The Impact of a Healthy Media Use Intervention on Sleep in Preschool Children

WHAT'S KNOWN ON THIS SUBJECT: Although observational studies have consistently reported an association between media use and child sleep problems, it is unclear whether the relationship is causal or if an intervention targeting healthy media use can improve sleep in preschool-aged children.

WHAT THIS STUDY ADDS: This study demonstrates that a healthy media use intervention can improve child sleep outcomes and adds evidence that the relationship between media and sleep in preschool-aged children is indeed causal in nature.

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KEY WORDS
sleep, media, preschool-aged children, randomized controlled trial, violence

ABBREVIATIONS
CI—confidence interval
OR—odds ratio
SCBE—Social Competence and Behavior Evaluation

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abstract

BACKGROUND: Although observational studies have consistently reported an association between media use and child sleep problems, it is unclear whether the relationship is causal or if an intervention targeting healthy media use can improve sleep in preschool-aged children.

METHODS: We conducted a randomized controlled trial of a healthy media use intervention in families of children aged 3 to 5 years. The intervention encouraged families to replace violent or age-inappropriate media content with quality educational and prosocial content, through an initial home visit and follow-up telephone calls over 6 months. Sleep measures were derived from the Child Sleep Habits Questionnaire and were collected at 6, 12, and 18 months after baseline; repeated-measures regression analyses were used.

RESULTS: Among the 565 children analyzed, the most common sleep problem was delayed sleep-onset latency (38%). Children in the intervention group had significantly lower odds of "any sleep problem" at follow-up in the repeated-measures analysis (odds ratio = 0.36; 95% confidence interval: 0.16 to 0.83), with a trend toward a decrease in intervention effect over time ($P = .07$). Although there was no significant effect modification detected by baseline sleep or behavior problems, gender, or low-income status, there was a trend ($P = .096$) toward an increased effect among those with high levels of violence exposure at baseline.

CONCLUSIONS: The significant effects of a healthy media use intervention on child sleep problems in the context of a randomized controlled trial suggest that the previously reported relationship between media use and child sleep problems is indeed causal in nature. *Pediatrics* 2012;130:492–499

Observational studies have consistently shown an association between media use and child sleep problems. Although this finding has been consistently replicated with high levels of use, bedtime use, and violent or frightening media content,[1–7] effects have been observed across cultures and in all media formats (television,[6,8–10] video games,[10–12] and computers[11,13,14]) and across the age spectrum, including preschoolers,[2,7–9] school-aged children,[1,3–6] and adolescents and adults.[13–15] Much of the existing research linking media use to child sleep problems has been cross-sectional, however, raising the possibility that the causality is reversed; that is, that sleep problems are leading to increased media use, evening media use, and exposure to violent media content, rather than the other way around. Although longitudinal studies have demonstrated that early childhood media use is associated with behavioral and developmental effects years later,[8,16–19] there is still the concern that these findings may be at least partly due to residual confounding by third factors, such as child behavior problems or household instability, that may lead to both problem media use and child sleep problems.[8,16–18,20]

In this article, we leverage the experimental design of a randomized controlled trial of healthy media use in preschool-aged children to ascertain whether changes in media use in the intervention group led to differences in child sleep between the intervention and control groups. The randomization of a sample of this size eliminates most confounding, because the random assignment leads to equal balance between study groups in child and family characteristics. The longitudinal nature of the 18-month follow-up period also allows us to examine to what degree any effects observed are transient versus lasting.

METHODS

We conducted a randomized controlled trial of a healthy media use intervention for families of preschool-aged children. This work was supported by grant 5R01HD056506 from the National Institute of Child Health & Human Development to Dr Christakis, and the study was approved by the institutional review board of the Seattle Children's Research Institute. Although the present analysis focuses on sleep outcomes, the primary outcomes of the trial were decreased aggressive behavior and increased prosocial behaviors, as is stated in the clinical trial registration; the analysis of these primary outcomes will be presented in a separate article.

Subjects

Letters describing the study were sent to families with age-eligible children (3–5 years) enrolled in community pediatric practices in the Seattle metropolitan area, without regard to whether the child had been seen in the clinic recently. Participating clinics were selected to capture a representative sample of the Seattle population and included clinics that have substantial Medicaid populations. To be eligible, children needed to consume at least some media each week and to have English-speaking parents. Families were given the opportunity to opt out of further recruitment efforts and also had the option to opt in by returning a postage-paid mailer. In a separate analysis, the differences between these 2 groups were found to be minimal.[21] Those who neither opted out nor in were contacted by way of telephone and asked to participate. Attempts were made to oversample low-income families at the initial contact stage, as identified by Medicaid status or zip code of residence. Randomization was stratified by low-income status and study case manager. After enrollment, study staff collected the survey and media diary during a home visit at the start of the intervention. For all follow-up surveys, families had the option of returning them by mail or submitting them online.

Because the primary objective of the randomized controlled trial was to decrease aggressive behaviors and increase prosocial behaviors, the sample size was based on power calculations for these aims. Of the 3334 families contacted and assessed for eligibility (Fig 1), 40% did not meet inclusion criteria, 35% declined to participate, and the remaining 25% ($N = 820$) were randomly allocated to the intervention or control arm within the DatStat Discovery Research Management System (DatStat, Inc, Seattle, WA) by using a computer-generated list of random numbers; of these, 617 (75%) completed the baseline visit between March 2009 and April 2010, and 565 of these (92%) completed at least 1 follow-up survey over the following 18 months and had sufficient data to be included in this analysis.

Intervention

The fundamental approach of this study was to try to get parents to substitute prosocial and educational content in place of violent content, because considerable research has shown that violent media exposure can lead to aggression and other behavioral and emotional problems in young children.[17–19,22–25] The intervention framework was based on social cognitive theory[26–29] and sought to increase parental outcome expectations and self-efficacy around making healthy media choices for the child, with a specific emphasis on replacing violent or age-inappropriate content with age-appropriate educational or prosocial content.

Although the intervention addressed all screen time (television, DVDs/videos, computers, video games, and handheld devices), the primary focus was on television and videos because these formats account for the most screen time engaged in by preschool-aged children. No attempt was made to reduce the total number of screen

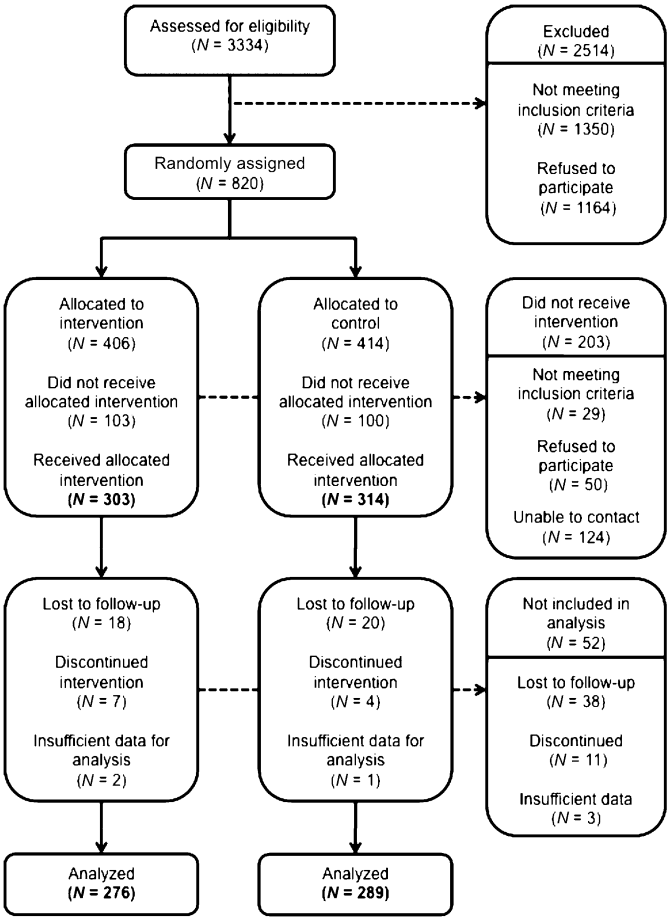

FIGURE 1
Consolidated Standards of Reporting Trials diagram.

time hours, nor was evening use or any other aspect of sleep hygiene specifically targeted.

Case managers received previous training in motivational interviewing techniques, the effects of violent television on children, and the use of parental controls in televisions and other media devices to monitor and modify viewing. Intervention sessions began with the initial home visit, in which the family's assigned case manager collected assessment materials, discussed the child's current media use with the parent, shared intervention handouts that were specific to the family's needs, and engaged the parent in goal setting and anticipatory problem-solving around barriers. The home visit was then followed by mailings and follow-up telephone calls with the case manager for 12 months. During both the home visit and the telephone calls, case managers used their training to try to motivate and empower parents to replace violent and age-inappropriate media content with content that was age-appropriate and educational or prosocial in nature. Parents also were encouraged to engage in co-viewing and to discuss media content with their children, because co-viewing can increase parent awareness of the media content consumed, and some evidence suggests that co-viewing or discussion may enhance the positive effects of educational and prosocial media,[30,31] although it may not mitigate the negative effects of violent or scary media.[32]

The monthly mailings included a program guide tailored to the family's available channels with recommended educational and prosocial television shows and schedules and a newsletter with tips and reinforcement. The criteria for recommended programming were based on previous research regarding the positive benefits of educational and prosocial media for young children[33–42] and were as follows: a TV Guidelines rating of TV-Y, being rated high on educational and/or prosocial value by CommonSenseMedia.org, and being currently available on network or cable television. In creating our final list, we sought to include programming that featured a diversity of gender, race, ethnicity, and culture and balance in terms of topical focus. Representative recommended shows included *Curious George*, *Sesame Street*, and *Dora the Explorer*.

The first 6 mailings also included DVDs with 5- to 10-minute clips of suggested educational and prosocial shows. During the monthly telephone calls, the case manager reviewed progress made on the parent's goals since the last encounter, coached the parent through problem-solving around barriers as needed, and worked with the parent to set new goals as appropriate. The control group received a nutrition intervention, with analogous materials, including monthly mailings that encouraged families to decrease consumption of sugary drinks and increase fruit and vegetable intake.

Outcomes

Sleep measures were a subset of the Child Sleep Habits Questionnaire (CSHQ), assessing the frequency of sleep-onset latency, repeated night wakings, nightmares, difficulty waking in the morning, and daytime tiredness.[43,44] Frequency choices were "2: Usually (5–7 days per week)," "1: Sometimes (2–4 days per week)," and "0: Rarely (0–1 day per week)." The items are summed after inverting the reversed item (latency), with total score ranging from 0 to 10 and higher scores indicating more

problematic sleep, which is the same scoring method used in the full Child Sleep Habits Questionnaire. The primary outcome dichotomized the sleep scale at 0 to 1 (59% at baseline) versus 2 to 10 (41%), so that children were defined as having "any sleep problem" if the parent answered that at least 1 sleep problem occurred 5 to 7 days per week, or at least 2 sleep problems occurred 2 to 4 days per week. The sleep measures were collected at baseline and each follow-up time point (6, 12, and 18 months after beginning the intervention).

Covariates

Demographic variables were collected in the baseline parent survey, including child gender and age in months at baseline. Children were defined as living in a low-income household if the parent-reported income category placed the family at or below twice the federal poverty level for their household size. For continuity, families were asked to choose 1 parent to receive the intervention and complete the baseline and all follow-up surveys; whether this respondent was the child's mother as opposed to another primary caregiver (such as father or grandmother) is included in the analyses as a covariate. We also collected data on child internalizing (such as anxiety and depression) and externalizing (such as hyperactivity and aggression) symptoms using the Social Competence and Behavior Evaluation (SCBE), parent version. The SCBE is a validated measure with subscales for internalizing (anxious, depressive, and withdrawn) and externalizing (angry, aggressive, and oppositional) behaviors.[45] Neither SCBE scale includes any questions about child sleep. One-week media diaries were collected at baseline, in which parents prospectively recorded all media use for the child. For each instance of media use, parents recorded format (television, DVD/video, computer, video game), content title, start time and duration, and co-use. Media diaries were coded for content as previously described.[2]

Analysis

Missing data for the questions contributing to the sleep, internalizing, and externalizing scales were imputed by using the Stata (Stata Corp, College Station, TX) impute command for subjects with no >20% of items missing in the scale. Imputation enabled us to still include in the analyses children whose parents had left blank 1 or 2 items within a scale, which is especially important given that low-income families were more likely to have missed at least 1 item within a scale (9% vs 4% for the externalizing behavior scale, $P = .01$), and 1 of the goals in imputation in these situations is to minimize the degree to which nonrandom missingness biases the final results.[46–48] Each item used in the analysis had <2% of values missing. Descriptive and bivariate statistics were calculated, with t tests used to compare continuous variables between the intervention and control groups, and χ^2 tests for categorical variables. The main intervention effect was tested in an intent-to-treat analysis using a repeated-measures logistic regression, with whether the child met criteria for having "any sleep problem" as the primary outcome. A repeated-measures regression analysis utilizes data from each available follow-up assessment per subject but takes into account the fact that different measurements across times within the same child will be more highly correlated with each other than measurements across children. The results of a repeated-measures analysis can be interpreted as the overall effect of the intervention on the child.

The intervention effect was then examined separately for each follow-up time point by using linear regression, with the child's sleep problem score at that follow-up as the outcome. Secondary analyses examined the individual components of the sleep problem score, also by using repeated-measures logistic regression models, with whether the given sleep problem occurred ≥2 days per week as the outcome. To test for potential effect modification, the model from the primary analysis also was conducted by using interaction terms by each of gender, baseline sleep problem status, low-income household, and whether the child was in the top quartile for internalizing or externalizing behavior problem scores. The Wald test was used to compare the interaction terms and test the hypotheses regarding effect modification.

All regression models controlled the child's baseline sleep problem score, the child's gender and age in months, low-income household status, and whether the mother was the respondent. In the repeated-measures analyses, we also included covariates for the time point to account for the natural change in prevalence of sleep problems as children age, and an interaction term for a time × intervention to assess the decay of the intervention effect over time. We also tested whether gender, baseline media use, or SCBE internalizing and externalizing behavior problem scores were a significant contribution to the model. All analyses were conducted by using Stata/SE, version 10.

RESULTS

A total of 565 families completed at least 1 follow-up and had sufficient data to be included in this analysis, which is 92% of those completing the baseline visit (Fig 1). The population was representative of the Seattle metropolitan area and well balanced across study arms (Table 1), although somewhat more children in the control group (43%) had an older sibling as compared with the intervention group (34%). There were no significant differences between study

TABLE 1 Study Sample

	Intervention, *N* = 276	Control, *N* = 289
Child demographics		
Female gender, %	45	46
Age, mo, mean (SD)	50.9 (7.7)	51.6 (7.7)
Race/ethnicity (not mutually exclusive), %		
White	82	81
Black	8	8
Hispanic	6	7
Asian/Pacific Islander	14	18
Native American	3	3
Family demographics, %		
Low-income	18	13
One-adult household	7	5
Older sibling(s)[a]	34	43
Respondent is mother	88	88
Parent education, %		
High school or less	19	18
College degree	45	44
Graduate or professional degree	36	38
Child baseline media use		
Television in bedroom, %	8	8
Average daily total use, min	73.9 (50.9)	70.4 (48.5)
Average evening use, min	13.7 (16.1)	13.7 (18.0)
Average daily violent content, min	22.1 (25.8)	22.9 (31.0)
Child baseline sleep, %		
Any sleep problem	42	39

[a] $P < .05$ for difference between groups.

arms at baseline in child sleep or media use. The most common sleep problem at baseline was difficulty with sleep-onset latency, with 26% of children taking >20 minutes to fall asleep for 2 to 4 nights a week and 12% taking >20 minutes to fall asleep 5 to 7 nights a week (Fig 2). In the primary analysis, gender, baseline media use, and SCBE internalizing and externalizing behavior problem scores did not contribute significantly to the model; because the *P* values for these covariates were >.20 and their inclusion did not significantly alter the intervention effort or improve model fit, they were not included in any of the final models.

The intervention had a positive impact on sleep (Table 2), with children in the intervention group having significantly lower odds of "any sleep problem" in the repeated-measures analysis (odds ratio [OR] = 0.36; 95% confidence interval [CI]: 0.16 to 0.83). As expected, the effect size for the time variable (OR = 0.59; 95% CI: 0.46 to 0.77) shows a decrease in sleep problems over the 18 months of follow-up. The time × intervention interaction term, however, demonstrates a trend toward a decrease in intervention effect over time (OR = 1.40; 95% CI: 0.97 to 2.02). When linear regression models were run separately for each follow-up time point, similar effect sizes are seen at 6 months (difference in score between study arms of −0.16, 95% CI: −0.35 to 0.02) and 12 months (−0.14; 95% CI: −0.31 to 0.02) after the baseline visit, with a decay in effect at the 18-month follow-up (−0.08; 95% CI: −0.27 to 0.10). When examining the repeated-measures logistic regression models for each separate component of the sleep problem score, the greatest difference between study arms was for the question asking whether the child had a difficult time becoming awake and alert in the morning (OR = 0.40; 95% CI: 0.16 to 1.01).

In examining potential effect modification, no significant differences were seen in effect by whether the child had sleep problems at baseline (*P* = .13). Likewise, there was no significant effect modification detected by gender (*P* = .12), low-income household (*P* = .24), whether the child had a television in the bedroom at baseline (*P* = .25), high levels of evening media use at baseline (*P* = .27), or by internalizing (*P* = .97) or externalizing (*P* = .76) behavior problems. There was a trend (*P* = .096), however, toward an increased effect among those with high levels of violence exposure at baseline (daily mean ≥30 minutes) compared with those with less violent content, with OR = 0.23 (95% CI: 0.09 to 0.62) versus OR = 0.43 (95% CI: 0.19 to 1.00), respectively.

DISCUSSION

A healthy media use intervention in preschool-aged children, aimed at replacing violent content with age-appropriate, educational, and prosocial content, led to improved sleep in the intervention group as compared with the control group. The lack of significant effect modification by baseline sleep problems suggests that health media choices may help treat existing behavioral sleep problems and be a useful preventive measure. The observed trend toward effect modification by baseline levels of violent media exposure, coupled with the fact that the intervention targeted content rather than quantity and had no effect on mean daily usage, suggests that the intervention effects at reducing violent media use may have been the initial mechanism by which the intervention improved child sleep outcomes. Although effect sizes were similar at both 6 and 12 months after the initial intervention encounter, there was a trend toward a decrease in effect by the 18-month follow-up. Given that the intervention itself ended at 12 months, the potential decay at 18 months suggests that families may need supportive maintenance after the active intervention or that the intervention protocol may need to be revised to ensure that families are mastering the

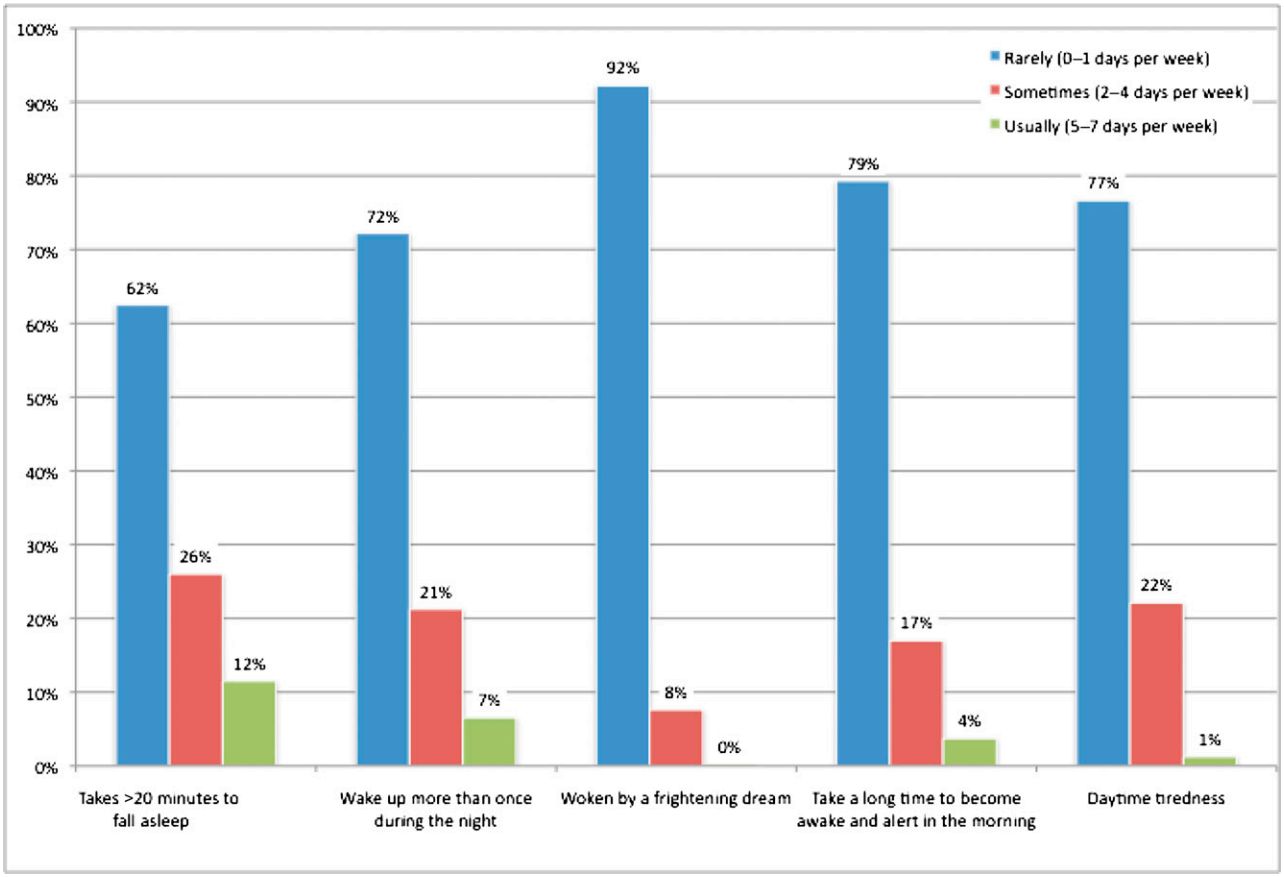

FIGURE 2
Baseline sleep problems.

skills needed to continue making healthy media choices as their child continues to grow older and media options evolve.

Although an intervention to change the child's media diet positively impacted sleep, it remains unknown how this relationship is mediated; the fact that the intervention targeted content choices rather than quantity of use, and in fact had no impact on total minutes of daily use, suggests that content indeed plays a key role. In our previous article describing the relationship between media use and child sleep at baseline in this study, we found not only that evening media use was associated with increased sleep problems but so was violent media use earlier in the day.[2] If the intervention affected child sleep by reducing violent media consumption across the day, the effects may have been mediated by decreases in factors such as fears and state anxiety,[20] arousal state at bedtime, or hyperactivity.

TABLE 2 Regression Results

	OR	95% CI	*P*
Intervention	0.36	0.16 to 0.83	.02
Low-income household	1.76	0.98 to 3.19	.06
Time point (1, 2, or 3)	0.59	0.46 to 0.77	<.001
Time × intervention	1.40	0.97 to 2.02	.07

The model also controlled for the child's age and baseline sleep score and whether the mother was the respondent.

This study has a number of limitations that warrant mention. First, the sleep measure used was only a brief excerpt from a validated measure, because the study was designed primarily to examine outcomes of the healthy media use intervention around aggression and prosocial behaviors. The use of such a rough measure increases the chances of misclassification of child sleep problems, with both false-positive and false-negative results; however, we would expect this misclassification to be nonselective in nature, and to therefore bias our findings toward the null. We hope that future studies will be able to replicate these findings by using more robust measures of child sleep, such as sleep diaries or actigraphy. Second, it is not possible to blind the subjects of behavioral intervention studies; however, the study was presented to the parents as targeting media and aggression, not children's sleep, so there is no reason to expect that social desirability or response bias would have led to differences in the sleep measure between study arms beyond that due to the intervention alone. Third, we drew our sample from clinics in a single urban area; however, because the children were eligible for inclusion regardless of whether they

had been seen in the clinic over the past year, the study more closely approximates a population-based sample than a clinical sample. Still, the extent to which the results can be generalized to children from other communities is unknown. Finally, we did not have enough case managers to examine the degree to which interventionist characteristics may have impacted the effects observed in their panels and may not have had sufficient sample sizes of some subpopulations (such as low-income children or those with a television in the bedroom at baseline) to adequately test for effect modification by these factors. Perhaps future studies will be able to selectively target and oversample these populations and explore the potential for effect modification.

Despite these limitations, the findings have 2 important implications. First, these results in the context of a randomized controlled trial suggest that the previously reported relationship between media use and child sleep problems is indeed causal in nature. Second, clinicians and parents should be mindful that healthy media use choices could be a valuable strategy in treating and preventing child sleep problems. Given that early childhood sleep problems have been associated with a range of deleterious outcomes, both acute and long-term, including increased injuries, behavioral and emotional problems, difficulties in school, and obesity, the availability of useful, feasible strategies is critical.

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PAINT FOR HEALTH: *I was taught at an early age how to paint: not pictures but walls, moldings, ceilings, and clapboards. A fresh coat of paint can dramatically alter the look of a room and preserve the siding of a house. According to an article in* The New York Times *(Health: July 24, 2012), highly specialized paints may have important health benefits. In a rural region of Bolivia heavily infested with vinchuca (also known as kissing bugs), a single application of insecticide-laden paint has had dramatic impact in the adobe homes. Residents report that the biting bugs, which spread the organism responsible for the Chagas disease, have virtually disappeared. The bugs live in the mud homes and feed at night, and their bites are so common and irksome that residents often prefer to sleep outdoors. However, within a week of applying the paint, the bugs are usually gone. The water-based paint contains slowly released microcapsules of pesticides and insect growth regulators. Two key advantages to such a system are that the anti-insect effect is durable and the paint is not associated with the toxicity to humans associated with fumigation. The paint has not been fully evaluated by the World Health Organization yet, but trials —such as the one conducted in rural Bolivia—have all been promising. The manufacturer hopes to use the paint to control other types of insect infestations, including mosquitoes. Eventually, the paint may make its way to the US market to help control cockroach and ant populations. I hope I do not have to use this paint on my own home, but the potential world-wide beneficial impact is remarkable.*

Noted by WVR, MD

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