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Title:

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Abstract

An important developmental task for adolescents is to become increasingly responsible for their own health behaviors. Establishing healthy sleep routines and controlling media use before bedtime are important for adequate, quality sleep so adolescents are alert during the day and perform well at school. Despite the prevalence of adolescent social media use and the large percentage of computers and cell phones in adolescents' bedrooms, no studies to date have investigated the link between problematic adolescent investment in social networking, their sleep practices, and associated experiences at school. A sample of 1,886 students in Australia from 12 to 18 years of age completed self-report data on problematic social networking use, sleep disturbances, sleep quality and school satisfaction. Structural equation modeling (SEM) substantiated our serial mediation hypothesis: for adolescents, problematic social networking use significantly increased sleep disturbances, which adversely affected perceptions of sleep quality that, in turn, lowered adolescents' appraisals of their school satisfaction. This significant pattern was largely driven by the indirect effect of sleep disturbances. These findings suggest that adolescents are vulnerable to negative consequences from social networking use. Specifically, problematic social networking is associated with poor school experiences which result from poor sleep habits. Promoting better sleep routines by minimizing sleep disturbances from social media use could improve school experiences for adolescents with enhanced emotional engagement and improved subjective well-being.

Introduction

Adolescents spend a great deal of time immersed in technology, and for some youth this can become problematic.^{1,2} Extensive use of technology, often accessible in the bedroom, raises a number of issues concerning adolescents' reliance on social media to fulfil their emotional needs. In particular heavy media use can alter sleeping and waking patterns¹ and thus undermine adolescents' performance at school.² Research investigating whether such excessive use of technology by adolescents has negative implications is growing.³⁻⁷ Studies have documented young people's growing dependency on social networking,⁹ labeling it a behavioral addiction (see Kuss and Griffiths⁸ for literature review) which is strongly correlated with other dysfunctional internet behaviors such as online gambling.⁷ Further, problematic use of social networking has been associated with negative indicators such as depression,¹⁰⁻¹¹ low self-esteem,¹² and suppression of empathic social skill.⁴ Because computers and online media devices have been woven into the fabric of our society, it is crucial to understand whether some young people may be vulnerable to problematic social networking use, and so to reduced sleep quality that is so vital for engaging in key aspects of daily life, particularly schooling.

Many parents, encouraged to develop a habitual bedtime routine for their young child, indicate "time for bed" or "lights out" by darkening their child's bedroom, yet this may not continue to signal for adolescents the same imperative to settle into a quality night's sleep. Rather, for some young people, social interactions with peers can occur via communication technology, 24 hours a day, 7 days a week and can interfere with the ability to get a good night's sleep. Developmentally, adolescents require about 9 hours of sleep per night and inadequate sleep on a regular basis can have adverse effects including decreased motivation.^{1,13} Time in bed often now includes sending and receiving text messages, posting on or perusing social networking sites, or gaming with on-line "friends", all of which can

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keep adolescents up well into the night, steadily eroding their sleep. Research has examined sleep patterns and technology use, and found both game playing and internet use are negatively related to good sleep patterns.¹⁴ Prevalence of mobile phone use after lights out is also linked to tiredness.¹⁵ Indeed, the hours devoted to media use can compete with sleep, leading to changes in adolescents' sleep habits and sleep time, resulting in a trend toward insufficient sleep and reduced sleep quality (See Cain and Gradisar¹⁶ for literature review).^{1,14,15} The more adolescents multitask with a variety of technological devices (texting, talking on the cell phone, using the internet, listening to an iPod), the fewer hours they sleep, which increases their daytime sleepiness.¹⁷ As a result, researchers suggest multitasking could put these students at risk for changes in their school performance.¹⁷ Although this has not yet been empirically tested,¹⁷ it may be that those adolescents who heavily invest in social networking become tired during the day and so encounter difficulties trying to meet the cognitive demands of study.

One of the most important tasks for adolescents is to positively engage in school and achieve to the best of their ability.¹⁸ Considering the amount of time students spend at school, it is important that their emotional appraisal of their school-related experiences, i.e. their school satisfaction, contributes positively to their subjective well-being.¹⁹⁻²¹ Students who are tired and sleepy in class have trouble performing tasks related to academic performance, such as effective time management, and sustaining effort, interest and attention, therefore they do poorly at school; and tired students feel less satisfied with their school experience.^{13, 22} Further, the use of social networking sites among college students has been linked to poor academic performance,^{23,24} with social networking use likely interfering with sleep. However, sleep deprivation has not yet been investigated as a negative consequence of social networking use, in relation to poor experiences in high school. Further, there are no studies of

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adolescents that explore the association between all three components; social networking, sleep habits, and subsequent school experiences.

The current study investigates the possibility of a developmental mismatch between adolescents' need for sufficient, uninterrupted sleep and adequate sleep quality to successfully navigate both school and their desire to socially network online. Identifying contexts (especially on-line) that hinder connections to school is an important and understudied area. Although research has established a link between adolescent sleep habits and academic outcomes, and separate research has demonstrated links between problematic adolescent media use and sleep habits, research is lacking that investigates how problematic investment in social networking relates to adolescent sleep patterns and school experience. We hypothesize that sleep disturbances and perceived sleep quality will play a serial mediating or explanatory role in the association between problematic use of social networking and school satisfaction.

Method

Participants

Data come from the Youth Activity Participation Study of Western Australia.^{25,26} Participants included 1,886 students (59.2% female) from thirty-two high schools (68% Metropolitan, 32% Regional). The mean age of the participants was 15 years ($SD = 1.41$ years) and youth ranged from 12 to 18 years of age. Of the sample, 71.4% of participants were Caucasian, 8.7% Asian, 1.9% Aboriginal or Torres Strait Islanders and 18% other. Socioeconomic status (SES) was measured at school level for survey schools²⁷ and obtained from the Australian Curriculum Assessment and Reporting Authority (ACARA), which computes the Index of Community Socio-Educational Advantage (ICSEA).²⁸ Schools are placed on a numerical scale that describes their comparative socio-economic advantage, and

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survey schools ranged between two standard deviations above and below the state mean on the ICSEA.^{27,28}

Materials and procedure

Data for this study were collected in 2010 and 2011. During a 45-minute classroom session participants entered responses onto laptops, or alternatively completed a paper and pencil version of the survey. Ethics approval to conduct research was obtained from the university Human Research Ethics Committee, the Education Department, and the Catholic Education Office. Study participation required active informed parent and student consent.

Measures

Problematic Social Networking Use was a latent construct that measured the degree to which adolescents' use of Social Networking Sites (SNS) affected their wellbeing. The construct consisted of four observed indicators (see Table 1). Possible responses ranged from 0 = *no SNS profile*; 1 = *completely disagree* to 5 = *completely agree*. These items were adapted from Young's²⁹ Internet Addiction Scale to reflect emotionally problematic use of SNS. *Sleep Quality* and *Sleep Disturbance* were latent constructs measuring adolescents' perceptions about sleep behaviors during the previous two weeks (see Table 1). Responses for all sleep indicators ranged from 1 = *never*; 2 = *once*; 3 = *twice*; 4 = *several times*; 5 = *every day/night*. These items were adapted from the School Sleep Habits Survey.^{13,22} *School Satisfaction* was a latent variable measuring adolescents' perceptions of how satisfied they were with their school experience (see Table 1). Responses on all indicators ranged from 1 (*not at all true for me*) to 5 (*very true for me*). These items were adapted from the Multidimensional Students' Life Satisfaction Scale (MSLSS).²¹ We controlled for relevant covariates including gender (0 = *female*, 1 = *male*), SES and age; both SES and age were mean centered.

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TABLE 1. LATENT CONSTRUCTS WITH MODEL FIT INDICES

Problematic Social Networking Use
1. I use SNS as a way of making me feel good.
2. I get into arguments with other people about the amount of time I spend on SNS.
3. I prefer to spend time on SNS rather than attend social activities/events.
4. If I can't access SNS I feel moody and irritable.
$\chi^2_{(2, n=1883)} = 4.943, p = .085, CFI = .998, RMSEA (90\%CI) = .028 (0.000-0.061)$
Sleep Disturbance
1. How often have you arrived late to class because you overslept.
2. How often have you fallen asleep in morning class.
3. How often have you stayed up until at least 3am.
Sleep Quality
1. How often have you felt satisfied with your sleep.
2. How often have you had a good night's sleep.
$\chi^2_{(4, n=1863)} = 7.197, p = .126, CFI = .997, RMSEA (90\%CI) = .021 (0.000-0.045)$
School Satisfaction (not identified)
1. School is interesting.
2. I enjoy school activities.
3. I look forward to going to school.
Measurement Model
$\chi^2_{(48, n=1882)} = 103.271, p = .000, CFI = .991, RMSEA (90\%CI) = .025 (0.018-0.031)$

Analysis

Covariance structure analysis, using the statistical software package *Mplus7.1*,³⁰ analyzed the measurement models using maximum likelihood estimation with robust standard errors (MLR).³¹ Bias-corrected (BC) bootstrap confidence intervals were used to generate an estimate for each indirect effect along with a 95% confidence interval to examine the significance and strength of a particular mediator in the multiple mediated model.³²⁻³⁵ This approach adjusts for non-normality and uses data from cases where the information is available to obtain estimates with missing data.³¹

We first performed a confirmatory factor analysis (CFA) to ensure that the measurement model was an appropriate fit, overall. Each of the latent constructs representing the conceptual variables for problematic SNS use, sleep disturbance, sleep quality, and school satisfaction were simultaneously estimated in the measurement model. We also divided the sample into two groups based on age (Age < 14.62=0), and gender (female=0), and estimated

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a multiple group measurement model. Chi-squared difference tests determined whether the items we used to measure our latent constructs adequately measured the underlying conceptual variables for each of the two age groups and gender.^{30,36}

Next, using Multiple Indicators, Multiple Causes (MIMIC) modeling,^{37,38} the observed variables, gender, age and SES were used to predict the unobserved latent variables in the overall sample; problematic SNS use, sleep quality, sleep disturbance, and school satisfaction. Finally, we hypothesized a serial mediation model,³⁹ whereby problematic social networking increased sleep disturbance, which in turn decreased sleep quality and, in turn, reduced students' satisfaction with their school. We used the product of coefficients approach,³²⁻³⁵ calculating the indirect effects by multiplying the path coefficients that link problematic SNS (X) to school satisfaction (Y) through the mediators, sleep disturbances (M_1) and sleep quality (M_2) as shown in Figure 1.

INSERT FIGURE 1 HERE

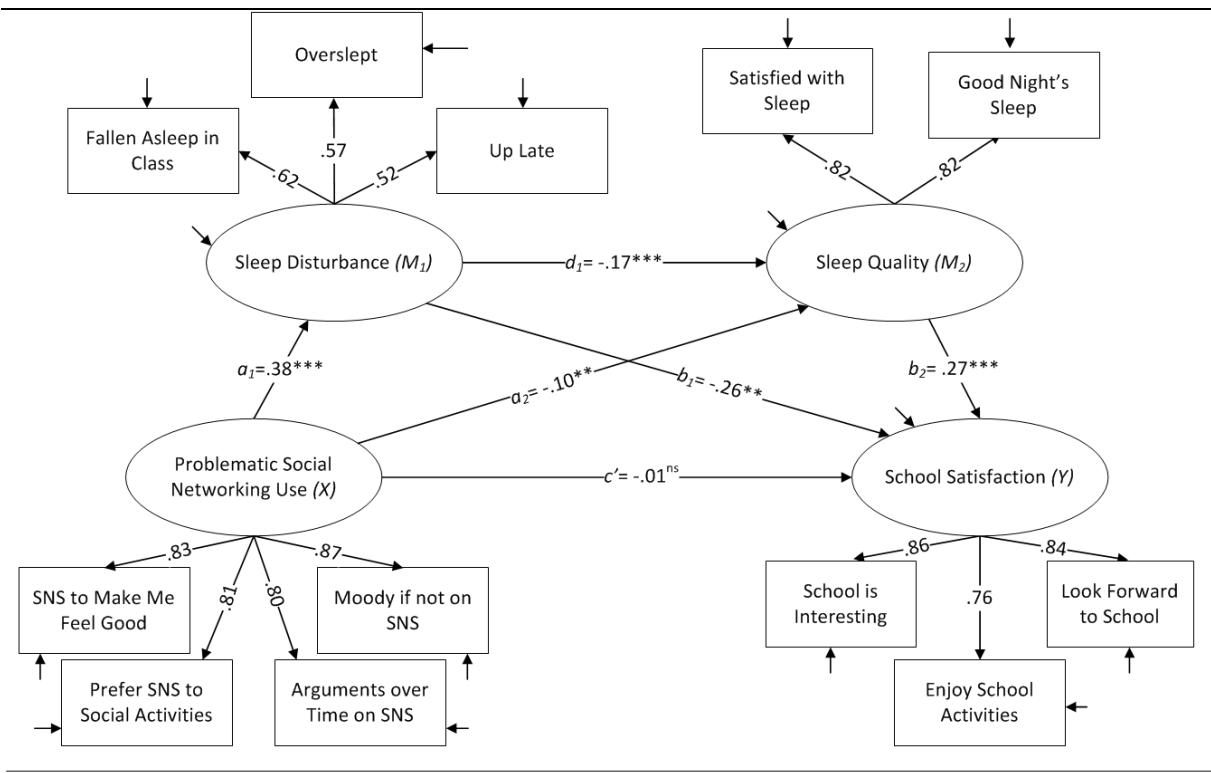


Fig.1. Research Model and Test Results

Results

Descriptive data (means, standard deviations) for gender, SES, age, the four latent variables Problematic Social Networking, Sleep Disturbance, Sleep Quality, and School Satisfaction, along with correlations among the variables, are presented in Table 2.

INSERT TABLE 2 HERE

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TABLE 2. CORRELATIONS AND DESCRIPTIVE STATISTICS

<i>Variables</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
1. Problematic SOCIAL NETWORKING	–					
2. Sleep Disturbances		.38***	–			
3. Sleep Quality			-.17***	-.20***	–	
4. School Satisfaction				-.33***	.33***	–
5. <u>Gender^a</u>					-.06*	–
6. <u>Age^b</u>						–
7. Socioeconomic Status ^c	.01					
<i>M</i>	1.36	1.46	3.50	3.18		
<i>SD</i>	.98	.65	.99	.97		
Range	0-5	1-5	1-5	1-5		

Note. ^aGender: 0 = female, 1 = male. ^bAge: Mean centered. ^cSocioeconomic status: Mean centered. **p* < .05. ***p* < .01. ****p* < .001.

The measurement model, demonstrated good fit $\chi^2(48) = 103.271$, $p = .000$, CFI=.991, RMSEA (90%CI) = .025 (0.018-0.031). Incremental fit indices were used to test for measurement invariance for age and gender.^{30,36,40,41} Although weak factorial invariance was supported meaning the different gender and age groups employed the same conceptual framework to answer the survey items,³⁶ scalar invariance was not achieved for either age or gender. Therefore both were included as predictors for the mediators, thus removing any secondary influences related to the association between the latent variables.^{37,38} MIMIC modeling investigated direct and interaction effects of covariates, age, gender, and SES, with good fit $\chi^2(104) = 332.17$, $p < .001$, CFI=.972, RMSEA (90%CI) = .033 (0.029-0.038). Further information related to the measurement and MIMIC models is available from the author. Finally a structural model was estimated to examine the direct and indirect relations between the latent variables of interest and the background variables for gender, age and SES.³³⁻⁴¹

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Sleep Quality and Sleep Disturbances as Serial Mediators

A focal question of the study was whether problematic SNS use influenced students' school satisfaction by adversely affecting their sleep. This hypothesis was modeled and tested by setting direct paths from problematic social networking to sleep disturbances, sleep quality and school satisfaction, as well as a serial mediation pathway through sleep disturbances and sleep quality to school satisfaction (see Figure 1) while statistically controlling for gender, age, and SES (not depicted in Figure 1). The data fit the model well, $\chi^2 (75) = 348.319$, $p=.000$, CFI=.971, RMSEA (90%CI) = .044 (.039 - .049).

Results are presented in Figure 1 and Table 3 and indicate a significant indirect path, such that participants with problematic social networking behavior experienced sleep disturbance which in turn was associated with a perception of poor quality sleep and a stronger dissatisfaction with their schooling. A bias-corrected bootstrap confidence interval for the total indirect effect, ($a_1 b_1 + a_2 b_2 + a_1 d_1 b_2 = -0.128$; CI = -0.167 to -0.093) indicated a significant effect between problematic social networking, sleep quality, sleep disturbance and school satisfaction. There was no evidence that problematic social networking influenced school satisfaction independent of its effect on sleep disturbance and on sleep quality ($c' = -.012$, $p=.666$). Examination of the single mediator paths compared to the serial mediation showed problematic social networking use had a stronger influence on school satisfaction through sleep disturbance in isolation ($a_2 b_2 - a_1 b_2 d_1 = -0.064$; CI = 0.110 to -.028) than through the serial mediation which also included sleep quality.

INSERT TABLE 3 HERE

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TABLE 3.PATH COEFFICIENTS, INDIRECT EFFECTS AND 95% BIAS-CORRECTED BOOTSTRAPPED CONFIDENCE INTERVALS CORRESPONDING TO THE THREE-PATH MEDIATION MODEL

Antecedent	Consequent									
	<i>M₁</i> (Sleep Disruptions)			<i>M₂</i> (Sleep Quality)			<i>Y</i> (School Satisfaction)			
	Estimate	95% BC Bootstrap CI		Estimate	95% BC Bootstrap CI		Estimate	95% BC Bootstrap CI		
		Lower	Upper		Lower	Upper		Lower	Upper	
Total Effect							' <i>c</i> '	-0.139	-0.185	-0.087
Direct effect							' <i>c'</i>	-0.012	-0.060	0.049
<i>X</i> (SNS)	' <i>a</i> ₁ '	0.161	0.124	0.207	' <i>a</i> ₂ '	-0.081	-0.127	-0.018		
<i>M₁</i> (Disruption)					' <i>d</i> ₁ '	-0.310	-0.528	-0.139		
<i>M₂</i> (Quality)							' <i>b</i> ₁ '	-0.547	-0.788	-0.355
<i>C₁</i> (GENDER)	0.147	0.091	0.203		0.266	0.018	0.366			
<i>C₂</i> (AGE)	0.014	-0.005	0.036		-0.048	-0.077	-0.013	0.009	-0.022	0.044
<i>C₃</i> (SES)	-0.001	-0.001	0.000		0.001	0.000	0.001	0.002	0.001	0.002
Indirect Effects										
<i>a</i> ₁ <i>b</i> ₁		-0.088	-0.129	-0.058						
<i>a</i> ₂ <i>b</i> ₂		-0.024	-0.042	-0.006						
<i>a</i> ₁ <i>d</i> ₁ <i>b</i> ₂		-0.015	-0.026	-0.008						
Total Indirect		-0.128	-0.167	-0.093						
# <i>a</i> ₁ <i>b</i> ₁ - <i>a</i> ₂ <i>b</i> ₂		-0.064	-0.110	-0.028						
# <i>a</i> ₁ <i>b</i> ₁ - <i>a</i> ₁ <i>b</i> ₂ <i>d</i> ₁		-0.073	-0.112	-0.043						
# <i>a</i> ₂ <i>b</i> ₂ - <i>a</i> ₁ <i>b</i> ₂ <i>d</i> ₁		-0.009	-0.031	0.014						

Note: Models include covariates gender, age, SES; age and SES centered at means.[^]The coefficients for *a*, *a*₂, *b*, *b*₂, *c*, *c'*, *d*, *d*₁ refer to the paths in Figure 1. # Comparison of multiplicative paths and bootstrap CI's

Discussion

The purpose of this study was to examine the role of sleep in the association between problematic social networking use and students' satisfaction with schooling. A serial mediation model confirmed that sleep disturbances and sleep quality mediated the association. Students reporting high levels of problematic social networking use reported more sleep disturbance problems which in turn were associated with lower sleep quality, resulting in lower school satisfaction. Notably, sleep disturbance exerted a stronger influence on school satisfaction than did sleep quality. This makes sense as the indicators of disturbance – staying up until at least 3 a.m., arriving late to school because of oversleeping, and falling asleep in morning class – impair every aspect of the school experience. When tired students try to engage in school activities, their resulting emotional evaluative response toward their school satisfaction will be low compared to students who routinely get a good night's sleep.

Consistent with our predictions, we found that poor sleep habits were an important underlying mechanism that helped explain why students with problematic SNS use reported

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low school satisfaction. When youth use their SNS at appropriate times of the day, and not into the night, they are less likely to experience sleep disturbance and so report better sleep quality which in turn is associated with an evaluative response that their school experience was positively contributing to their subjective well-being.¹⁹ This finding is congruent with previous research, which shows that the protective effects of a good night's sleep improve academic performance.^{13,22,42-44}

One of the factors that contributes to problematic SNS use for adolescents included using social media as a *way of making them feel good* (Table 1) so if students have a poor experience at school they may tend to increase social media use to improve feelings of well-being. This over-use may then further disturb their sleep, and lead to lower satisfaction with their school the next day. This finding affirms the value of good sleep habits for adolescents' subjective sense of well-being as they undertake their student role.

Several limitations need to be considered when interpreting the results of the present study. First, we cannot make causal inferences from these cross-sectional data. Studies using longitudinal data could provide further evidence for the effects found in this study particularly related to following the trajectories of students to examine associations over time. Second, data were based on students' retrospective self-reported measures of their sleep habits. Although previous research has shown that retrospective self-report measures of sleep quality as collected in this study do not contain strong bias,⁴⁵ future studies may benefit from using technology to capture real time sleep patterns.

Despite these limitations, this research has practical implications. Our results suggest that parents should consider limiting adolescents' access to mobile technology (computers and cell phones) in the bedroom to reduce the risk of poor sleep habits and associated poor school experience. Students who are identified as problematic users of SNS have associated

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problems with their sleep, suggesting they continue to use social media after bedtime or lights out.¹⁵ Given the fact that a positive school experience is associated with strong academic achievement,^{19,20} parents will likely wish to maximize their child's emotional engagement in school^{42-44,46} by making sure they have undisturbed, quality sleep. Well-rested students find school both enjoyable and interesting.

Our findings could also inform school curriculum and pedagogy. Illustratively, high schools could include course content detailing positive sleep habits, and could provide opportunities for students to develop and monitor their own individualized sleep schedules. Students could examine their sleep habits with an associated behavioral analysis of their SNS practices (i.e. monitoring bedtimes, checking for excessive use of social networking sites past bedtime, and feelings when using SNS), and reporting their tiredness and related emotional evaluation of their daytime school experiences. When provided with information about the importance of regular sleep patterns, adolescents will arguably be better equipped to make healthy lifestyle choices. At a minimum, such knowledge may facilitate students' acceptance of the potentially fraught job of parents in monitoring night-time technology use.

Author Disclosure Statement

No competing financial interests exist.

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