



EDITORIAL

Current scholarship and future questions on delayed school start times for adolescents' sleep and well-being

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Over the last 25 years, we have developed a clear understanding of the implications of early school start times for delayed and insufficient sleep for adolescents and, in turn, the consequences include daytime sleepiness, challenges to academic performance, increased automobile accidents, substance use, emotional instability, and health concerns including weight gain and obesity [1–6]. Likewise, increasingly, researchers, educators, health care providers, secondary school administrators, and families are collaborating on research, policy changes, and the practical work needed to carefully consider how to effectively implement such a countermeasure to insufficient sleep: later school start times for middle and high school-age adolescents (e.g. Refs. 7–10). Since Carskadon and colleagues' landmark study [11] demonstrating that adolescents' biological sleep-wake schedules are constrained by early school start times, three recent systematic reviews and a recent special issue on school start times in *Sleep Health* capture the body of work, to date, on school start times and adolescents' sleep [8, 12–14]. Taking these reviews together, there is significant evidence that delaying start times at the middle and high school level increases school-night sleep duration by at least 30 min, primarily by delaying rise times, and that later start times generally correspond to improved attendance, lower tardiness records, better grades, improved mood, decreased school health center/nurse's office visits, and fewer motor vehicle crashes [8, 12–18].

At this juncture, additional and new questions arise regarding the effectiveness of delaying school start time for adolescents' sleep and other outcomes including cultural nuances and differences, sustained benefits, role of sleep knowledge and hygiene, and a range of implementation and assessment questions that are particularly relevant to policy and education experts and researchers. Furthermore, the overwhelming majority of school start time outcome studies, to date, were convenience studies, utilized self-reported sleep patterns and other variables, and were conducted in the United States [12–19].

Lo and colleagues' recent study, "Sustained benefits of delaying school start time on adolescent sleep and well-being," investigated four understudied areas—cultural factors, role of parents and students views on school schedule changes, longer-term ramifications, and the use of actigraphy in assessing the impact of delayed school start times [20]. Specifically, they centered their study in Singapore where education is highly valued, managed by the Ministry of Education, and is ranked as one of the strongest in the world according to various rankings including the Programme for International Student Assessment (Pisa), World Economic Forum (WEF), and the Organization for Economic Co-operation and Development (OECD). This well-designed study addresses some of the gaps in our knowledge regarding the benefits of later school start times for adolescents. First, high school-age students self-reported increased total sleep, lower levels of subjective sleepiness, and improved mood at 1 and 9 months following a 45 min delay in school start time [20]. Few studies have documented the sustained benefits of later school start times for adolescents. One study conducted in our lab compared students attending an early versus late starting middle school and found that seventh and eighth graders at the later starting school reported sleeping an average of just over 50 min longer on school nights due to getting up over an hour later, less daytime sleepiness, and four times fewer times being late to school (i.e. school transcript tardiness record) than students at the earlier starting school [17]. Similar to Lo and colleagues, these benefits were sustained approximately 7 months later at a spring assessment. Second, Lo et al. report that actigraphically estimated sleep increased at 9 months only, and by only 10 min. As the authors discuss, the delayed increase in actigraphically estimated sleep might suggest that it takes some time to realize the benefit of the school start time change [20]. This explanation, however, is surprising as the overwhelming majority of studies' have found that adolescents report increased sleep duration due to a delayed rise time following a delay in middle and high school

start times. Furthermore, studies have documented significant agreement between self-reported and actigraphically estimated school-night sleep times [21]. Nonetheless, as the authors point out, participants' self-reported that total sleep times might be overestimated in comparison to actigraphically estimated. Future studies might want to examine this further [20].

Third, the difference between weekend and school-night self-reported time in bed and actigraphically estimated total sleep was significantly decreased following the delay in school start time [20]. As the authors also emphasize, it seems clear that the delayed school start time significantly decreased their sleep debt and jet lag. Finally, the majority of students, teachers, and parents were supportive of the schedule change [20]. It is noteworthy that the researchers included this in their analyses and discussion, suggesting that the schools' engagement in promoting sleep and the delayed school start time might have added to the success. Studies, to date, have not examined the role of sleep education, often geared more towards individuals, in possibly increasing the impact of establishing later school start times. Yet, an increasing number of studies have developed and evaluated the effectiveness of sleep hygiene prevention/intervention programs for children and adolescents, and future research might want to consider the role of sleep education in connection to school start time countermeasures [22–24].

Keeping the study's significant findings in mind, there are a few shortcomings and questions regarding Lo and colleagues' study. As the authors readily acknowledge, one limitation of this study is the lack of a comparison group with no or a different school schedule change [20]. This is not a new concern as the overwhelming majority of studies, to date, have been convenience designs rather than experimental approaches. The sample is not diverse and focuses on girls only and, therefore, if it were not for the numerous prior studies reporting similar results, it would be difficult to generalize the findings. Similarly, although the study assessed a school in Singapore, findings cannot be generalized to Southeast Asia as countries, cultures, and educational systems vary greatly throughout the region. Furthermore, although the 9 month follow-up assessment adds to the literature regarding the impact of delaying school start times, it will be helpful to continue to follow the participants as they progress through high school in to college and develop as emerging adults. To the best of my knowledge, few studies have followed adolescents longitudinally with an eye on sleep and daytime functioning, particularly with regards to examining students attending early versus later/delayed school start times.

Thus far, a few key reviews along with the American Academy of Pediatrics and the American Academy of Sleep Medicine policy statements on school start times have examined the scholarship on school start time interventions to improve adolescents' sleep and well-being [8, 12–14, 25, 26]. Researchers are encouraged to examine these systematic reviews as in addition to providing a summary of the work thus far; they thoughtfully discuss future research questions and gaps in the field. Some of the gaps are addressed in Lo and colleagues' study including sustainability, examination of school start time changes outside of the United States, and the use of actigraphy in the assessment process [20]. Future directions might include outcome measures beyond academic achievement and mood, including measures of mental health, risk behaviors in addition to automobile crashes, and health ramifications such as eating behaviors and body mass index. Moreover, similar to the importance of examining cultural

differences and with an increased understanding of sleep-health disparities, it is important and timely to continue to take culture and social class into account in research and policy around delaying school start times for adolescent sleep health [27–30]. Some of these conversations are taking place; for example, the author recently chaired a symposium titled, *School Start Time Change for Adolescents: Finding Solutions for a Global Epidemic*, at the 5th congress of the International Pediatric Sleep Association (IPSA [31]). Some of these cross-cultural dialogues have raised new questions including as follows: how late is too late for school start times for adolescents? What are the implications of alternating school start times whether it is morning and afternoon start times across a week or by semester or rotating start times across the week? What is the role of culturally relevant sleep education or the development of healthy sleep health practices in the successful implementation of delayed school start times?

Finally, as my colleague, Wendy Troxel, and I discussed in the introduction to *Sleep Health's* special issue, "The intersection between sleep science and policy: introduction to the special issue on school start times," the scholarship continues to reliably demonstrate the scope of benefits to delaying school start times for adolescents' sleep, well-being, and success, and a lack of evidence of negative implications of later middle and high school start times [12]. Lo and colleagues' study further adds to this significant body of research with their examination of the effectiveness of a later high school start time for adolescents growing up Southeast Asia, specifically Singapore.

Note

Conflict of interest statement. Dr. Wolfson is a member of the Board of Directors of Start School Later (<http://www.startschoollater.net/>).

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