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A process-oriented model linking adolescents' sleep hygiene and psychological functioning: the moderating role of school start times

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ABSTRACT

Objective: To examine a mediational model linking sleep hygiene to better mental health in adolescents via the mechanism of improved sleep quality, and to test the moderating role of school start times (SST) (before 8:30 AM vs. 8:30 AM or later) on that mediation model.
Design: Cross-sectional.
Setting: Online survey for high school students across the United States.
Participants: A total of 197 adolescents aged 14–17 years old (M_{age} = 15.6 years, SD = 1.8; 53% female) completed a baseline survey and 7-day sleep diaries; their parents (M_{age} = 47.7 years, SD = 5.5; 79% female) reported on family socioeconomic status and high SST.
Measurement: Adolescents reported on their sleep hygiene, circadian chronotype, daily levels of sleep quality and duration (morning diaries) and their depressive/anxiety symptoms (evening diaries) for 7 days.
Results: A moderated-mediation model suggested that baseline sleep hygiene was directly associated with lower average daily depressive/anxiety symptoms across all students, but that association was marginally stronger in students with later SST (8:30 AM or later). A mediated path emerged only for students with earlier start times, suggesting that, for those students, baseline sleep hygiene was indirectly associated with lower average daily psychological symptoms by improving average daily sleep quality.
Conclusions: The current study is one of the first to demonstrate that SST might serve as a critical moderator in models of adolescent sleep and daily functioning. The findings provide additional evidence in the debate on how SST may affect adolescent health.

Approximately 90% of high-school aged adolescents get either insufficient sleep during school nights or barely meet the required amount of sleep (ie, 8–10 hours) expected for healthy functioning.[1] In fact, sleep problems and insufficient sleep are so pervasive for adolescents that they could be considered an epidemic due to their adverse impact on adolescent mental and physical health.[2–5] As a result, addressing insufficient adolescent sleep represents a critical point of study and intervention. The growing body of evidence suggests that later school start times (SST), 8:30 AM or later as recommended by the American Academy of Pediatricians,[6] convey multiple benefits on adolescents, including improved sleep, better mental and physical health, and improved academic outcomes.[7–10] This research, however, has focused on the direct effects of delaying SST, or specifically how moving SST back directly predicts changes in an outcome (eg, mental health, academic achievement). This type of analysis precludes examining the important role that SST might play as a condition or context under which other sleep-related processes take place. For instance, earlier SST might exacerbate the impact of sleep-related processes on adolescent behavioral health outcomes. Thus, incorporating SST as a larger contextual variable that might moderate models of sleep and adolescent functioning represents a gap in the literature and a unique opportunity to advance conceptual models. Accordingly, the current study examines the moderating role of SST on the associations between sleep hygiene, sleep quality, and mental health.

The importance of sleep hygiene

One line of research addressing insufficient adolescent sleep has focused on sleep hygiene, which refers to behaviors that promote

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good sleep quality, sufficient sleep duration, and full daytime alertness.[11] Examples of good sleep hygiene include not drinking caffeinated beverages after 6 PM, limiting cognitively stimulating activities (eg, watching television, playing videogames) before bed, and maintaining a consistent bedtime routine. Several studies indicate that good sleep hygiene predicts better sleep quality and psychological functioning, and sleep hygiene has emerged as a critical point of intervention.[1,11–15] Accordingly, sleep hygiene-focused interventions (eg, the Sleep Smart Program) have demonstrated benefits to both sleep quality and psychological functioning both in early adolescents[16,17] and college students.[18] Despite such findings supporting the efficacy of these interventions, the results have been mixed, with some sleep hygiene-focused intervention studies failing to yield significant results.[19,20]

Sleep quality as a mechanism

Sleep quality may be a mechanism to explain how sleep hygiene might promote psychological functioning. Sleep hygiene improves sleep quality,[18] and extensive work links poor sleep quality and adolescents' mental health problems.[1,21–24] Taken together, these studies suggest a mediational model in which adolescents with poor sleep hygiene (eg, irregular bedtimes, pre-bed media usage, excessive napping) will generally struggle with poor quality sleep (eg, trouble getting to sleep, restless sleep, awaking fatigued), which, in turn, will increase the likelihood of mood disturbance (see Fig. 1). Although such a mediational model has been examined in college students,[15] it has yet to be examined in high school students. As a result, the current study sought to address this gap in the literature by examining sleep quality as a potential mechanism (ie, mediator) linking sleep hygiene to psychological functioning.

School start times

Despite such calls for high schools to move their SSTs to 8:30 AM or later,[6] only approximately 14% nationwide have done so.[25] To date, the research in this area has focused on the benefits of delaying start times for adolescent health by examining SSTs' role as a main effect (ie, directly predicting changes in behavior).[6] To extend this line of research, the current study addresses the calls for more comprehensive modeling of sleep processes[26] by examining a novel role of SSTs as a moderator of links between sleep hygiene, sleep quality, and psychological functioning. More specifically, the study conceptualized early SSTs as an external stressor that may exacerbate the impact of poor sleep hygiene and sleep quality on adolescent behavioral health. In contrast to the general pattern of findings, several studies attempting to link sleep hygiene improvements with these outcomes have failed to yield improvements on either sleep quality[19] or sleep patterns,[20] which supports the search for a moderator of those links. The presence of possible moderators, such as SSTs, could help to explain these mixed findings. In an effort to increase our understanding of how best to address adolescents' sleep issues and their negative sequelae, the current study sought to capitalize on naturally occurring variation in SST to examine if SST might moderate the hypothesized connections between sleep hygiene, sleep quality, and psychological functioning.

The current study

The current study sought to examine a moderated-mediation model (Fig. 1) in a sample of 197 14–17 year old high school students who completed a baseline survey and daily morning and evening diaries across 7 days. **Hypothesis 1.** We hypothesized that adolescents' baseline sleep hygiene practices will predict lower levels of average daily depressive/anxiety symptoms across the diary reports. **Hypothesis 2 (mediation).** We hypothesized that average daily sleep quality will mediate the association between adolescents' baseline sleep hygiene practices and their average daily depressive/anxiety symptoms. **Hypothesis 3 (moderation of the mediation model).** We hypothesized that early SSTs (before 8:30 AM) would magnify the adverse effects of poor sleep hygiene and poor sleep quality on depressive and anxiety symptoms. Given findings linking the constructs in the model and their previously reported associations to adolescents' age,[24] gender,[27] socio-economic status,[28] sleep duration,[29] and circadian chronotype,[30] we further hypothesize that these associations would continue to emerge even after accounting for these key covariates.

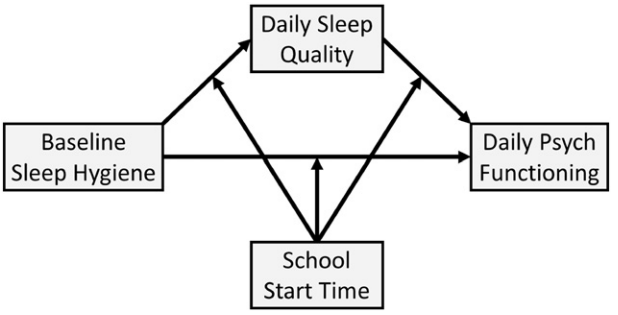

Fig. 1. Conceptual moderated-mediation model.

Method

Participants

Recruitment

In order to participate, adolescents had to be in 9-11th grades in either a public or private day school within the United States, between the ages of 14 and 17, living 7 days/week in the participating family's household (ie, not attending a boarding school), and both parent and child had to agree to participate. Parent–child dyads located near the authors' institutions were recruited through direct solicitation (eg, receiving a study brochure following a brief presentation at school), emails to distribution lists (eg, parenting groups), and through a non-profit national registry of study volunteers (ResearchMatch).

Procedure

The study was approved by the local Institutional Review Board and informed consent from parents and assent from adolescents was obtained prior to participation. The baseline survey took roughly 20–25 min. to complete; respondents were compensated $10 each as an incentive. After completing the baseline survey, adolescents were invited to complete the follow-up survey, a 7-day daily sleep diary. Adolescent respondents received $15 for completing a minimum of 4 morning and evening diary entries, an entry to win a lottery prize (an iPad mini) for every diary entry completed, and brief feedback on their sleep (eg, average bed/waketimes) based on the diary data they provided as incentives for completing daily diaries.

Longitudinal follow-up assessments

During the baseline survey, parents and adolescents provided their own email addresses (to obtain a dyadic sample), and parents set a start date for their child to complete the 7-day sleep diary, which was completed each day within an hour of waking up (morning diary) and within an hour of going to sleep (evening diary). A total of 190 adolescents (96%) completed at least 2 days of the daily diaries. Among those giving diary data, respondents

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