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SLEEP AS A MEDIATOR OF SCREEN TIME EFFECTS ON US CHILDREN'S HEALTH OUTCOMES

A prospective study

Natalie D. Barlett, Douglas A. Gentile, Christopher P. Barlett, Joey C. Eisenmann and **David A. Walsh**

There is growing concern regarding the influence of media exposure on American children's health and development. The current prospective study tested the direct relations between media exposure, sleep, and various health outcomes (e.g. attention problems, aggression, and body composition) and the indirect effect of media exposure through sleep disturbances. Child participants (N = 1,317) completed measures of media consumption and sleep. Teachers reported on children's attention problems and use of physical aggression. Results showed that media exposure at Time 1 was indirectly related to attention, physical aggression, and Body Mass Index at Time 3 (13 months later), mediated by sleep at Time 2. Overall, these results support the hypothesis that screen time is negatively related to health outcomes, and that displaced sleep is one of the mediating mechanisms underlying these relations.

KEYWORDS children; longitudinal; media; screen time; sleep

American children's total screen time (including time with television, video games, computers, etc.) has been steadily increasing (Rideout, Foehr, & Roberts, 2010). The average home with children currently has 3.8 television sets, 2 computers, and 2.3 video game consoles, with 71% of youth over 7 having television sets in their bedrooms. Youth spend an average of 7.63 hours with media each day, a significant rise from 5 years ago (Rideout et al., 2010). Once media multitasking is considered, children actually expose themselves to 10.75 hours of media during their 7.63 hours of media use. Screen time has been implicated as a risk factor for several different health-related outcomes, including obesity, attention, aggression, and several other issues. The focus of the current study is to examine the relations between media exposure and multiple health-related outcomes, including aggression, attention, and body mass index (BMI) with a prospective study, specifically testing sleep as a mediator.

Many different types of outcomes are of relevance to children's long-term health and wellness. These range from psychological indicators of maladjustment (e.g. aggression) to physiological indicators of health problems (e.g. children's weight). We argue that it is valuable to consider a breadth of outcomes, rather than just focusing on one, especially if the mechanisms involved may be similar. Thus, we will focus on attention problems, aggression, and BMI as health outcomes for the current study. These were chosen because research has found significant relations between children's media use and attention

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problems (Chan & Rabinowitz, 2006; Christakis, Zimmerman, DiGiuseppe, & McCarty, 2004; Landhuis, Poulton, Welch, & Hancox, 2007; Swing, Gentile, Anderson, & Walsh, 2010), levels of aggression (Anderson, Gentile, & Buckley, 2007; Ostrov, Gentile, & Crick, 2006), and risk of obesity (Laurson et al., 2008; Vandewater, Shim, & Caplovitz, 2004).

Although myriad studies document a link between screen time and health outcomes, the processes and mechanisms underlying these relations have been understudied. Several plausible mediators have been tested, although these mediators are usually specific to one outcome variable. For example, research has found that the relation between violent media exposure and aggression is mediated by increases in aggressive cognitions (Anderson et al., 2007), but it is unlikely that aggressive cognition mediate relations with attention problems or BMI. Although there are several valid domain-specific mechanisms, it is also valuable to consider whether there may be some general mechanisms mediating the relations between screen time and health-related outcomes. We posit that decreases in sleep may be one such general mediating mechanism.

Media Exposure and Health Outcomes: BMI, Attention, Aggression

Body Composition

For the purposes of the current study, body composition is defined using body mass index (BMI). Heelan and Eisenmann (2006) found small, yet significant, positive relations between the amounts of media girls used and their BMI and fat mass as well as between the amount of computer time boys used and their fat mass. Screen time is believed to be related to BMI because media may replace other more physically active activities (the displacement hypothesis; Neuman, 1995). In a screen time intervention study with third- and fourth-grade students, Robinson (1999) found that the children who reduced their screen time had less of an increase in BMI over a 7 month period than the children who did not receive the intervention.

The displacement hypothesis also suggests that screen time can displace time spent sleeping (Neuman, 1995). Sleep is important to children's mental and physical development because sleep aids in synaptic and cognitive development as well as providing energy and weight maintenance (Spiegel, Tasali, Penev, & van Cauter, 2004). Research has shown that media use can disturb sleep (Dworak, Schierl, Bruns, & Struder, 2007) and is related to sleeping fewer hours and feeling more tired throughout the day (Eggermont & van den Bulck, 2006; van den Bulck, 2004). Hofferth (2008) found that "children who spent one more hour per week playing video games or watching television spend 7–10 fewer minutes playing, sleeping, reading, and studying" (p. 128). Assuming this tradeoff is correct, an average child who plays 1 hour of video games a day could sacrifice over an hour of sleep each week.

In the US, reported amounts of sleep have been on the decline at the same time that childhood obesity rates have been on the increase (National Sleep Foundation, 2005). Sleep restrictions over time do predict childhood obesity (Gupta, Mueller, Chan, & Meininger, 2002; Nixon et al., 2008). In their meta-analysis, Cappuccio et al., (2008) found a negative relation between sleep duration and obesity. In a longitudinal study, Landhuis, Poulton, Welch, and Hancox (2008) found that shorter sleep time in childhood (5–11 years) significantly negatively predicted adults' BMI at age 32 even after controlling for variables such as adult sleep time and childhood BMI. This suggests that the lack of sleep children

accumulate can have long lasting consequences, and may be one mediating variable that helps to explain the link between screen time and BMI.

Attention Problems

Children's ability to attend to their environments is important for processing and learning new information. Lack of attention can result in poor academic achievement (Barry, Lyman, & Klinger, 2002) and increased aggression (Mannuzza, Klein, Abikoff, & Moulton, 2004). Research has shown a positive relation between children's screen time and attention problems throughout childhood, including early childhood (Christakis et al., 2004), middle childhood (Swing et al., 2010), and adolescence (Landhuis et al., 2007). Although this is a relatively new field of study, this effect appears robust to the type of experimental design. Indeed, significant effects have been found between media exposure and attention problems using cross-sectional/correlational (Levine & Waite, 2000) and longitudinal (Mistry, Minkovitz, Strobino, & Borzekowski, 2007) designs. Some researchers hypothesize that screen time is related to attention because the fast transitions within the media program make attending to slower paced activities more difficult (Anderson, Levin, & Lorch, 1977). It has also been hypothesized that children who watch many hours of television have a harder time paying attention to less interesting activities (Christakis et al., 2004).

Similar to the research on BMI, lack of sleep has also been found to be related to poorer attention (Epstein, Chillag, & Lavie, 1998; Fallone, Acabo, Arnedt, Seifer, & Carskadon, 2001; Fallone, Acebo, Seifer, & Carskadon, 2005). In a recent study, children with sleeping difficulties scored significantly higher on lack of attention than children with minimal to no sleeping difficulties (Paavonen et al., 2009). Although the literature on children's amount of sleep is typically limited by its correlational nature, Fallone and colleagues (2001, 2005) found that sleep deprivation, for even one night, was related to lower levels of attention using an experimental design. This suggests that sleep may be one mechanism by which screen time can affect attention problems.

Aggression

Physical aggression is defined as behavior intended to harm another (Anderson & Bushman, 2002) and may include hitting, kicking, and biting. Much research has shown that exposure to media (particularly violent media) is positively related to children's use of physical aggression (see Anderson et al., 2003). Several studies have demonstrated a link between screen time and aggressive behavior (e.g. Gentile, Lynch, Linder, & Walsh, 2004; Johnson, Cohen, Smailes, Kasen, & Brook, 2002). Several researchers have noted that it is more important to measure violent media exposure (i.e. media content) than screen time (i.e. amount), and have demonstrated that the link between screen time and aggression is greatly weakened when one includes violent content exposure in the model (e.g. Anderson et al., 2007; Gentile, 2011). Although this argument makes theoretical and empirical sense, it is also possible that screen time may have an effect itself through other mediating mechanisms, such as sleep.

A limited amount of research has investigated the relation between amount of sleep and aggressive behavior. Research with adults has shown that sleep deprivation decreases one's inhibitions to aggress and increases hostility (Kahn-Greene, Lipizzi, Conrad, Kamimori, & Killgore, 2006), which is related to aggressive behavior (see Anderson & Bushman, 2002).

Research using child samples has shown that sleep problems are positively related to externalizing/aggressive behaviors even in children as young as 2 and 3 years (Reid, Hong, & Wade, 2009). Although there is a paucity of research in this area, amount of sleep may be related to physical aggression because a lack of sleep has been found to decrease executive functioning (Heuer, Kohlish, & Klein, 2005).

Conclusion

Sleep disturbances are related to BMI, attention problems, and aggression. Lack of sleep has implications for neural, bodily, and brain functioning. Although the specific causal mechanisms for why sleep is related to these outcomes are beyond the scope of this research, we are interested in testing whether sleep is a mediator in the relation between media exposure and health outcomes.

Although a great deal of research has investigated relations between children's media use and health outcomes, little research has studied children's media use and multiple health outcomes (i.e. BMI, attention, and use of physical aggression) simultaneously as well as prospectively. There is also a need for research investigating the mediating variables that may explain the mechanisms underlying these relations. The current study tested how screen time relates to these aforementioned variables using prospective mediated path models. It was predicted that children's screen time (i.e. watching TV, playing video games, and online time) at Wave 1 would predict health outcome variables 13 months later (Wave 3). Also, we predicted that these relations will be mediated by amount of sleep 7 months later (Wave 2). Specifically, it was hypothesized that children's screen time at Wave 1 would be negatively related to amount of sleep and would be positively related to children's attention problems, use of physical aggression, and BMI at Wave 3 with amount of sleep mediating these relations. Amount of sleep at Wave 1 was also expected to be negatively related to attention problems, BMI, and physical aggression at Wave 3.

Method

Participants

Children were recruited from four public elementary schools in Lakeville, MN (population approximately 50,000) and six public elementary schools in Cedar Rapids, IA (population approximately 125,000). Both communities were involved in a community-, school-, and family-based intervention for the prevention of childhood obesity. Prior to participation, parents provided active written consent, and children provided assent.

A sample of 1,323 third ($n = 430$), fourth ($n = 446$), and fifth ($n = 423$) grade children returned consent forms, yielding a 65% participation rate. Forty-seven percent of participants were male (618 male, 704 female, 1 unknown) and most of the children (90%) were White, which is representative of the communities from which they were sampled. The average age of the students was 9.6 years ($SD = 0.9$, median $= 9.6$, range 6–12 years of age). Data were collected at three points in time, once as a baseline at the beginning (October) of a school year, again 7 months later at the end of the school year (May), and 6 months later during the next school year (November). Out of 1,323 consenting families, 1,288 children (97%) provided data. Of those, 1,196 (93%) provided data at baseline, 1,156 (90%) at Time 2, and 1,110 (86%) children at Time 3. Data were provided by 1,076 children

(84%) at both baseline and at Time 2, 1,029 (80%) at both baseline and Time 3, and 992 (77%) at all three time points. Data were also gathered from parents (which are not reported here) and from the children's teachers. The study was approved by the University of Minnesota Institutional Review Board in accordance with the Declaration of Helsinki and the American Psychological Association's "Ethical Principles of Psychologists and Code of Conduct."

Materials

Demographics. A demographic questionnaire was used to assess school grade when the study began, parental education level, sex, age, parental income, and other relevant demographic variables.

Anthropometry. Standing height and body mass were measured by school nurses according to standard procedures (Malina, 1995). Standing height was measured using a portable stadiometer (Seca Road Rod). Body mass was measured using a strain gauge scale (Lifesource MD). The BMI (kg/m^2) was calculated from standing height and body mass. Overweight and obesity were determined based on age- and sex-specific reference values developed by the Centers for Disease Control (CDC) (Kuczmarski et al., 2002). Prior to data collection, the nurses were trained by the research team and intra- and interobserver measurement error was determined at the completion of the training. In addition, measurement error was also determined during data collection for this study by duplicate measures of every twenty-fifth subject. Overall, measurement error was small (SEM = 0.3 cm standing height; 0.1 kg body mass).

Screen time. Children reported the number of hours they watched TV, played video games, and spent time on the computer. For example, children were asked to report how much time they watch TV between waking up and lunch, between lunch and dinner, and between dinner and when they go to bed. Separate questions were included for weekdays and weekends and a weekly amount was calculated by multiplying the weekday totals by 5 (days) and adding it to the weekend totals multiplied by 2. Total screen time values were generated by summing the weekly totals for TV, video games, and computer time. This approach has been used reliably with children in other studies (Anderson et al., 2007; Gentile et al., 2004).

Sleep time. Children reported what time they usually go to sleep on weeknights and weekend nights separately, and what time they usually wake up on weekdays and weekend days. From these, the amount of sleep was calculated by multiplying the weekday totals by 5 (days) and adding it to the weekend totals multiplied by 2. This summation was divided by 7 to indicate average daily sleep.

Attention problems. Attention problems were assessed by teacher report. Teachers responded to three items that measured attention problems in the classroom on a 5-point scale, with responses ranging from "never true" to "almost always true" ("This child: has difficulty staying on task; has difficulty paying attention; often interrupts other children's work"). These items showed good internal reliability ($\alpha = .91$ at Time 1 and .92 at Time 3; Swing et al., 2010).

Teacher ratings of social adjustment. Teachers completed a survey assessing children's social behaviors, including physical aggression (Anderson et al., 2007). Teachers responded to four items that measured aggression on a 5-point scale, with responses ranging from "never true" to "almost always true" ("This child: hits or kicks peers; initiates or gets into fights with peers; pushes or shoves peers; threatens to hit or beat up other children"). Coefficient alpha was satisfactory at Waves 1 and 3: $\alpha s > .88$.

Results

Data Analysis Strategy

Path analysis was used to test the main hypotheses of the current study. Our model predicted that Wave 1 screen time would predict Wave 1 sleep, Wave 2 sleep, and Wave 2 screen time. Wave 1 sleep predicted Wave 2 sleep and Wave 2 screen time. Wave 2 screen time predicted Wave 2 sleep and the three Wave 3 outcomes (attention problems, physical aggression, and BMI). Wave 2 sleep also predicted all Wave 3 outcomes. Wave 3 outcome variables were predicted by their Wave 1 counterpart (see Figure 1). Finally, we correlated all Wave 3 outcome variables, all Wave 1 covariates, and the error terms for certain observed variables based on modification indices.

Path Model Findings[1]

Results showed that the model fit the data well, $\chi^2 = 64.71$, $df = 15$, $p < .001$, CFI = .99, TLI = .97, RMSEA = .050 (90% CI: .038 to .063), SRMR = .028. Examination of the path coefficients revealed that Wave 1 screen time significantly predicted Wave 1 sleep, $\beta = -.26$, $p < .001$, and Wave 2 screen time, $\beta = .52$, $p < .001$. Wave 1 sleep predicted Wave 2 sleep, $\beta = .39$, $p < .001$, and Wave 2 screen time, $\beta = -.08$, $p < .01$. Wave 2 sleep predicted Wave 3 BMI, $\beta = -.03$, $p < .03$, attention problems, $\beta = -.08$, $p < .01$, and physical aggression, $\beta = -.09$, $p < .01$. Naturally, all outcome variables were significantly predicted by their Wave 1 counterparts (all $\beta s > .33$, all $ps < .001$). See Table 1 for the zero-order correlation matrix and Figure 2 for the significant paths in the model.

In order to test the effect of Wave 2 sleep on Wave 3 outcomes while controlling for several relevant covariates, sex, socioeconomic status (SES), parental education level, and

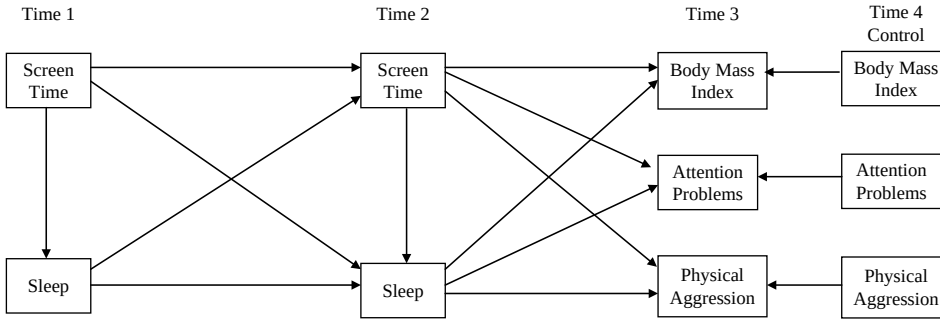

FIGURE 1
Hypothesized longitudinal mediation model

TABLE 1
Correlations between variables in path model

	1	2	3	4	5	6	7	8	9	10
1	—									
2	−.26**	—								
3	.54**	−.21**	—							
4	−.19**	.43**	−.25**	—						
5	.19**	−.16**	.21**	−.15**	—					
6	.13**	−.12**	.15**	−.15**	.39**	—				
7	.18**	−.16**	.17**	−.20**	.06	.14**	—			
8	.22**	−.14**	.26**	−.09*	.55**	.28**	.10**	—		
9	.22**	−.17**	.25**	−.14**	.32**	.38**	.17**	.43**	—	
10	.16**	−.17**	.15**	−.18**	.04	.13**	.94**	.06	.15**	—
Mean	35.65	10.06	35.99	9.86	2.00	1.16	19.24	2.10	1.23	18.42
Var.	936.26	1.10	856.65	0.92	1.20	0.33	14.63	1.24	0.19	11.71

1 = Wave 1 screen Wave, 2 = Wave 1 sleep, 3 = Wave 2 screen Wave, 4 = Wave 2 sleep, 5 = Wave 3 attention problems, 6 = Wave 3 physical aggression, 7 = Wave 3 BMI, 8 = Wave 1 attention problems, 9 = Wave 1 physical aggression, 10 = Wave 1 BMI. $^{**}p < .01$, $^{*}p < .05$.

school grade were entered into the model by having them predict all observed variables. Results showed that the relations between Wave 2 sleep and all Wave 3 outcomes remained significant (all βs $< -.03$, all *ps* $< .04$) even while controlling for all these covariates.

Mediated Pathways

These results suggest that early screen time predicted later sleep problems, which predicted later BMI, attention problems, and physical aggression. The pattern of results described earlier suggests several possible mediated pathways to predict Wave 3 outcomes.

The first mediated pathway had Wave 1 screen time predict Wave 1 sleep, which predicted Wave 2 sleep, and then subsequent Wave 3 outcomes. Results showed that this

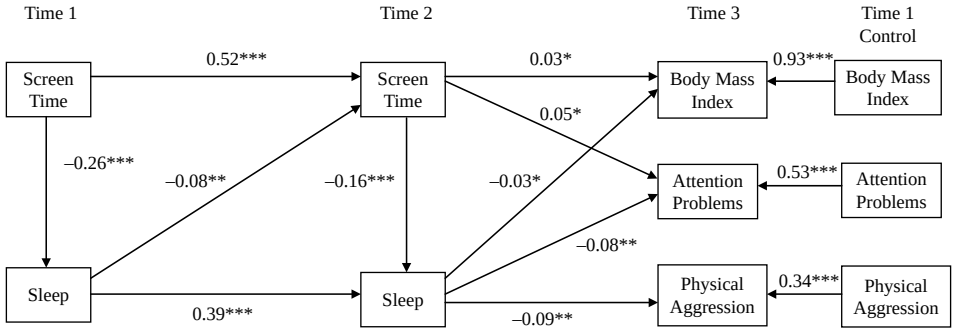

FIGURE 2
Findings from the longitudinal mediation model. $^{***}p < .001$, $^{**}p < .01$, $^{*}p < .05$. Only significant paths are depicted. For the purposes of readability, correlated error terms are not depicted

mediated pathway significantly predicted BMI ($p < .03$), attention ($p < .01$), and physical aggression ($p < .01$). Thus, part of the reason why early media exposure was related to the outcome variables was because of the significant negative relation between media exposure and sleep. When all four covariates (grade, sex, parental education, SES) were entered into the model, the indirect effect for attention and physical aggression remained significant; however, the indirect effect for BMI became nonsignificant.

The second mediated pathway had early screen time predict Wave 2 screen time, which predicted Wave 2 sleep and then later negative outcomes. Results showed that this pathway was significant for BMI ($p < .04$), attention problems ($p < .02$), and physical aggression ($p < .02$). Consistent with the previous mediation test, these results suggest that one possible reason why early media consumption is related to the outcome variables 13 months later is partly due to the negative relation between media consumption and sleep. When all four covariates were entered into the model (grade, sex, parental education, and SES), only the indirect effect for physical aggression remained significant. The indirect effect for attention and BMI became marginally significant ($ps < .07$).

Discussion

The purpose of the current study was to understand how early media exposure was related to attention problems, physical aggression, and BMI 13 months later. Research has shown that several different mediators may explain the direct relations between media exposure and these health outcomes. This makes theoretical sense because attention, aggression, and BMI are very different constructs, despite being conceptualizable broadly as health outcomes. We argue that there may be general mediating mechanisms at work in addition to specific mechanisms. Thus, the current study tested the mediating role of the amount of sleep in the relation between early media exposure and the aforementioned health outcomes. Overall, the tested path model in the current study involves many direct and indirect predictions. For ease of understanding, the direct and indirect relations will be discussed separately.

Prior to testing mediation, evidence for the direct effect of media exposure (the IV) on sleep (the mediator) and the measured health outcomes (the DVs) were tested. Results showed that children's Wave 1 total screen time (amount of time spent watching TV, playing video games, and being online) was negatively related to children's amount of sleep (at Waves 1 and 2). Interestingly, results from the path analysis showed that Wave 1 media exposure was *directly* unrelated to these health outcomes longitudinally. Although this does not support past research, this is evidence for a mediated effect (e.g. Baron & Kenny, 1986). Examination of the zero order correlations presented in Table 1 showed that the relations between Wave 1 screen time and Wave 3 health outcomes were sizable and significant (all $rs > .14$, all $ps < .05$). Thus, we argue that media exposure at Wave 1 is, indeed, related to Wave 3 health outcomes, but when the mediators are taken into account, that direct effect goes away, as predicted.

Second, results showed that Wave 1 media exposure negatively predicted sleep at the concurrent time and longitudinally. This suggests that as screen time increases, sleep decreases simultaneously and over time. This is important because it demonstrates the first link in testing the indirect effect of sleep in between media exposure and health outcomes longitudinally.

The second aim of the study was to test the indirect relation between Wave 1 screen time and negative health outcomes 13 months later. Inspection of our predicted path

model in Figure 1 shows that we predicted that Wave 2 sleep would mediate the relations between Wave 1 screen time and Wave 3 health outcomes. Results from our indirect model analyses showed two primary indirect pathways. The first predicted that Wave 1 screen time negatively predicted Wave 1 sleep, which in turn predicted Wave 2 sleep. Wave 2 sleep predicted Wave 3 health outcomes. This indirect pathway was significant for attention problems, physical aggression, and BMI. This suggests that one plausible reason why early media use is related to later attention problems, physical aggression, and BMI is partially due to a lack of sleep.

The second mediated pathway had Wave 1 screen time predict Wave 2 screen time, which in turn predicted amount of sleep at Wave 2, which negatively predicted Wave 3 health outcomes. Consistent with the previous indirect path analysis, results showed that this indirect effect was significant for attention problems, physical aggression, and BMI. This provides further evidence for the importance of early sleep for later health outcomes, and if sleep is reduced because screen time is increased, that could be detrimental to later health outcomes.

Overall, these indirect findings suggest that independent of the exact mediating pathway from Wave 1 screen time to Wave 3 health outcomes, sleep time is important. Results from the indirect tests showed that sleep time was the precursor to later health outcomes. However, caution must be used in generalizing these findings because when certain covariates (i.e. gender, sex, parental education, and SES) were added to the analyses, a few of the indirect effects became nonsignificant. This was the case for BMI in both mediated pathways and for attention in the second mediated pathway. Future research should examine the role that these covariates play in the relations between media exposure and sleep and media exposure and BMI and attention.

Our findings suggest that Wave 1 sleep is negatively related to Wave 3 health outcomes. The amount of sleep children initially reported getting significantly predicted health outcomes 13 months later. Although previous research has shown that amount of sleep is negatively related to attention problems (Epstein et al., 1998; Fallone et al., 2001, 2005), use of physical aggression (Kahn-Greene et al., 2006; Reid et al., 2009), and BMI (Gupta et al., 2002; Nixon et al., 2008) at single time points, the current study extended this literature by finding that the amount of sleep was still related to these outcomes over a year later. Although the impact of amount of sleep on children's health is already of concern for most parents, this study showed that early lack of sleep may influence health-related variables in multiple domains. For instance, sleep may negatively influence children's school performance (e.g. due partially to potential increases in attention problems), social relations (e.g. more aggressive), and health (e.g. higher BMI).

These findings can be partially explained using the displacement hypothesis (Neuman, 1995). Recall that this hypothesis predicts that when children use media, it replaces time given to other activities (e.g. studying, free play, sports, etc). The results from the current study support this hypothesis by showing that screen time was negatively related to later sleep. In other words, as screen time increases sleep time decreases, suggesting that the amount of sleep is displaced by extended screen time.

However, the displacement hypothesis can only explain the direct relations between screen time and the sleep amount. Other theoretical underpinnings may explain why lack of sleep is related to more attention problems and physically aggressive behavior and higher BMI. Although we did not test other theories to explain such relations, myriad reasons may explain why sleep is related to these health outcomes. For example, lack of

sleep is negatively related to executive functioning (Heuer et al., 2005), which in turn is related to the likelihood of aggressive behavior (Giancola, Roth, & Parrott, 2006). Although this is just one example, other theoretical reasons may explain the relations between sleep and health outcomes, and that is an area for future work.

Although the current findings add to the existing literature, this study is not without limitations. Due to the correlational nature of the data, direct causal directions cannot be determined (although the results are consistent with causal predictions). Although we tried to estimate causality by using longitudinal data and following temporal precedence for mediation (Baron & Kenny, 1986), the data are still correlational. Future research that is able to manipulate the amount of media used by children and/or the amount of sleep children get will be better able to make casual statements regarding how amount of sleep mediates the relation between screen time and health outcomes.

Second, the amount of sleep was the mediating variable examined in the current study; however, other variables may mediate the relations between media use and the examined health outcomes and between sleep and health outcomes. Although elaborated on previously, we believe that future work should test for several potential mediating variables and conduct multiple mediation tests to determine the relative strength of all possible mediating variables. Naturally, the indirect relations between screen time and health outcomes are likely complex, we believe that our study is an important step in testing just one important mediator and future work should examine others to see if the results are similar.

Third, although media use is highly prevalent at the ages examined (i.e. third, fourth, and fifth graders), the findings may not generalize to children of different ages or adults. Future research should attempt to continue to follow younger children into adulthood to determine if the direct and indirect relations between screen time and myriad health outcomes (that are age-appropriate) are consistent. However, given the direction and magnitude of the correlations in the current study, we predict that the findings of the current study will be replicated throughout the lifespan. For example, Pagani, Fitzpatrick, Barnett, and Dubow (2010) found that amount of television exposure at 2 years of age was related to negative health, academic, and psychosocial outcomes 8 years later.

With children, on average, spending more time using the media than they do attending school in a week, it is important to understand the influences that media exposure may have on youth and the direct *and* indirect consequences that exist for devoting a large amount of time to media use. The current study helps to better understand the long-term direct and indirect relations that exist between media use, amount of sleep, and various health outcomes including attention problems, aggression, and BMI.

NOTE

1. One possible limitation in these analyses is the possibility of making a Type 1 error due to the number of comparisons without changing the alpha level of significance ($\alpha = .05$). According to the calculations of Stavig (1981), the probability of making at least one Type 1 error in the model in Figure 2 is high (96%). This suggests that at least one of the significant paths in Figure 2 may, in reality, be significant because it is capitalizing on chance. However, this issue is less problematic for the conclusions of the study for two reasons. First, the p-value for the relation between Wave 2 sleep and Wave 3 attention problems and Wave 3 physical aggression was less than .004, reducing the likelihood of a Type 1 error for these relations. The significant p-value ($p = .022$) for the relation between Wave 2 sleep and Wave 3 BMI is

more likely to be due to chance. One limitation with this argument is that when more control variables are added (e.g., Wave 1 attention problems, Wave 1 physical aggression, and Wave 1 BMI), that adds more paths to the model, which adds more comparisons, thereby increasing the likelihood of a Type 1 error being made somewhere in the model. Thus, we ran another model that decreases the likelihood of a Type 1 error by reducing the number of paths in the model by only including the paths that were essential to test the hypotheses of the current study. Specifically, this model had Wave 1 screen Wave predict Wave 2 sleep. Wave 2 sleep predicted Wave 3 BMI, physical aggression, and attention. All Wave 3 outcomes were correlated as were other error terms based on modification indices. The expected and observed variance-covariance matrix of this new model were identical, as the model was a perfect fit for the data, $X^2 = 0.00$ (df = 0). Because only four paths were estimated, the likelihood of making at least one Type 1 error was low (0%; Stavig, 1981). All of the relations in the model were significant (all βs $< -.11$, all ps $< .01$), as was the indirect relation between Wave 1 screen Wave and Wave 3 attention problems ($p < .01$), physical aggression ($p < .01$), and BMI ($p < .01$) through Wave 2 sleep. In sum, although the likelihood of making at least one Type 1 error in the model in Figure 2 is high, the reduced model with less estimated parameters is similar to the full model, and the p-values for the primary regression coefficients in the model in Figure 2 are low

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