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RESEARCH ARTICLE

SCREENS IN THE SLEEP ENVIRONMENT IN RELATION TO DURATION OF SLEEP AND RESTFULNESS AMONG YOUTH

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ABSTRACT

Back ground: Relation between inadequate sleep and health outcomes among youth require identifying its modifiable determinants. Television has been associated with reduced sleep time, but our knowledge about small screens influence is restricted.

Objectives Therefore, we analyzed the association of different screens in sleep environments with duration of sleep & perception of insufficient sleep or rest.

Materials & Methods: There were 892 participants constituting students from Private & Government Schools along with Government & Private Colleges in Kashmir valley in India in the year 2015. Using linear & logistic regressions, we examined cross sectional associations of small-screens & TVs in sleep environments and screen time with weekday sleep duration and perceived insufficient sleep or rest in the past week.

Results: People who slept near a small screen (compared with never) reported 97.8 minutes lesser sleep (95% confidence interval (CI), -113.9 to -81.7) and a higher prevalence of perceived insufficient rest or sleep (prevalence ratio, 2.25; 95% CI, 1.53 to 3.31). People who slept in a room with a TV (compared with no TV) reported 17.6 fewer minutes of sleep (95% CI, -33.9 to -1.3). Use of small screens and playing with video or computer games were associated with both sleep outcomes ($P < .05$).

Conclusions: Sleeping near a small screen, sleeping with a TV in the room, and more screen time with computer/video games playing was associated with shorter sleep durations. Presence of small screen in the sleep environment was also associated with perceived insufficient rest or sleep. Our findings warn us against unrestricted screen access in student's bedrooms along with excessive playing of computer/video games.

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INTRODUCTION

The cumulative evidence indicates use of technology is a novel risk factor against healthy sleep in childhood and later in life (Gamble *et al.*, 2014; Grandner *et al.*, 2013; Snell *et al.*, 2007; Hale *et al.*, 2015; Haug *et al.*, 2015; Lemola *et al.*, 2015; Bickham *et al.*, 2015). However, repercussions of interference due to technology in sleep environment is not limited to effect on sleep only. Improving sleep duration and quality may improve somatic and psychosocial health, school performance and risk taking behaviors among youth (Shochat *et al.*, 2014) and reduce Non Communicable Diseases like hypertension, coronary heart disease, and stroke in adulthood (Guo *et al.*, 2013; Cappuccio *et al.*, 2011). Sleep may also play key role in

immunity (Bryant and Curtis, 2013). Therefore, the continuous decline in child sleep duration throughout the past century is troubling (Matricciani *et al.*, 2012). Effective sleep promotion necessitates identifying its modifiable determinants in all age groups especially in youth's (students) environments and routines. Sleep curtailment has widely been attributed to life style change, especially technology. Further, introduction of new devices and the affordability of older technologies such as television (TVs), youth are now consuming media for the amount of time that most adults spend at work (Rideout *et al.*, 2010). Presence of a TV in a student's bedroom and TV viewing have been linked to shorter sleep duration, later bedtimes, and other dimensions of sleep (Cain and Gradisar, 2010). TV viewing is a risk factor for weight gain (Tremblay *et al.*, 2011; Falbe *et al.*, 2013), decreased academic achievement and behavioral problems (Tremblay *et al.*, 2011). Although there is ample evidence that food marketing mediates the TV-

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obesity relationship (Harris *et al.*, 2009; Halford *et al.*, 2007; Borzekowski and Robinson, 2001; Falbe *et al.*, 2014), sleep may also mediate this relationship and others. Possible mechanisms include direct displacement of screen time for sleep, increased cognitive and emotional arousal, and delays in circadian rhythm from screen light (Cain and Gradisar, 2010). Compared with TV, which involves passive observation, interactive media such as video games, tabs and smart phones may be more disruptive of sleep (Gradisar *et al.*, 2013). Smart phones and other internet-enabled small devices are particularly concerning, because they are portals to almost all content (e.g., games, videos, music, web sites, texts & email). Because these devices are held near the face, they may delay melatonin release more strongly than TV light, which decays with distances (Calamaro *et al.*, 2009). Despite the dramatic increase in the use of small screens, few studies have examined student's use of small screens in relation to sleep duration (Chahal *et al.*, 2013; Arora *et al.*, 2013; Yen *et al.*, 2008) and these studies have taken place outside India among predominantly white or Asian youth. However, the presence of a small screen in a student's bedroom may affect sleep beyond use, because unlike TVs, small screens can emit audible notifications (e.g., text messages) when not in use. These alerts may not only delay sleep but also interrupt it, thereby reducing overall sleep quality. We are aware of only one study assessing small screens in children's sleep environments and sleep duration (Chahal *et al.*, 2013).

MATERIALS AND METHODS

Participants and Setting

Data was collected in March through September 2015 by surveying various government and private institutes. Institutes were line listed and Probability proportionate sampling was used for selecting of schools and colleges. Four Schools (both govt. and private *in toto*) along with graduates and postgraduates under University of Kashmir got selected. Consent was taken from respective heads of the organizations and departments. Only those students who were residents of state of Jammu & Kashmir and had been residing in Kashmir for more than a year were included. Subjects who were under medication and suffered from any other morbidity were excluded.

Measures

Primary outcome were usual weekday sleep duration & perceived insufficient rest or sleep in the past week. Secondary outcomes were usual weekday bedtimes and wake times in the past week. The self reported wake time was subtracted from bed time in order to estimate sleep duration. Subject reported sleep durations from similar surveys have been moderately to strongly related with duration from actigraphy and sleep diaries (Matricciani, 2013). We assessed perceived insufficient rest or sleep in the past week by using an item modified Behavioral Risk Factor Surveillance System Questionnaire (Centers for Disease Control and Prevention (CDC) 2008). "On how many days in the past week you felt need of more sleep?" Response options ranged from 0-7 days. Because of its strongly bimodal distribution, perceived insufficient rest or sleep was modeled dichotomously, as feeling like more sleep was needed most days (i.e. >3 days) or ≤3 days. In a study examining perceived insufficient rest or sleep and chronic disease risk among adults, a similar cutoff was clinically meaningful (Shankar *et al.*,

2010). Primary exposures were screens in children's sleep environments, including small screens (e.g., smart phones) and TVs, assessed with the following item: "How often do you sleep with any of these devices (e.g. Smart phones, iPod Touch, cell phones) near where you sleep, such as in your bed or next to your bed?". Response options ranged from 0 to 7 days and were dichotomized as ever and never in the main analysis because of strongly bimodal distribution. Presence of a TV in sleep environment was determined by asking, "Is there a TV in the room where you sleep?". Additional exposures (TV or DVD viewing and video or computer games in the past week) by asking how much time students spent with each on a usual weekday and weekend in the past week. Moderate validity has been reported for similar surveys of child reported screen time (Gortmaker *et al.*, 1999; Schmitz *et al.*, 2004).

Covariates, included self reported gender, grade and physical activity. Assessment of physical activity was done by asking on which days in the last week students took part on physical activity that made their heart beat fast or made them breathe hard for ≥30 minutes. Days were summed and modeled continuously. Physical activity was included as a covariate to reduce confounding by common determinants of screen time and physical activity (e.g., Socio economic status (SES), parenting).

Analytic sample

Eligible participants (854 of 892) had complete data on sleep, screens in their environment, and covariates. Among 854 participants, 49 were excluded because of implausible sleep durations (ie, <3 hours or >16 hours) (Kim *et al.*, 2011). Therefore, our primary analytic sample consisted of 805 students.

Statistical Analyses

Using multivariate linear regression, we examined associations of screens in children's sleep environment and screen time with sleep duration, bed time and wake time. Multivariate log binomial regression (Spiegelman and Hertzmark, 2005) was used to examine associations between screens in children's sleep environment and perceived insufficient rest or sleep. For each outcome, we ran partially (model 1) and fully adjusted (model 2) models. Model 1 was adjusted for gender & grade. Model 2 additionally adjusted for physical activity and when exposures were screens in the sleep environment, Model 2 simultaneously examined presence of small screens and a TV in the same model; when exposures were screen time, model 2 simultaneously included hours per day of TV or DVDs and video or computer games. We examined heterogeneity by grade, gender, physical activity and tested for interaction between presence of a small screen and a TV by including cross products of these terms in model 2. Additionally, small screens can affect perceived insufficient rest or sleep beyond curtailing sleep (e.g., by interrupting sleep or shortening rapid eye movement sleep). Consequently, to examine associations between media and aspects of sleep beyond duration, model 3, a model with perceived insufficient rest or sleep as the outcome, additionally adjusted for sleep duration. We conducted analysis by using IBM SPSS Statistics (version 20) & SAS® University Edition software.

RESULTS

Mean age ± SD of the sample (Table 1) was 20.6 ± 4.3 years. The majority reported sleeping near small screens (83.4%) and

in a room with a TV (16%). The proportion of University students was highest for both small screens as well as TV in room (Fig. 1 and 2).

Table 2. Students who slept near a small screen reported 97.80 fewer minutes of sleep per weekday in the past week (95% confidence interval (CI), -113.9 to -81.7) than those who never

Table 1. Sample characteristics of 805 students attending different institutes in Srinagar city

| Student Characteristics, mean ± SD or % | Grade 11 (n=202) | Grade 12 (n=199) | College (n=203) | University (n=201) |
|--|------------------|------------------|-----------------|--------------------|
| Female (n) | 120 | 135 | 73 | 72 |
| Age in years | 17.2±0.2 | 17.9±0.3 | 22.1±0.1 | 26.1±0.1 |
| Obese | 29.2 | 22.2 | 24.3 | 22.7 |
| Days in past week participated in ≥30 min of physical activity | 0.5±0.5 | 0.7±0.6 | 0.6±0.5 | 0.6±0.5 |
| Screens in students sleep environment,% | | | | |
| Ever sleeps near a small screen | 92 | 46 | 96 | 98 |
| TV in room where student sleeps | 2 | 14 | 8.8 | 40.2 |
| Screen time | | | | |
| TV or DVDs (hrs/day) | | | | |
| On a usual day | 2.0±0 | 1.4±0.9 | 1.8±0.8 | 1.6±0.8 |
| On a weekend | 2.9±0.1 | 2.5±1.2 | 2.3±1.1 | 2.6±1.8 |
| Video or Computer games or Small screen games (hrs/day) | | | | |
| On a usual day | 2.5±0.5 | 2.1±1.2 | 2.3±0.7 | 2.4±0.9 |
| On a weekend | 4.9±0.2 | 3.1±1.5 | 3.3±1.3 | 3.5±0.9 |
| Outcomes, mean ± SD or % | | | | |
| Usual sleep duration per 24hr on a weekday in past week (hrs) | 05:0±0:12 | 07:48±1:24 | 07:30±1:36 | 06:48±1:42 |
| Perceived insufficient rest or sleep >3d in past week (%) | 78 | 56.2 | 53.6 | 60.1 |
| Usual bed time in the past week, hh:mm (24hrs clock) | 02:39±0:48 | 11:54±03:11 | 00:59±2:39 | 01:17±2:08 |
| Wake up time, mean ± SD | 07:56±0:20 | 07:24±1:03 | 08:26±1:26 | 07:42±0:49 |

Table 2. Associations of screens in student's sleep environment & screen time with typical week daily sleep duration in the past week

| | Weekday Sleep Duration, min | | R square |
|---|--|--|----------|
| | Model 1 (partially adjusted) ^a β(95% CI) | Model 2 (fully adjusted) ^b β(95% CI) | |
| Presence of Screen in Sleep Environment (n=805) | | | |
| Small Screen ^c | -109.7 (-126.9 to -92.9) | -97.8(-113.9 to -81.7) | 0.53 |
| TV ^d | -28.6 (-46.4 to -10.9) | -17.6 (-33.9 to -1.31) | 0.39 |
| Screen time, hrs/day (n=805) | | | |
| TV or DVDs (usual day) | -3.2(-12.2 to 5.7) | -3.5(-12.4 to 5.4) | 0.38 |
| Video or Computer or Mobile Games (usual day) | -0.4**(-7.4 to 6.5) | -0.8(-7.7 to 6.1) | 0.37 |
| TV or DVDs (weekend) | -7.0(-13.0 to -0.9) | -6.9(-13.0 to -0.8) | 0.42 |
| Video or Computer or Mobile Games (weekend) | -27.5 (-32.7 to -22.4) | -27.0 (-32.2 to -21.8) | 0.52 |

^a Results from multivariate linear regression models using generalized estimating equations for estimation, adjusted for grade, gender.

^b Additionally adjusted for days in past week participated in ≥30 min of physical activity, simultaneously included indicators for presence of a small screen and TV in the student's sleep environment for models examining screens in the sleep environment & simultaneously included hours per day of TV or DVD viewing & Video/Computer/Mobile game playing in models examining screen time.

^c The reference group reported never sleeping near a small screen in the past week.

^d The reference group reported never sleeping near a TV in the room in which they sleep.

Table 3. Associations of screens in student's sleep environment & screen time with perceived insufficient rest or sleep

| | Perceived Insufficient Rest or Sleep | |
|---|---|---|
| | Model 3a (partially adjusted) ^a PR (95% CI) | Model 3b (fully adjusted) ^b PR (95% CI) |
| Presence of screen in sleep environment (n=805) | | |
| Small Screen ^c | 2.6 (1.8 to 3.7) | 2.2(1.5 to 3.3) |
| TV ^d | 0.8(0.6 to 1.1) | 0.8(0.6 to 1.1) |
| Screen time, hrs/day (n=805) | | |
| TV or DVDs | 1.9 (1.0 to 3.6) | 1.3 (0.7 to 2.6) |
| Video/Computer/Mobile games | 3.7 (1.1 to 12.1) | 2.0 (0.6 to 6.8) |

^a Results from multivariate log binomial regression models using generalized estimating equations for estimation, adjusted for grade, gender.

^b Additionally adjusted for days in past week participated in ≥30 min of physical activity, simultaneously included indicators for presence of a small screen and TV in the student's sleep environment for models examining screens in the sleep environment & simultaneously included hours per day of TV or DVD viewing & Video/Computer/Mobile game playing in models examining screen time.

^c The reference group reported never sleeping near a small screen in the past week.

^d The reference group reported never sleeping near a TV in the room in which they sleep.

The 11th graders reported shortest sleep duration (5.0 ± 0.1 hrs) along with highest proportion of insufficient sleep or rest (78%). Both Duration of sleep and Perceived insufficient rest or sleep were normally distributed as established by Kolmogorov-Smirnov (KS) test. Associations between screens in sleep environments & duration of sleep are presented in

slept near a small screen, independent of having a TV in the room. Students who slept in a room with a TV reported 17.6 fewer minutes of weekday sleep (95% CI, -33.9 to -1.31) than those without a TV in their room, independent of small screens. Associations between screens in sleep environments and sleep duration were mainly because of delayed bedtime.

Sleeping near a small screen was associated with -114.0 minutes (95% confidence interval (CI) 130.9- 97.1) later bedtimes.

not a TV in the sleep environment was significantly related to perceived insufficient rest or sleep in the past week. Video games or computer/Small screen game playing were associated

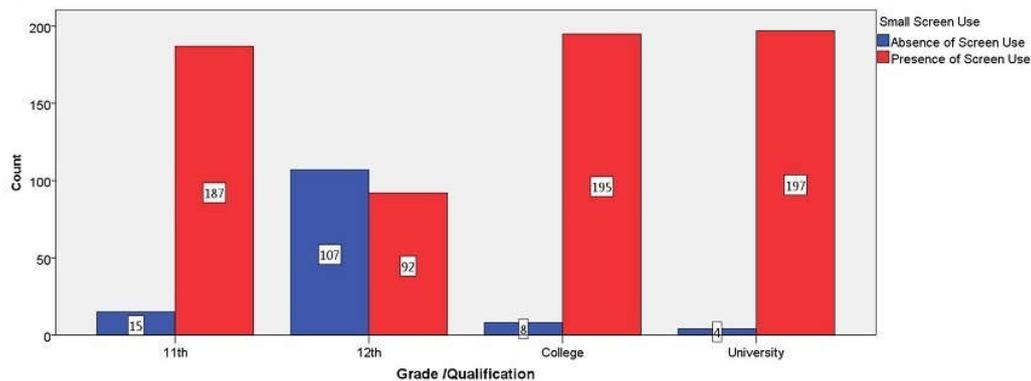


Figure 1 : Frequency of Small Screen Users with respect to Grades

Almost all the grades have higher number of small screen users except 12th grade possibly due to involvement in studies.

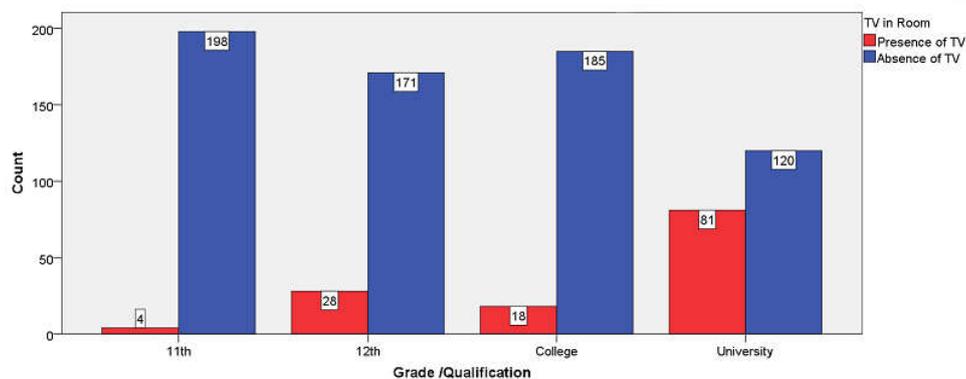


Figure 2 : Frequency of presence of TV in the room with respect to grades

Most of the students did not have a TV set in the room where they sleep with a higher proportion among University students compared to other grades.

We further categorized bedtime as an ordinal variable and applied the chi square which showed significant association between presence of a small screen and later bedtimes. By applying unpaired t test, a mean difference of 114mins was reported. Students who slept near a small screen slept 114mins later on an average than those not sleeping near a small screen. Table 3 shows results for perceived insufficient rest or sleep. Sleeping near a small screen, but not a TV was associated with 2.25 (95% CI, 1.53 to 3.31) times the prevalence of perceived insufficient rest or sleep. This did not vary significantly by grade, gender & physical activity. Among the 805 students with a screen time data, time watching TV or DVDs& playing video/computer games were associated with shorter weekday sleep durations (Table 2).Associations did not vary by grade, gender & were accounted for later bedtimes. Each hour spent with small screens & playing video or computer games (without adjustment for physical activity-Model 3a) was associated with a higher prevalence of perceived insufficient rest or sleep (Table3).

DISCUSSION

Among 805 students in Kashmir, students who slept near a small screen (compared with never) and students involved in playing games on computer/Small screens/video games had shorter weekday sleep durations. Presence of a small screen but

with shorter weekday sleep duration and perceived insufficient rest or sleep. Small screens were associated with shorter sleep durations in all groups. Associations between playing computer or video games and perceived insufficient rest or sleep were stronger among University students. The physical activity attenuated the association between small screen and perceived insufficient rest or sleep & also between playing video or computer games and perceived insufficient rest or sleep. Although most studies of stressors related to sleep have been conducted among adults, its possible that similar stressors increase youth's vulnerability to effects of screens on sleep. Stronger associations with small screens for younger youth may have been accounted for by differences in content or timing. For example, eleventh graders may be involved in more talking on the phone with people of opposite gender than University students, increasing impacts of screens on sleep (Swaleha, 2011). Lastly, physical activity has been associated with better sleep quality (Lang *et al.*, 2013; Yang *et al.*, 2012), an attribute that may partially compensate for sleep-disruptive activities such as video or computer game playing. These results suggest that effects of screens on sleep may not be experienced uniformly. This study makes a contribution by examining how sleeping near a small screen is associated with sleep, independent of the known association with TV in the bedroom, among diverse sample of students in the Kashmir valley. One other study has examined presence of cellular

phones and other small screen devices in a child's bedroom in relation to sleep duration among a predominantly Caucasian sample of fifth-graders in Canada (2013). The authors reported presence of cell phones or similar devices was associated with 26 minutes fewer per day of sleep. We observed a stronger magnitude of association, perhaps because of our use of student reporting rather than their use of parent report, our examination of weekday duration and different age groups. We also observed a higher prevalence of sleeping near a small screen (83%) than was found in the Canadian sample (17%).

Sleeping near a small screen was associated with 114 minutes of later bedtimes. Possible mechanisms include direct displacement of screen time for sleep, increased cognitive and emotional arousal, and delays in circadian rhythm from screen light (Cain and Gradisar, 2010). Compared with TV, which involves passive observation, interactive media such as video games, tabs and smart phones may be more disruptive of sleep (Gradisar *et al.*, 2013). Smart phones and other internet-enabled small devices are particularly concerning, because they are portals to almost all content (e.g., games, videos, music, web sites, texts & email). Because these devices are held near the face, they may delay melatonin release more strongly than TV light, which decays with distances (Calamaro *et al.*, 2009). One of the prime limitations of the study being we did not take these variables into account. Additionally, we found that student who slept near a small screen had a higher prevalence of perceived insufficient rest or sleep, even after adjustment for sleep duration, likely mediator. Perceived insufficient rest or sleep may reflect not only duration but also other sleep parameters, including poor quality, awakenings, or parasomnias. Exposure to stimulating content on small screens around bedtime and receiving calls or audible alerts while sleeping may alter these parameters. The 2011 sleep in America poll revealed that 18% of adolescents were awakened at least a few times a night by phones (Gradisar *et al.*, 2013). A longitudinal study of children in Belgium found that using mobile phones after lights out was associated with feeling very tired 1 year later (Van den Bulck, 2007). Our finding that a TV in the sleep environment was associated with shorter sleep duration is concordant with other studies (Garmy *et al.*, 2012; Li *et al.*, 2007; Mindell *et al.*, 2009; Owens *et al.*, 1999; Shochat *et al.*, 2010). Also consistent with the extant literature (Cain and Gradisar, 2010) is our finding that playing video or computer games were associated with shorter sleep duration & perceived insufficient rest or sleep. However, unlike small screens, TV presence was not significantly related to the perceived insufficient rest or sleep, perhaps because TV sets do not interrupt sleep when turned off. There were no relationship between sleep duration and playing computer games or video games in usual days as well as perceived insufficient sleep and Screen time in fully adjusted model (MODEL 2). The plausible explanation can be that subjects did not get apt time for playing games during weekdays due to the busy schedule on weekdays, however it needs to be evaluated further.

For all media, additional mechanisms that may underlie the screen-sleep relationship include direct displacement of sleep or of behaviors that may promote sleep with screen time; consumption of heavily advertised containing caffeine; evening exposure to bright, short wavelength light interfering with circadian rhythm (Lang *et al.*, 2013; Slopen and Williams, 2014); or increased cognitive, physiologic, and emotional arousal (Cain and Gradisar, 2010) after playing a video game (Higuchi *et al.*, 2005), watching an exciting movie or show, or

sending chats or texts. The large size of our sample enabled us to detect stronger associations between screens and sleep among some groups. The primary limitation of this study is its cross-sectional design, limiting our ability to make causal inferences. Although longitudinal evidence indicates that screens affect subsequent sleep. The relationship may be bidirectional. Another limitation is that measures were self-reported, introducing random error and possible social desirability bias. Additionally, we did not check media content, nor did we assess and therefore adjust for potentially important confounders, such as SES, parenting style (e.g., permissive parenting), or the over scheduling of youth. We did not conduct analyses with weekend sleep duration and daytime naps which would be apt if evaluated in future studies. The strength of the study is that it includes a large diverse sample investigated of differences by grade, gender and even students from different socioeconomic classes & definitely helped to address the dearth of studies assessing small screens and sleep.

Conclusion

Among a myriad sample of different grades, the presence of small screens was associated with shorter weekday sleep durations. Students who slept near a small screen & those with more screen time were more likely to have perceived insufficient rest or sleep in the past week. Although, longitudinal & experimental studies are needed to confirm these associations, our findings caution against student's unchecked access to screen-based media in their rooms. Further studies should perform detailed assessments of screen content to identify the types most strongly related to poor sleep. Longitudinal studies should also continue to examine the medicating contribution of sleep to screen time's impact on obesity & other outcomes.

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