Media Use and Sleep Among Boys With Autism Spectrum Disorder, ADHD, or Typical Development

AUTHORS: Christopher R. Engelhardt, PhD,[a,b] Micah O. Mazurek, PhD,[a,b] and Kristin Sohl, MD[b,c]

[a]Department of Health Psychology, [b]Thompson Center for Autism and Neurodevelopmental Disorders, and [c]Department of Child Health, University of Missouri-Columbia, Columbia, Missouri

KEY WORDS

media, sleep, bedroom access, television, video game, autism, autism spectrum disorder, attention-deficit/hyperactivity disorder, ADHD

ABBREVIATIONS

ADHD—attention-deficit/hyperactivity disorder
ASD—autism spectrum disorder
GLM—general linear model
SCQ—Social Communication Questionnaire
TD—typical development/typically developing

Dr Engelhardt conducted the initial analyses and drafted the initial manuscript; Dr Mazurek conceptualized and designed the study, coordinated and supervised data collection, contributed to the analysis plan, and reviewed and revised the manuscript; Dr Sohl collaborated with Dr Mazurek in the conceptualization of the study, assisted with recruitment, and critically reviewed the manuscript; and all authors approved the final manuscript as submitted.

www.pediatrics.org/cgi/doi/10.1542/peds.2013-2066

doi:10.1542/peds.2013-2066

Accepted for publication Aug 29, 2013

Address correspondence to Christopher R. Engelhardt, PhD, Department of Health Psychology, 205 Portland St, Columbia, MO 65211. E-mail: engelhardtc@health.missouri.edu

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

Copyright © 2013 by the American Academy of Pediatrics

FINANCIAL DISCLOSURE: The authors have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: All phases of this study were supported by a grant from the University of Missouri research board.

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

WHAT'S KNOWN ON THIS SUBJECT: Children with autism spectrum disorders (ASD) or attention-deficit/hyperactivity disorder (ADHD) are at increased risk for sleep disturbances and excessive media use. However, the relationship between media use and sleep in children with ASD or ADHD has not been studied.

WHAT THIS STUDY ADDS: In-room access to screen-based media and video game hours were associated with less sleep among boys with ASD. The relationships between media use and sleep were much more pronounced among boys with ASD than among boys with ADHD or typical development.

abstract

FREE

OBJECTIVE: The current study examined the relationships between media use (television, computer, and video games) and sleep among boys with autism spectrum disorder (ASD) compared with those with attention-deficit/hyperactivity disorder (ADHD) or with typical development (TD).

METHODS: Participants included parents of boys with ASD (n = 49), ADHD (n = 38), or TD (n = 41) (ages 8–17 years). Questionnaires assessed daily hours of media use, bedroom access to media, and average sleep hours per night.

RESULTS: Bedroom media access was associated with less time spent sleeping per night, irrespective of diagnostic group. Bedroom access to a television or a computer was more strongly associated with reduced sleep among boys with ASD compared with boys with ADHD or TD. Multivariate models showed that, in addition to bedroom access, the amount of time spent playing video games was uniquely associated with less sleep among boys with ASD. In the ASD group only, the relationship between bedroom access to video games and reduced sleep was mediated by hours of video game play.

CONCLUSIONS: The current results suggest that media-related variables may be an important consideration in understanding sleep disturbances in children with ASD. Further research is needed to better characterize the processes by which media use may affect sleep among individuals with ASD. Overall, the current findings suggest that screen-based media time and bedroom media access should be routinely assessed and may be important intervention targets when addressing sleep problems in children with ASD. *Pediatrics* 2013;132:1081–1089

Downloaded from http://pediatrics.aappublications.org/ by guest on December 15, 2017

Children with neurodevelopmental disorders are at increased risk for a variety of sleep-related disturbances.[1] Sleep problems are common among children with autism spectrum disorders (ASDs), with prevalence rates ranging from 50% to 80%,[2–5] and include high rates of delayed sleep onset and night waking.[6,7] Children with attention-deficit/hyperactivity disorder (ADHD) also experience difficulties with sleep, including bedtime resistance and increased difficulty falling asleep.[8] Sleep problems are more common among children with ASD or ADHD than among typically developing (TD) children[9–11] and can have detrimental effects on daytime functioning for both children and their families.[12–14]

The etiologies of sleep problems in individuals with ASD or ADHD are multifaceted, including, for example, disruptions in circadian rhythms and melatonin regulation.[7,8]

Because these biological processes are primarily influenced by the light/dark cycle,[15] children with ASD or ADHD may be particularly susceptible to sleep-related environmental factors that emit bright light, such as computer or television screens.[16]

Screen-based media use is one well-established environmental correlate of sleep problems in TD children.[16] Indeed, in-room access to a TV, computer, or electronic games has been shown to be associated with less total sleep in previous studies.[17–20] Similarly, children who spend more time using these media sleep less,[17,21–23] leading some researchers to speculate that bedroom access to screen-based media may have an indirect effect on sleep.[16] However, to the best of our knowledge, no study has specifically tested this indirect effect hypothesis, nor has any study examined how media use relates to sleep among individuals with ASD or ADHD.

Screen-based media use may be a particularly important variable to consider as it relates to sleep in children with ASD and ADHD. Compared with TD children, children with ASD or ADHD spend more time playing video games and watching TV,[24–27] exhibit higher rates of problematic game use,[28–30] and have more difficulty disengaging from screen-based media.[31] This increased use and preoccupation with screen-based media, coupled with the potential influence of bright screens on melatonin production and circadian rhythms, might place individuals with ASD or ADHD at greater risk for media-related sleep problems than TD children.

The purpose of the current study was to examine the relationships between bedroom media access, average media exposure, and average time spent sleeping. The first hypothesis was that bedroom access (and average exposure) to screen-based media would be associated with less time spent sleeping. Consistent with research indicating that individuals with ASD and ADHD are at increased risk for sleep problems and problems disengaging from screen-based media, our second hypothesis was that the relationships between media use and sleep would be more pronounced in the ASD and ADHD groups (relative to the TD group). Finally, consistent with research on media use and sleep in the general population,[16] we specifically tested the hypothesis that in-room access to screen-based media would have an indirect effect on total sleep time through average media hours.

METHODS

Participants

Parents of boys with ASD, ADHD, or TD were recruited for participation in a study on screen-based media use. Data from boys taking melatonin (n = 14) were removed before analyses. Thus, the final sample consisted of 128 boys (ASD = 49, ADHD = 38, TD = 41) ranging in age from 8 to 17 years (mean $\pm$ SD: 11.8 $\pm$ 2.5 years). The majority of the boys were white (85%). Most participants earned more than $41 000 per year (63%) and were currently married (71%). Some participants also indicated that their child was taking medications associated with insomnia (18%; eg, stimulants) or drowsiness (28%; eg, α_1 agonists) (see Table 1 for demographic characteristics by group).

Boys in the ASD group all had a previous diagnosis of ASD, including autistic disorder (42.9%), Asperger's disorder (26.5%), or pervasive developmental disorder not otherwise specified (30.6%). They were recruited through an academic medical center specializing in the treatment and diagnosis of individuals with ASD. The standard diagnostic process includes evaluation by a physician and/or a psychologist and standardized diagnostic tools, such as the Autism Diagnostic Observation Schedule[32] and/or Autism Diagnostic Interview–Revised.[33] Three boys with ASD had an IQ of $\leq$70, and only 2 were reported by parents to have no current use of phrase speech.

Boys with ADHD all had a previous diagnosis of ADHD and were recruited through a behavioral and developmental pediatrics clinic at an academic medical center.

Boys in the TD group were recruited by word of mouth and with the use of flyers placed in community locations and in local general pediatric offices. They had no previous diagnosis of ASD, ADHD, or other developmental disorder (as reported by their parents); were not taking medications for developmental or behavioral problems; and did not score above clinical cutoffs on the diagnostic screening measures described below.

Measures

Demographic and History Form

Parents provided information about their child's age, race, number of siblings, parent marital status, household

Downloaded from http://pediatrics.aappublications.org/ by guest on December 15, 2017

TABLE 1 Demographic Information by Group

	ASD	ADHD	TD	*P*
Age, y	11.8 ± 2.7	11.3 ± 2.5	12.2 ± 2.4	.32
Number of siblings	2.2 ± 1.5	1.9 ± 1.2	1.9 ± 1.3	.47
SCQ score	13.5 ± 5.9[a]	7.1 ± 4.8[b]	4.4 ± 2.5[c]	<.0001
ADHD Total score	27.0 ± 11.5[a]	29.2 ± 11.6[a]	7.5 ± 5.9[b]	<.0001
Average sleep hours per night	8.3 ± 1.3	8.3 ± 0.9	8.6 ± 0.8	.40
Average TV hours per day	2.3 ± 1.3[a]	1.8 ± 0.9[ab]	1.7 ± 0.9[b]	.03
Average video game hours per day	2.1 ± 1.3[a]	1.8 ± 1.1[ab]	1.2 ± 0.9[b]	.004
Race, %				.12
African American	6.1	5.3	0.0	
Asian American	0.0	0.0	4.9	
White	79.6	86.8	92.7	
Native American	6.1	0.0	0.0	
Other	8.2	7.9	2.4	
Medications associated with insomnia, %				<.0001
Yes	12.2	44.7	0.0	
No	87.8	55.3	100.0	
Medications associated with drowsinesss, %				<.001
Yes	32.6	44.7	7.3	
No	67.4	55.3	92.7	
Total family income, %				<.0001
<$10 000	15.1	7.0	2.4	
$10 000–$20 000	7.6	18.6	0.0	
$21 000–$30 000	11.3	25.6	0.0	
$31 000–$40 000	7.6	16.3	0.0	
$41 000–$80 000	32.1	20.9	17.1	
>$80 000	26.4	11.6	80.5	
Parental marital status, %				.003
Married	55.4	61.4	90.2	
Separated	1.8	2.3	0	
Divorced	30.4	11.4	7.3	
Never married	12.5	25	2.4	

Data are presented as means ± SDs or percentages. Group comparisons including continuous outcome measures were analyzed with analysis of variance; the analysis examining average sleep hours per night controlled for marital status, income, use of medications associated with insomnia or drowsiness, and age. Rows with different superscript letters denote significant group differences ($P < .05$) by using Tukey's adjustment. Group comparisons including categorical outcome measures were analyzed with χ^2 tests. Fisher's exact *P* values are given for analyses involving race, marital status, and total family income. ADHD Total score, ADHD Total scale score from the Vanderbilt Attention-Deficit/Hyperactivity Disorder Parent Rating Scale.

income, current medications, and diagnostic information.

Current ASD Symptoms

Current ASD symptoms (past 3 months) were measured by using the Social Communication Questionnaire (SCQ).[34] Parents respond to 40 "yes" or "no" items, yielding a composite score ranging from 0 to 39. The SCQ has adequate reliability,[35,36] as was the case here (Cronbach's α ranged from 0.62 to 0.81 across groups).

ADHD Symptoms

ADHD symptoms were measured by using the 18-item ADHD Total score from the Vanderbilt Attention-Deficit/Hyperactivity Disorder Parent Rating Scale.[37] Parents responded to items by using a scale ranging from 0 (never) to 3 (very often). The Vanderbilt Attention-Deficit/Hyperactivity Disorder Parent Rating Scale has shown adequate reliability in previous research,[38] as was the case here (Cronbach's α ranged from 0.87 to 0.93 across groups), and has been used in previous research examining ASD samples.[39]

In-Room Access to Screen-Based Media

Parents responded to 3 separate questions indicating whether their child had in-room access to a (1) TV, (2) computer, or (3) video game system.

Average Hours Spent Watching TV and Playing Video Games per Day

Parents indicated the number of hours per average weekday and per average weekend day their child spent watching TV and playing video games (on a computer or dedicated game system). The average number of hours per day (for each activity) was calculated by multiplying the weekend and weekday responses by 2 and 5, respectively, and then dividing the sum of this total by 7, consistent with previous research.[26,30]

Sleep Hours

Parents were asked "How many hours does your child sleep per night?"

Analytic Approach

To test our first hypothesis, the bivariate associations between in-room media access and sleep, and the associations between daily hours of media and sleep, were analyzed separately. Our second hypothesis that the relationship between these variables differed as a function of diagnostic group was tested by using general linear models (GLMs). Sleep hours served as the dependent variable; diagnostic group, media variable, and group × media variable interaction terms served as independent variables. All GLMs controlled for the following variables (which will not be mentioned further): marital status, income, use of medications associated with insomnia or drowsiness, and age. Our hypothesis that the association between in-room access to screen-based media and time spent sleeping would be mediated by the daily hours spent with that particular media was tested by using 2 linear equations.[40] Mediation analyses were conducted for average TV and video game hours separately by group.

Downloaded from http://pediatrics.aappublications.org/ by guest on December 15, 2017

RESULTS

Only boys with complete data on the variables included in a specific analysis were retained for that analysis. As a result, different degrees of freedom were observed across the models reported below. Table 2 shows the zero-order relationships between all continuous variables. All reported means depict least square estimates.

Sample Characteristics

Groups differed on parental marital status, total family income, and use of medications associated with insomnia or drowsiness and on SCQ and ADHD Total scores but did not differ on age, number of siblings, or race (see Table 1 for sample characteristics by group). The ASD group had higher SCQ scores than both the ADHD and TD groups (Cohen's *d*s = 1.2 and 2.0, respectively); the ADHD group had higher SCQ scores than the TD group (d = 0.71). The ASD and ADHD groups had higher ADHD Total scores than the TD group (*d*s = 2.1 and 2.4, respectively); the ASD and ADHD groups did not differ on ADHD Total scores.

A GLM showed that the average number of hours spent sleeping per night did not differ between the ASD, ADHD, or TD groups. The ASD group spent more time watching TV and playing video games per day than the TD group (*d*s = 0.54 and 0.80, respectively); the ADHD group did not differ from the ASD or TD group on these measures.

Hypothesis 1: Media Use and Sleep

Boys with an in-room TV spent less time sleeping per night (mean ± SD: 8.3 ± 1.1 hours) than boys without an in-room TV (mean ± SD: 9.0 ± 0.9 hours; $F[1,121] = 16.9$, $P < .001$, d = 0.70). However, the average amount of time spent watching TV per day was unrelated to the number of hours spent sleeping per night ($r = -0.14$, $P = .12$). Boys with an in-room computer spent less time sleeping per night (mean ± SD: 7.9 ± 1.2 hours) than boys without an in-room computer (mean ± SD: 8.7 ± 1.0 hours; $F[1,121] = 9.9$, $P = .002$, d = 0.72), and boys with an in-room video game system slept fewer hours per night (mean ± SD: 8.3 ± 1.1 hours) than boys without an in-room system (mean ± SD: 8.8 ± 1.0 hours; $F[1,121] = 7.2$, $P < .01$, d = 0.48). Additionally, the amount of time spent playing video games per day was negatively associated with the number of hours spent sleeping per night ($r = -0.50$, $P < .0001$).

Hypothesis 2: Group Differences in the Relations Between Media Use and Sleep

The relationship between having an in-room TV and sleep was moderated by group ($F[2,112] = 3.8$, $P = .03$) (see Fig 1). Post-hoc mean comparisons using Tukey's adjustment showed that the association between having an in-room TV and sleep was pronounced among the ASD group ($t = 4.2$, $P < .001$, d = 0.78), but not among the ADHD group ($t = 0.55$, $P = .99$) or the TD group ($t = 0.35$, $P = 1.0$). Group diagnosis did not moderate the relationship between the average amount of time spent watching TV per day and time spent sleeping ($F[2,109] = 0.93$, $P = .40$). The relationship between having an in-room computer and sleep also was moderated by group ($F[2,112] = 5.2$, $P < .01$) (see Fig 2). Post hoc mean comparisons using Tukey's adjustment suggests that the association between an in-room computer and sleep was large in the ASD group ($t = 3.7$, $P < .01$, d = 1.0) but negligible in the ADHD (t = 0.64, $P = .99$) and the TD ($t = 0.19$, P = 1.0) groups. The relationship between in-room video game access and sleep was found to be similar across groups ($F[2,112] = 1.0$, $P = .36$). The relationship between sleep and time spent

TABLE 2 Zero-Order Correlations Between All Continuous Variables

Variable	1	2	3	4	5	6	7
1. Age							
2. Number of siblings	0.21						
3. SCQ score	−0.01	0.20					
4. Average sleep hours	−0.54	−0.13	−0.08				
5. ADHD Total score	−0.16	0.08	0.45	−0.06			
6. Average TV hours	0.12	0.16	0.40	−0.14	0.20		
7. Average video game hours	0.30	0.14	0.17	−0.50	0.20	0.36	

Correlations larger than 0.20 in absolute value are significant at the .05 level. ADHD Total score, ADHD Total scale score from the Vanderbilt Attention-Deficit/Hyperactivity Disorder Parent Rating Scale.

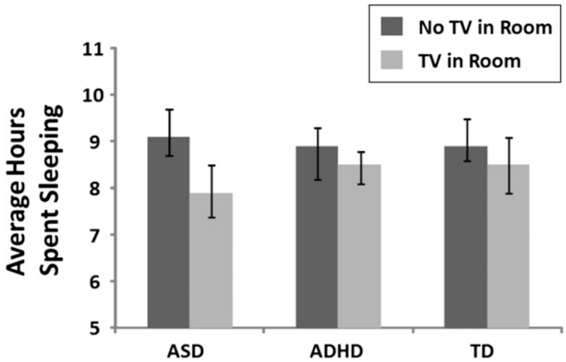

FIGURE 1
Average number of hours spent sleeping per night as a function of diagnosis group and in-room access to a TV. Bedroom access to a TV predicted less sleep among boys with ASD (but not ADHD or TD). Error bars denote a 95% confidence interval for the mean.

Downloaded from http://pediatrics.aappublications.org/ by guest on December 15, 2017

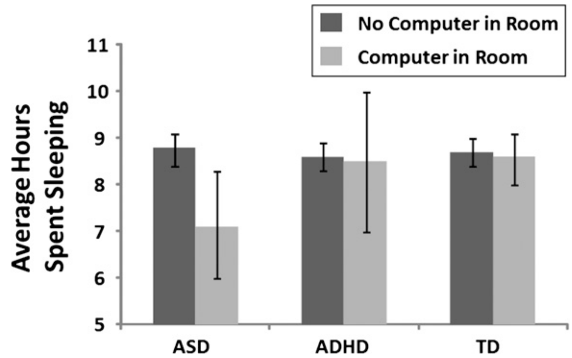

FIGURE 2
Average number of hours spent sleeping per night as a function of diagnosis group and in-room access to a computer. Bedroom access to a computer predicted less sleep among boys with ASD (but not ADHD or TD). Error bars denote a 95% confidence interval for the mean.

playing video games per day differed by group (F[2,108] = 3.5, P = .03). This interaction was probed by inspecting the bivariate correlations between sleep hours and average video game hours played per day as a function of group (a scatterplot depicting the nature of this interaction is shown in Fig 3). These analyses showed that the relationship between sleep and average video game hours per day among boys with ASD was large ($r = -0.70$, $P < .001$). This same pattern, although smaller, held among boys with ADHD ($r = -0.35$, P = .04) but was nonexistent in the TD group ($r = -0.10$, P = .56).

Separate GLMs were also conducted within diagnostic group to determine the extent to which each of these media-related variables accounted for variability in sleep, the outcome variable, while also controlling for age and medications associated with insomnia or drowsiness. Table 3 depicts all model results by group. Only the significant results are discussed. In the ASD group, age and average video game hours per day were negatively associated with sleep, and boys with in-room access to a TV slept less than boys without in-room access to a TV. No predictors were significant in the ADHD group. In the TD group, age was the only significant predictor, such that older boys slept less per night than younger boys.

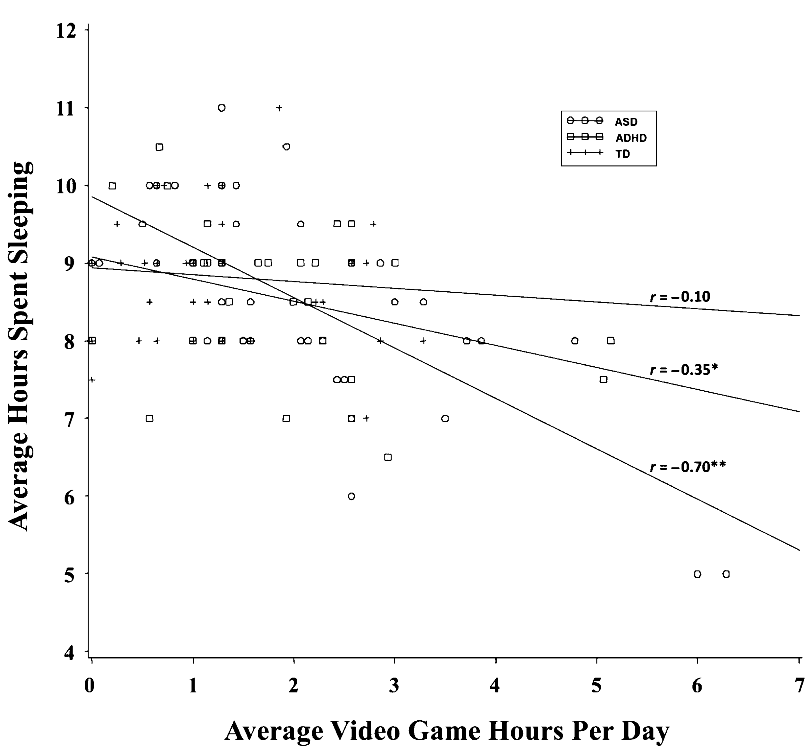

FIGURE 3
Scatterplot depicting the relationship between average number of hours spent sleeping per night and average number of hours spent playing video games per day by group. *$P < .05$, **$P < .0001$.

Hypothesis 3: Indirect Effects (Mediation) of In-Room Media Access on Sleep

In the ASD group, in-room access to video games (ie, access to a computer or dedicated game system) was associated with daily video game hours ($P < .0001$), and daily video game hours were associated with less sleep after accounting for the association between in-room game access and sleep ($P < .0001$; see Fig 4A). The 95% confidence interval for the magnitude of this indirect effect ranged from −0.42 to −1.50, suggesting significant mediation (see Fig 4B). Notably, although in-room access to a video game was associated with less sleep ($P < .001$) in a simple linear regression, this relationship disappeared (P = .52) after controlling for daily video game hours. That is, among boys with ASD, the variance in sleep hours accounted for by in-room access to a game system and/or computer is largely transmitted through average hours spent playing video games per day. All other models testing for mediation were nonsignificant and are not discussed.

DISCUSSION

This is the first study, to our knowledge, to examine how access and exposure to media relate to sleep among boys with ASD, ADHD, or TD. Results showed that in-room access to a video game

Downloaded from http://pediatrics.aappublications.org/ by guest on December 15, 2017

TABLE 3 Multivariate General Linear Models Predicting Average Sleep Hours by Group

Variable	*t*	*P*	$\eta^2 p$
ASD			
Age	−2.62	.01	0.16
Medications associated with insomnia	0.05	.96	0.00
Medications associated with drowsiness	1.30	.20	0.04
TV in room	2.96	.01	0.20
Computer in room	1.35	.19	0.05
Game console in room	−1.72	.09	0.08
Average TV hours	0.98	.33	0.03
Average video game hours	−2.68	.01	0.17
ADHD			
Age	−1.30	.21	0.06
Medications associated with insomnia	1.27	.21	0.06
Medications associated with drowsiness	1.68	.10	0.10
TV in room	0.23	.82	0.00
Computer in room	−1.80	.08	0.11
Game console in room	0.29	.77	0.00
Average TV hours	−0.43	.67	0.01
Average video game hours	−1.50	.15	0.08
TD			
Age	−5.01	<.0001	0.46
Medications associated with insomnia	—	—	—
Medications associated with drowsiness	−0.86	.40	0.02
TV in room	0.69	.50	0.02
Computer in room	0.91	.37	0.03
Game console in room	−1.68	.10	0.09
Average TV hours	−1.55	.13	0.07
Average video game hours	−0.11	.91	0.00

$\eta^2 p$, partial η squared (effect size estimate).—, values could not be derived (no TD boy was taking a medication associated with insomnia).

system was associated with less time spent sleeping per night for all groups, consistent with previous research.[17,19] Interestingly, in-room access to a computer or TV was significantly related to less sleep among boys with ASD but not among those with ADHD or TD. Average video game exposure per day was also associated with less time spent sleeping in the ASD and ADHD groups but not in the TD group. Among boys with ASD, multivariate regression models examining the unique contribution of media-related variables to sleep revealed that in-room TVs and average video game hours per day were associated with less sleep, above and beyond the effect of additional media and sleep-related variables. The results also indicated that in-room access to video games had an indirect effect on time spent sleeping among boys with ASD.

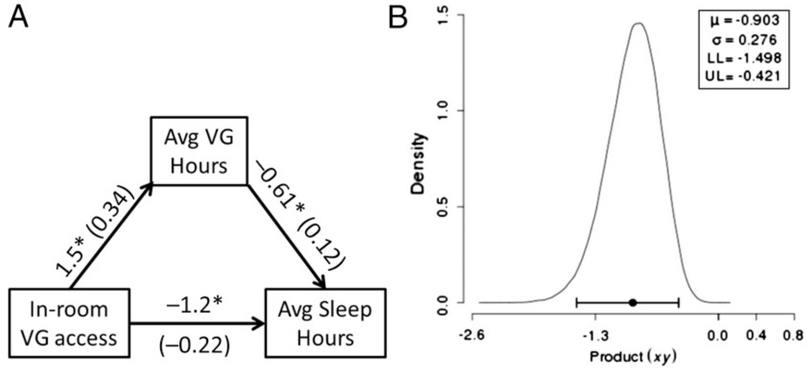

FIGURE 4
A, Paths including 2 values side by side represent unstandardized regression coefficients and standard errors (in parentheses), respectively. B, A kernel density plot shows the 95% confidence interval for the magnitude of the indirect effect using bootstrapped standard errors. *$P < .05$. Avg, average; LL, lower limit; UL, upper limit, ; VG, video game.

Although the current results indicate that media-related sleep effects are markedly greater among children with ASD, the reasons for this finding are unclear. Perhaps the most intuitive explanation is that exposure to video games, particularly at night, intrudes on the amount of time that could be spent sleeping, otherwise known as the displacement hypothesis.[16] Because children with ASD have more trouble disengaging from screen-based media,[31] it may be more likely that these media would contribute to bedtime resistance and delayed sleep onset for this group. Another possibility is that exposure to brightly lit screens may disrupt melatonin production,[41–45] which could have a particularly detrimental effect on sleep quality in children with ASD because they are already at risk for abnormally low melatonin concentrations.[42–44] Alternatively, media-related physiologic arousal may interfere with sleep onset. For example, video game play has been shown to increase physiologic arousal,[46] which could be especially problematic if games are played immediately before bedtime. Given that children with ASD are at risk for autonomic hyperarousal,[47,48] and that hyperarousal has been linked to insomnia in the general population,[49,50] these potential physiologic effects may be especially pronounced for children with ASD.

Sleep-related disturbances are a clinically important issue for children with neurodevelopmental disorders and their families. For example, sleep problems can exacerbate and worsen repetitive and stereotypic behaviors,[51] inattention and hyperactivity, and other problematic daytime behaviors.[52–54] Sleep problems can also interfere with learning

Downloaded from http://pediatrics.aappublications.org/ by guest on December 15, 2017

and cognition,[55] contributing to worsening functional impairment. Evidence also suggests that problems with sleep can adversely affect family functioning.[56,57] Although much of the data reported on the relationship between sleep problems and outcomes have been correlational, treatment intervention studies suggest that efforts aimed at treating sleep problems can help mitigate daytime behavioral problems in children with ASD.[58,59]

Limitations and Future Directions

Our study provides important preliminary information about the relations between screen-based media and sleep in children with ASD and ADHD. However, several limitations should be noted. First, our measure of sleep consisted of a simple parent-reported estimate of average nighttime hours of sleep. Future research should include more comprehensive standardized sleep measures, including multidimensional tools that assess different features of sleep, such as sleep onset, bedtime resistance, sleep duration, night waking, and parasomnias.[60] Additionally, the use of multiple informants, sleep diaries, or objective measures (eg, actigraphy) may also be helpful.[61]

An additional limitation of the current study is that we were unable to accurately assess the timing of screen-based media use. As a result, although we suspect that much of the reductions in total sleep time in the current study are related to nighttime (versus daytime) media use, similar to previous research,[62] we cannot definitively say that this is the case. Therefore, future studies in individuals with ASD or ADHD should include measures that better approximate prebedtime media exposure.[62] Additionally, experimental designs[63] may be especially helpful in investigating the effect of screen-based media on both sleep and daytime behavior in children with ASD or ADHD. Such studies may involve randomized assignment into presleep media exposure versus no exposure groups to investigate within- and between-subject effects. These study designs would allow for the most direct testing of hypothesized processes (eg, displacement, hyperarousal, melatonin interference) by which media exposure may affect sleep and behavioral outcomes.

Finally, although diagnostic screening instruments and information about previous diagnoses were collected, comprehensive diagnostic measures were not administered as part of the current study. Future research on media use and sleep in children with ASD and ADHD should include gold standard diagnostic tools to further examine the relationships between these variables among well-characterized samples.

Conclusions

The current findings suggest that the associations between media exposure and sleep are more pronounced among boys with ASD than among boys with ADHD or TD and suggest that in-room access to screen-based media and time spent playing video games may place individuals with ASD at increased risk for sleep problems. These findings highlight the importance of considering screen-based media use in both research and assessment of sleep problems in children with ASD. Autism specialists and primary care physicians should routinely assess screen-based media habits when addressing sleep problems in children ASD, because this may represent an important intervention target for improving sleep.

ACKNOWLEDGMENTS

We thank all the families who participated in this study and Colleen Wenstrup and Megan Ellingsworth for their help with recruitment and data collection.

REFERENCES

1. Stores G. Sleep-wake function in children with neurodevelopmental and psychiatric disorders. *Semin Pediatr Neurol*. 2001;8(4):188–197
2. Couturier JL, Speechley KN, Steele M, Norman R, Stringer B, Nicolson R. Parental perception of sleep problems in children of normal intelligence with pervasive developmental disorders: prevalence, severity, and pattern. *J Am Acad Child Adolesc Psychiatry*. 2005;44(8):815–822
3. Krakowiak P, Goodlin-Jones B, Hertz-Picciotto I, Croen LA, Hansen RL. Sleep problems in children with autism spectrum disorders, developmental delays, and typical development: a population-based study. *J Sleep Res*. 2008;17(2):197–206
4. Miano S, Bruni O, Elia M, et al. Sleep in children with autistic spectrum disorder: a questionnaire and polysomnographic study. *Sleep Med*. 2007;9(1):64–70
5. Souders MC, Mason TB, Valladares O, et al. Sleep behaviors and sleep quality in children with autism spectrum disorders. *Sleep*. 2009;32(12):1566–1578
6. Malow BA, McGrew SG. Sleep disturbances and autism. *Sleep Med Clin*. 2008;3(3):479–488
7. Richdale AL, Schreck KA. Sleep problems in autism spectrum disorders: prevalence, nature, & possible biopsychosocial aetiologies. *Sleep Med Rev*. 2009;13(6):403–411
8. Konofal E, Lecendreux M, Cortese S. Sleep and ADHD. *Sleep Med*. 2010;11(7):652–658
9. Allik H, Larsson J-O, Smedje H. Sleep patterns of school-age children with Asperger syndrome or high-functioning autism. *J Autism Dev Disord*. 2006;36(5):585–595
10. Cortese S, Konofal E, Yateman N, Mouren MC, Lecendreux M. Sleep and alertness in children with attention-deficit/hyperactivity disorder: a systematic review of the literature. *Sleep*. 2006;29(4):504–511
11. Hoshino Y, Watanabe H, Yashima Y, Kaneko M, Kumashiro H. An investigation on sleep disturbance of autistic children. *Folia Psychiatr Neurol Jpn*. 1984;38(1):45–51
12. Meltzer LJ, Mindell JA. Relationship between child sleep disturbances and maternal sleep, mood, and parenting stress:

Downloaded from http://pediatrics.aappublications.org/ by guest on December 15, 2017

a pilot study. *J Fam Psychol*. 2007;21(1):67–73
13. Robinson AM, Richdale AL. Sleep problems in children with an intellectual disability: parental perceptions of sleep problems, and views of treatment effectiveness. *Child Care Health Dev*. 2004;30(2):139–150
14. Wiggs L, Stores G. Sleep patterns and sleep disorders in children with autistic spectrum disorders: insights using parent report and actigraphy. *Dev Med Child Neurol*. 2004;46(6):372–380
15. Pandi-Perumal SR, Srinivasan V, Spence DW, Cardinali DP. Role of the melatonin system in the control of sleep: therapeutic implications. *CNS Drugs*. 2007;21(12):995–1018
16. Cain N, Gradisar M. Electronic media use and sleep in school-aged children and adolescents: a review. *Sleep Med*. 2010;11(8):735–742
17. Li S, Jin X, Wu S, Jiang F, Yan C, Shen X. The impact of media use on sleep patterns and sleep disorders among school-aged children in China. *Sleep*. 2007;30(3):361–367
18. Mindell JA, Meltzer LJ, Carskadon MA, Chervin RD. Developmental aspects of sleep hygiene: findings from the 2004 National Sleep Foundation Sleep in America poll. *Sleep Med*. 2009;10(7):771–779
19. Oka Y, Suzuki S, Inoue Y. Bedtime activities, sleep environment, and sleep/wake patterns of Japanese elementary school children. *Behav Sleep Med*. 2008;6(4):220–233
20. Owens J, Maxim R, McGuinn M, Nobile C, Msall M, Alario A. Television-viewing habits and sleep disturbance in school children. *Pediatrics*. 1999;104(3). Available at: www.pediatrics.org/cgi/content/full/104/3/e27
21. Adam EK, Snell EK, Pendry P. Sleep timing and quantity in ecological and family context: a nationally representative time-diary study. *J Fam Psychol*. 2007;21(1):4–19
22. Van den Bulck J. Television viewing, computer game playing, and Internet use and self-reported time to bed and time out of bed in secondary-school children. *Sleep*. 2004;27(1):101–104
23. Punamäki R-L, Wallenius M, Nygård CH, Saarni L, Rimpelä A. Use of information and communication technology (ICT) and perceived health in adolescence: the role of sleeping habits and waking-time tiredness. *J Adolesc*. 2007;30(4):569–585
24. Acevedo-Polakovich ID, Lorch EP, Milich R, Ashby RD. Disentangling the relation between television viewing and cognitive processes in children with attention-deficit/hyperactivity disorder and comparison children. *Arch Pediatr Adolesc Med*. 2006;160(4):354–360
25. Mazurek MO, Shattuck PT, Wagner M, Cooper BP. Prevalence and correlates of screen-based media use among youths with autism spectrum disorders. *J Autism Dev Disord*. 2012;42(8):1757–1767
26. Orsmond GI, Kuo H-Y. The daily lives of adolescents with an autism spectrum disorder: discretionary time use and activity partners. *Autism*. 2011;15(5):579–599
27. Shane HC, Albert PD. Electronic screen media for persons with autism spectrum disorders: results of a survey. *J Autism Dev Disord*. 2008;38(8):1499–1508
28. Bioulac S, Arfi L, Bouvard MP. Attention deficit/hyperactivity disorder and video games: a comparative study of hyperactive and control children. *European Psychiatry*. 2008;23(2):134–141
29. Mazurek MO, Engelhardt CR. Video game use in boys with autism spectrum disorder, ADHD, or typical development. *Pediatrics*. 2013;132(2):260–266
30. Mazurek MO, Wenstrup C. Television, video game and social media use among children with ASD and typically developing siblings. *J Autism Dev Disord*. 2013;43(6):1258–1271
31. Nally B, Houlton B, Ralph S. Researches in brief: the management of television and video by parents of children with autism. *Autism*. 2000;4(3):331–337
32. Lord C, DiLavorne PC, Risi S. *Autism Diagnostic Observation Schedule*. Los Angeles, CA: Western Psychological Services; 2002
33. Lord C, Rutter M, Le Couteur A. Autism Diagnostic Interview-Revised: a revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *J Autism Dev Disord*. 1994;24(5):659–685
34. Berument SK, Rutter M, Lord C, Pickles A, Bailey A. Autism screening questionnaire: diagnostic validity. *Br J Psychiatry*. 1999;175(5):444–451
35. Chandler S, Charman T, Baird G, et al. Validation of the social communication questionnaire in a population cohort of children with autism spectrum disorders. *J Am Acad Child Adolesc Psychiatry*. 2007;46(10):1324–1332
36. Rutter M, Bailey A, Lord C. *The Social Communication Questionnaire (SCQ) Manual*. Los Angeles, CA: Western Psychological Services; 2003
37. Wolraich ML, Hannah JN, Baumgaertel A, Feurer ID. Examination of DSM-IV criteria for attention deficit/hyperactivity disorder in a county-wide sample. *J Dev Behav Pediatr*. 1998;19(3):162–168
38. Wolraich ML, Lambert W, Doffing MA, Bickman L, Simmons T, Worley K. Psychometric properties of the Vanderbilt ADHD diagnostic parent rating scale in a referred population. *J Pediatr Psychol*. 2003;28(8):559–567
39. Mazurek MO, Engelhardt CR. Video game use and problem behaviors in boys with autism spectrum disorders. *Res Autism Spectr Disord*. 2013;7(2):316–324
40. Tofighi D, MacKinnon DP. RMediation: an R package for mediation analysis confidence intervals. *Behav Res Methods*. 2011;43(3):692–700
41. Kulman G, Lissoni P, Rovelli F, Roselli MG, Brivio F, Sequeri P. Evidence of pineal endocrine hypofunction in autistic children. *Neuroendocrinol Lett*. 2000;21(1):31–34
42. Melke J, Goubran Botros H, Chaste P, et al. Abnormal melatonin synthesis in autism spectrum disorders. *Mol Psychiatry*. 2008;13(1):90–98
43. Nir I, Meir D, Zilber N, Knobler H, Hadjez J, Lerner Y. Brief report: circadian melatonin, thyroid-stimulating hormone, prolactin, and cortisol levels in serum of young adults with autism. *J Autism Dev Disord*. 1995;25(6):641–654
44. Tordjman S, Anderson GM, Pichard N, Charbuy H, Touitou Y. Nocturnal excretion of 6-sulphatoxymelatonin in children and adolescents with autistic disorder. *Biol Psychiatry*. 2005;57(2):134–138
45. Reynolds AM, Malow BA. Sleep and autism spectrum disorders. *Pediatr Clin North Am*. 2011;58(3):685–698
46. Anderson CA, Shibuya A, Ihori N, et al. Violent video game effects on aggression, empathy, and prosocial behavior in Eastern and Western countries: a meta-analytic review. *Psychol Bull*. 2010;136(2):151–173
47. Hirstein W, Iversen P, Ramachandran VS. Autonomic responses of autistic children to people and objects. *Proc Biol Sci*. 2001;268(1479):1883–1888
48. Watson LR, Roberts JE, Baranek GT, Mandulak KC, Dalton JC. Behavioral and physiological responses to child-directed speech of children with autism spectrum disorders or typical development. *J Autism Dev Disord*. 2012;42(8):1616–1629
49. Riemann D, Spiegelhalder K, Feige B, et al. The hyperarousal model of insomnia: a review of the concept and its evidence. *Sleep Med Rev*. 2010;14(1):19–31
50. Bonnet MH, Arand DL. Hyperarousal and insomnia: state of the science. *Sleep Med Rev*. 2010;14(1):9–15
51. Schreck KA, Mulick JA, Smith AF. Sleep problems as possible predictors of intensified symptoms of autism. *Res Dev Disabil*. 2004;25(1):57–66
52. Frazier JA, Biederman J, Bellordre CA, et al. Should the diagnosis of attention-deficit/hyperactivity disorder be considered in children with pervasive developmental disorder? *J Atten Disord*. 2001;4(4):203–211

Downloaded from http://pediatrics.aappublications.org/ by guest on December 15, 2017

53. Mayes SD, Calhoun SL, Mayes RD, Molitoris S. Autism and ADHD: overlapping and discriminating symptoms. *Res Autism Spectr Disord*. 2012;6(1):277–285
54. Weisbrot DM, Gadow KD, DeVincent CJ, Pomeroy J. The presentation of anxiety in children with pervasive developmental disorders. *J Child Adolesc Psychopharmacol*. 2005;15(3):477–496
55. Maquet P. The role of sleep in learning and memory. *Science*. 2001;294(5544):1048–1052
56. Patzold LM, Richdale AL, Tonge BJ. An investigation into sleep characteristics of children with autism and Asperger's disorder. *J Paediatr Child Health*. 1998;34(6):528–533
57. Richdale AL. Sleep problems in autism: prevalence, cause, and intervention. *Dev Med Child Neurol*. 1999;41(1):60–66
58. Malow BA, McGrew SG, Harvey M, Henderson LM, Stone WL. Impact of treating sleep apnea in a child with autism spectrum disorder. *Pediatr Neurol*. 2006;34(4):325–328
59. Paavonen EJ, Nieminen-von Wendt T, Vanhala R, Aronen ET, von Wendt L. Effectiveness of melatonin in the treatment of sleep disturbances in children with Asperger disorder. *J Child Adolesc Psychopharmacol*. 2003;13(1):83–95
60. Lewandowski AS, Toliver-Sokol M, Palermo TM. Evidence-based review of subjective pediatric sleep measures. *J Pediatr Psychol*. 2011;36(7):780–793
61. Acebo C, Sadeh A, Seifer R, et al. Estimating sleep patterns with activity monitoring in children and adolescents: how many nights are necessary for reliable measures? *Sleep*. 1999;22(1):95–103
62. Garrison MM, Liekweg K, Christakis DA. Media use and child sleep: the impact of content, timing, and environment. *Pediatrics*. 2011;128(1):29–35
63. Dworak M, Schierl T, Bruns T, Strüder HK. Impact of singular excessive computer game and television exposure on sleep patterns and memory performance of school-aged children. *Pediatrics*. 2007;120(5):978–985

FLIGHT TO THE CITY: *We live in a beautiful rural area of Vermont. The views of the meadows, mountains, and farms are gorgeous. However, maintaining the yard and animals is a lot of work. We cannot simply walk a few blocks or even a few miles to a restaurant, and buying milk involves a two mile bike ride or walk. As the children leave the nest, my wife and I keep thinking about returning to the city. Evidently we are not alone in our thoughts.*

As reported in The Wall Street Journal *(August 9, 2013), baby boomers are flocking to cities. Hip urban neighborhoods are the new hot spot – not only for the young with money, but the middle-aged as well. Baby boomers have been migrating to the cities since the early 1990s. The movement slowed during the recession, but has picked up speed again. Based on online real estate brokerage data, over the past decade, more than a million baby boomers have moved within five miles of the downtown of the 50 largest cities in the US.*

The reasons for the migration are myriad. Cities are now safer and cleaner, offering immediate access to restaurants, theater, movies, concert venues, and shops. Often, the commute can be on foot or via public transportation. With children out of the house, baby boomers do not have to worry about schools or having enough space for all the children and their friends. Many baby boomers like the ethnic and age diversity of the city, preferring not to stay in the same spot with the same acquaintances forever. One problem with the migration is that the cost to live in these trendy areas continues to rise as baby boomers are competing for a limited number of condominiums with other baby boomers and young adults. While I do not expect we will move anytime soon, as I ride the two miles to buy some groceries, I can certainly understand the appeal of city living.

Noted by WVR, MD

Downloaded from http://pediatrics.aappublications.org/ by guest on December 15, 2017

Media Use and Sleep Among Boys With Autism Spectrum Disorder, ADHD, or Typical Development

Christopher R. Engelhardt, Micah O. Mazurek and Kristin Sohl

Pediatrics originally published online November 18, 2013;

Updated Information & Services	including high resolution figures, can be found at: http://pediatrics.aappublications.org/content/early/2013/11/12/peds.2013-2066
Permissions & Licensing	Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at: https://shop.aap.org/licensing-permissions/
Reprints	Information about ordering reprints can be found online: http://classic.pediatrics.aappublications.org/content/reprints

Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since . Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2013 by the American Academy of Pediatrics. All rights reserved. Print ISSN: .

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™

Downloaded from http://pediatrics.aappublications.org/ by guest on December 15, 2017

PEDIATRICS®

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Media Use and Sleep Among Boys With Autism Spectrum Disorder, ADHD, or Typical Development

Christopher R. Engelhardt, Micah O. Mazurek and Kristin Sohl

Pediatrics originally published online November 18, 2013;

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://pediatrics.aappublications.org/content/early/2013/11/12/peds.2013-2066

Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since . Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2013 by the American Academy of Pediatrics. All rights reserved. Print ISSN: .

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™

Downloaded from http://pediatrics.aappublications.org/ by guest on December 15, 2017