other components of MYME. The median compensation received by participants was $100. Remuneration rate was chosen to compensate for the burden of this intensive data collection and is comparable to previous EMA studies.[36]

Measures

Duration of Screen Media Use

TUDs were used to calculate durations of participants' TV viewing, video game play, and computer use. The number of 15-minute blocks in which a specific type of media use was reported were totaled and divided by 4, resulting in total hours using each medium over the combined weekday and weekend day.

Duration of Physical Activity

Similarly, TUDs were used to calculate duration of participants' physical

TABLE 1 Characteristics of Participants and Their Media Use (N = 91)

Female gender	45 (49.5%)
Age, y, mean (range)	14.0 (13–15)
Race (%)	
White	62.6
Black	13.2
Other	17.9
Multiracial	6.6
Hispanic	16.5
BMI, mean (range)	23.7 (16.6–43.1)
Weekly number of EMA signals completed, mean (range)	28.9 (7–49)
Mean duration of physical activity in minutes/48 h[a] (SD)	87.5 (123.6)
Mean durations of media use in min/48 h[a] (SD) [lower quartile, upper quartile], number of cases >1.5× IQR	
TV viewing	402.9 (260.4) [210.0, 555.0], 1
Video game play	95.1 (148.2) [0.0, 135.0], 9
Computer use	140.0 (188.0) [0.0, 195.00], 6
Primary attention, mean % EMA reports (SD), [lower quartile, upper quartile]	
TV	25.5 (13.9) [14.3, 33.3]
Video games	6.9 (11.0) [0.0, 10.5]
Computer	9.2 (9.4) [0.0, 6.3]
Secondary/tertiary attention, mean % EMA reports (SD), [lower quartile, upper quartile]	
TV	8.7 (10.7) [0.0, 10.8]
Video games	1.1 (2.4) [0.0, 2.1]
Computer	3.1 (5.6) [0.0, 3.7]

IQR, interquartile range.

[a] Durations are over the 2 (weekday and Saturday) TUD days.

activity. If reported activities were structured sports (eg, football practice, swim meet), unstructured sports (eg, volleyball, basketball with friends), or playing outside, physical activity was documented for that 15-minute block. Blocks identified as physical activity were summed and divided by 4 to calculate duration in hours.

Attention to Media

The extent to which participants paid primary or secondary/tertiary attention to TV, video games, and computers was assessed with EMA. At each signal, participants were asked, "Among the things you were doing when the beeped, what were you paying the MOST attention to?" Response choices included the following: *people*, *reading/homework*, *sports/activities*, *media*, *something else*. An EMA report was considered to indicate primary attention to a specific medium when "media" was chosen in response to this question and a screen medium (eg, video games) was chosen from a list provided in a follow-up question: *computer, video games, phone, music, TV/movies*. Percent of primary attention to a given medium is operationalized as the percentage of a participant's EMA reports in which he or she chose "media" and then "TV/movies," "computer," or "video games" as receiving his or her most attention. Percentages of reports in which the participant reported paying second or third most attention to TV, computers, and video games are considered percent of secondary/tertiary attention to them.

Analysis

For descriptive purposes, means, standard deviations, and quartile cut points were calculated for the overall use of and attention to TV, video games, and computers. Multivariate linear regression was used to estimate independent associations of BMI with duration of use and attention to different types of media. Analyses were performed separately for each screen medium (TV, video games, and computer). Model 1 included the duration of use of each medium adjusted for duration of physical activity, gender, and age. Model 2 added measures of attention to media.

RESULTS

Sample

Of 126 enrolled, 91 (72%) participants (45 girls, mean age 14.0 years) who completed both TUDs and at least 7 EMA reports were included in the analytic sample (Table 1). Excluded participants were not different from retained participants in gender, age, or BMI. The analytic sample had a lower percentage of nonwhite participants (sample, 37.4%; excluded, 57.6%; $\chi^2[1, N = 124] = 4.04$, $P = .04$) and trended toward a lower percentage Hispanic participants (sample, 16.5%; excluded, 31.3%; $\chi^2[1, N = 122] = 3.08$, $P = .08$) than the excluded group.

Duration of Use and Attention to Screen Media

Participants spent the most time viewing TV with an average daily use across weekdays and Saturdays of 3:21 (Table 1). This was followed by computer use (1:10), and, lastly, video gaming (0:48). Computer and video game use was characterized by many participants reporting no use (as indicated by the 0 for the lower quartile) and some reporting heavy amounts of use (as indicated by values $>$1.5 times the interquartile range, see Table 1).

In total, participants completed 2631 EMA reports and responded to an average of 29 signals (range 7–49). On average, participants reported that watching TV was the activity that they were "paying the most attention to" on 25.5% of their reports and the activity they were "paying the second" or "third most attention to" on 8.7% of their reports (see Table 1 for video game and computer values). Correlations between the duration and primary attention were moderate for TV ($r = .39$) and computers ($r = .44$) and larger for video games ($r = .69$). Smaller associations were detected between duration and secondary/tertiary attention (TV, $r = .20$; computers, $r = .18$; video games, $r = .24$).

Screen Media Use and BMI

Results from Model 1 showed no significant association between duration of use of any screen medium and BMI (Table 2). Physical activity was significantly and negatively related to BMI, indicating that the more time young people spent engaging in physical activity, the lower their BMI.

Each of the final regression models (model 2) included measures of participants' primary and secondary/tertiary attention to 1 of the 3 screen media types. As shown in Table 2, the percentage of primary attention paid to TV was significantly and positively associated with BMI. Given the unstandardized regression coefficient of 0.13, the difference between the cut points for the 25th percentile and the 75th percentile of primary attention to TV (14.3% vs 33.3% of reports) corresponds to an average BMI difference of 2.4. Proportion of EMA reports indicating secondary/tertiary attention to TV was unrelated to BMI. No level of attention to video games or computers was associated with BMI.

DISCUSSION

This study investigated associations between characteristics of screen media use (total duration and attention allocated to 3 types of media) and young adolescents' concurrently measured BMI. We found that BMI was higher when a higher percentage of

TABLE 2 Results of Linear Regression Models Predicting BMI by Type of Screen Media Use

	Television						Video Games						Computer					
	Model 1			Model 2			Model 1			Model 2			Model 1			Model 2		
	B	SE	*β*	*B*	SE	*β*	*B*	SE	*β*	B	SE	*β*	*B*	SE	*β*	*B*	SE	*β*
Age	0.18	0.82	0.02	0.53	0.79	0.07	0.05	0.81	0.01	0.05	0.82	0.01	0.14	0.81	0.02	0.17	0.81	0.02
Female gender	1.68	1.17	0.15	1.77	1.12	0.16	1.46	1.18	0.13	1.34	1.25	0.12	1.69	1.16	0.15	1.42	1.21	0.13
Physical activity (h)	−0.59	0.28	−0.22[b]	−0.67	0.28	−0.25[b]	−0.60	0.28	−0.22[b]	−0.60	0.29	−0.23[b]	−0.66	0.29	−0.25[b]	−0.69	0.29	−0.26[b]
Duration (h)[a]	−0.10	0.13	−0.08	−0.26	0.14	−0.20	−0.19	0.23	−0.09	−0.14	0.32	−0.06	−0.24	0.18	−0.14	−0.16	0.21	−0.09
Percent primary attention[a]	–			0.13	0.04	0.32[c]	–			−0.02	0.08	−0.05	–			−0.06	0.07	−0.10
Percent secondary/tertiary attention[a]	–			−0.03	0.05	−0.05	–			0.06	0.25	0.03	–			−0.02	0.11	−0.02
Adjusted R^2		.05			.13			.05			.03			.06			.05	

Model 1 tests the association between the duration of the media use listed in the column and BMI adjusted for the other listed variables. Model 2 adds primary and secondary/tertiary attention to model 1.

[a] Duration and attention variables correspond to use of the single medium type identified with the column header.

[b] $P < .05$.

[c] $P < .01$.

overall sampled moments was spent paying primary attention to TV. We found no evidence that BMI was associated with duration of TV viewing or with attention to or duration of using video games or computers. The difference between high level (75th percentile) of attention to TV and low level (25th percentile) corresponded to an estimated BMI difference of 2.4. For 14-year-olds at the 50th percentiles for weight and height, this BMI difference translates to a difference of 14.2 pounds for boys and 13.5 pounds for girls.

Although we did not directly test mechanisms explaining the link between obesity and media use, our finding of the importance of attention to TV is consistent with advertising effects. For advertisements of energy-dense, nutritionally questionable foods to affect preferences, the viewer must receive the message by paying attention to a medium that delivers this content.[24,25,40–43] Food advertising is especially common during the times young people watch TV.[44] Such messages are rarer in video games and computer content, appearing in product placement, immersive advertising environments, and "advergames."[45,46] Additional research is necessary before conclusive statements can be made about the role that attention to TV plays in advertising's influence on food preference and obesity.

Our findings could also support a mechanism of "unconscious eating" while distracted by TV from physiologic hunger and satiety signals.[26,47] When young people eat while watching TV, they tend to choose energy-dense snack foods, be less aware of the amount they eat, and eat more.[22,27,47,48] Primary attention to TV may be necessary to activate this distraction effect, but research that specifically addresses this hypothesis is necessary. Distracted eating could be less common during use of video games and computers, both of which require physical interaction with the device. Again, additional investigation is needed to establish this premise.

The finding that attention to TV is a key characteristic of media use associated with increased BMI is less supportive of a displacement mechanism in which overall use of sedentary media is expected to replace physical activity. Lack of associations between duration of screen media and BMI cannot disprove displacement and may be attributable to our sample size. This consideration is especially important given that a meta-analysis established a small but significant effect size of TV viewing on body fatness (0.084).[20] Noticeably, in model 2 the relationship between total TV viewing and BMI is negative and approaching significance (P = .08). Although this result is not strong enough to justify firm conclusions (especially considering the unexpected direction of the association), it does suggest that the relationship changes once we consider attention to the medium. Future research should examine characteristics of media use in addition to duration as potential contributors to obesity.

Alternative explanations that consider third variables driving both attention to TV and obesity may also account for our results. For example, lower family income could be associated with both higher BMI and less availability of media devices to distract attention from TV. Children's tendencies to be sedentary may increase their BMIs and make them more likely to engage with TV. Future research that assesses aspects of the child, the family, and viewing environments will help elucidate the forces linking media use and obesity.

Although this study expands our understanding of the characteristics of media use associated with higher BMIs,

it is not without limitations. Our TUD and EMA methods may have underestimated infrequent activities such as secondary/tertiary attention to video games or computers, thereby reducing our ability to detect an association between these behaviors and BMI.[33] Because young people from ethnic minorities use screen media more[49] and are at higher risk for obesity,[1] our small, regional convenience sample limits the generalizability of our findings. However, our estimates of use were similar to those reported for 11- to 14-year-olds in a recent national survey:[5] 4:23 versus 3:57 for TV, 1:40 versus 1:27 for computers, and 1:02 versus 1:44 for video games, respectively. Additionally, the mean BMI of our sample is fairly similar to national estimates for 14-year-olds (23.7 vs 22.3).[50] Our assessment of primary attention to media may be a proxy measure for total use that is less error prone and therefore more likely to be significantly associated with BMI. However, TV duration and primary attention are moderately correlated (0.39), indicating that the 2 measures are related but unique. This correlation is higher for video games as would be expected for an interactive medium that is typically used as a primary activity. Furthermore, because our model adjusts for duration as measured by the diary, the results for primary attention to TV are above and beyond the associations with an established measure of total viewing. Finally, cross-sectional data analysis cannot attach a direction of effect to observed associations.

CONCLUSIONS

Despite dramatic shifts in how young people use media, TV, the only screen medium that consistently delivers food advertising, remains the most used. TV viewing, however, is not a homogeneous behavior, and examining specific characteristics that link viewing to weight status can help us understand what it is about this behavior that makes it a risk factor for obesity. The observed association between attention to TV and BMI supports continued research on the influence of screen media on health, so that we can develop focused interventions that are feasible, palatable, and sustain the health, happiness, and productivity of young people in the Digital Age.

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