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The intersection between sleep science and policy: introduction to the special issue on school start times

Introduction

Over the last three decades, there has been tremendous growth in our understanding of adolescents' sleep–wake patterns, circadian timing, underlying bioregulatory processes, and environmental factors and constraints, as well as the consequences of insufficient sleep for adolescents' brains, bodies, and behavior. Despite these scientific advances, however, minimal progress has been made in increasing the number of adolescents who are regularly obtaining adequate sleep, with some evidence even suggesting a decline in adolescent sleep.¹

Numerous factors have been identified at the individual, family, and societal levels that contribute to the quality, timing, and duration of adolescent sleep.^{2–5} To date, however, only one modifiable, policy-level countermeasure has been identified as directly contributing to adolescent sleep deprivation: early school start times. School start times are currently being debated in school districts across the United States and in other countries as well.

Later school start times and the implications for adolescent sleep represent an important and rare example of the intersection between sleep science and education policy. Consistent with the mission of this journal, to provide an “evidence-based voice that elucidates sleep's role in population health”, by exploring multiple perspectives that extends across diverse sleep-related fields, including public policy, education, health services research and implementation science, human development, law, psychology, and other disciplines, we are delighted to serve as Guest Editors of this special issue that focuses on the state of the science of school start times and adolescent health. To provide context for the broad and multi-disciplinary perspectives represented in this special issue, we provide a brief historical perspective on the scientific basis for delaying school start times for adolescent-age students and the intersections with education policy. Following a discussion of this historical foundation, we summarize several key themes raised by the articles in this special issue and point to some next steps for the field.

A brief historical perspective

Following earlier studies that demonstrated adolescents' continuous sleep need and delayed weekend versus school night sleep patterns,^{6–9} in 1993, Dr Mary Carskadon and colleagues published a landmark study¹⁰ that documented an association between more

mature pubertal development and delayed (ie, later) circadian preference. Further, Carskadon concluded that “[T]he starting time of school puts limits on the time available for sleep. This is a nonnegotiable limit established largely without concern for sleep.”^{10,11} Since these groundbreaking early studies, research on the maturation of the biological regulation of sleep, has continued and expanded over the past 25 years, demonstrating that during adolescence: the circadian timing system undergoes a phase delay which is due to two significant biological changes in sleep regulation: (1) a delay in the release of melatonin across adolescence resulting in difficulty falling asleep at an earlier bedtime and (2) an altered “sleep drive” where the pressure to fall asleep builds up more slowly over adolescence making it difficult to fall asleep after being awake in older versus younger teenagers.^{7,12–15}

Inspired by Carskadon and others' early research on adolescent sleep–wake biology, in 1994, Dr Mark Mahowald, then Director of the Minnesota Regional Sleep Disorders Center, and his colleagues at the Minnesota Medical Association (MMA) urged all Minnesota school districts to eliminate early starting school hours for teenagers.¹⁶ Based on this recommendation and under the leadership of superintendent, Kenneth Dragseth, Edina, MN, voted to delay their high school start times, beginning with the 1996–97 academic year from 7:20 to 8:30 AM. Seven high schools in Minneapolis, MN delayed their start times from 7:15 to 8:40 AM the following year. The districts asked Dr Kyla Wahlstrom, Director of the Center for Applied Research and Educational Improvement (CAREI), University of Minnesota, to study the impact of the SST change in these two districts, representing different size, socioeconomic groups, and other contrasting factors.¹⁷ Wahlstrom's study of over 18,000 high school students demonstrated increased attendance among 9th through 11th graders, improved high school enrollment, and slight improvement in grades. Moreover, the high school students had similar bedtimes to students from other earlier starting schools, despite the delay in school start time. Further, on average, students at the later starting high schools got almost 1 hour more sleep each school night.¹⁸

Over this time period, US school districts have worked largely on their own and/or in collaboration with clinicians, researchers, and organizations, including the Centers for Disease Control and Prevention (CDC), Start School Later, and other public and private advocates to implement healthy school start times for middle and high school-age adolescents. Although there is no systematic tracking of the number of schools that have heeded the science and made the change for

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later start times for adolescents, an ever-growing number of school districts have already or are actively considering delaying their start times, including large and diverse districts, such as Seattle Public Schools (Washington) or Fairfax County Public Schools (Virginia), and smaller districts as well. The increasing momentum in the movement for later start times has been spurred, in part, by increased messaging and resources provided by advocacy groups, such as Start School Later, and by recommendations issued by major medical organizations, including the American Academy of Pediatrics, the American Medical Association, and the American Academy of Sleep Medicine, all of whom recommend that middle and high schools start no earlier than 8:30 AM, to accommodate the known biological changes in adolescent sleep-wake cycles. In April 2016, the first national conference on school start times was held,¹⁹ bringing together researchers, health care providers, representatives from school districts throughout the USA, and elected government officials to discuss the intersection between adolescent sleep needs, school start times, and the policy implications. Nevertheless, according to the CDC, the vast majority of middle and high schools still start before 8:30 AM, with the average school start time being 8:03 AM in the USA.

On the legislative front, there have also been numerous efforts to promote healthy start times. For instance, California Congresswoman Zoe Lofgren has repeatedly introduced versions of a “ZZZ’s to A’s” Bill and Resolution to the US Congress since 1998, all proposing restrictions on the hours at which American high schools can begin required instruction. More recently, bills related to sleep and school start times have been introduced in state legislatures across the country, including California, Florida, Maryland, Massachusetts, Virginia, Tennessee, New Jersey, Maine, Rhode Island, Utah, Washington, and Nevada. Notably, California’s bill that proposes a state-wide mandatory start time for middle and high school students no earlier than 8:30 AM, has proceeded the furthest to date, along the path to becoming law. Although the bill did not pass the state Assembly in September 2017, it may be reconsidered by the legislature in January 2018.

With this context, one might ask, why is a special issue on this topic needed today? As Guest Editors, we asked ourselves this very question, and we hope that our answer resonates with others: there remains a critical need to bring together multiple disciplines and theoretical perspectives to advance the scientific study of adolescent sleep and school start times and to translate this work into a meaningful resource that can be used by parents, educators, policy makers, and community members, to effectively implement healthy school start time policy change.

Key themes in this special issue

In summary, the submissions for this special issue represented a diverse cross-section of research topics and ideas across multiple disciplines. Most of the empirical articles are based on US samples; however, two articles are focused on international samples, one from Canada²⁰ and one from Israel,²¹ which attests to the importance of this issue across the globe. Although each of the articles contribute a unique perspective to the science and ongoing policy debate over school start times, three key themes emerged which are useful for summarizing the findings across the studies.

First, several studies added to the existing literature by demonstrating the benefits of later start times, across multiple outcomes. For instance, a meta-analysis conducted by Bowers and Moyer²² demonstrated that later starting school times are associated with longer sleep durations. Additionally, the meta-analysis concluded that later start times were associated with less daytime sleepiness and tardiness to school, all of which have important implications for students’ academic performance. Consistent with the meta-analytic results, several empirical articles published in this issue^{20,23,24}

showed demonstrable changes in sleep duration following a delay in school start time, although the magnitude of the effect varied across studies. For instance, in a sample of Canadian youth, Patte and colleagues found that for each hour delay in SST, average nightly sleep duration increased by almost 7 minutes, a small but statistically significant result. Using data from Fairfax County, Virginia schools, before and after a school start time change, Owens et al.,²³ found that with a 50-minute delay, students slept 30.1 minutes longer on school-nights and reported less daytime sleepiness. Finally, the Nahmod and colleagues’ study, used a daily diary study of a diverse sample of teens from the Fragile Families cohort, finding a dose-response relationship between earlier school start times and shorter total time in bed, primarily due to earlier wake times. Further, they found that start times after 8:30 AM were associated with 27–57 minutes increased time in bed, and those teens (starting at 8:30 AM or later) were the *only* group with time in bed permitting 8 hours of sleep, as recommended by expert consensus.²⁵ One important difference between the Canadian sample and the US samples is that Canadian schools generally start later than US schools, which may have contributed to the smaller magnitude of the effect in the Patte study. In fact, 50 percent of the schools in the Canadian sample started at 8:30 AM or later, whereas the average school start time in the USA is 8:03 AM. Beyond these outcomes, Hafner and colleagues’²⁶ study extend the implications of later start times to include economic benefits of later SST, finding that later start times could contribute \$83 billion to the US economy over a 10 year period, by improving academic performance and potential lifetime earnings of students and by reducing car crash rates. Collectively, the findings suggest that shifting to later school start times could not only benefit the health, functioning, and safety of adolescents, but could also benefit the economy.

The second theme that emerged highlights the importance of considering other contextual factors, including culture or other factors that may moderate the impact of school start times and sleep-wake patterns on adolescents’ behavioral outcomes. For example, Vidal and colleagues looked at how culture and a religious lifestyle might influence the ways in which adolescents’ sleep patterns and habits among ultra-orthodox and non-religious Jewish adolescents in Israel. In addition, the Peltz et al.²⁷ study examined direct and indirect paths between sleep hygiene, school start times and mental health, finding that baseline sleep hygiene was directly associated with lower average daily depressive/anxiety symptoms across all students, but the association was marginally stronger in students with later school start times (8:30 AM or later). Taken together, and as articulated in several of the articles in the special issue, healthy school start times are a necessary, but not sufficient strategy to promote sleep health among adolescents. By the same token, it has long been recognized by sleep researchers and clinicians that sleep hygiene is also a necessary but not sufficient strategy to promote sleep health.²⁸ Indeed, multi-pronged strategies that address individual-level factors, such as use of technology in the bedroom or other sleep hygiene behaviors, in combination with policy-level factors may be the most effective population-level strategy to reduce the epidemic of insufficient sleep among teens. This conclusion coheres with contemporary strategies to address other pressing public health issues, such as childhood obesity. Indeed, in large part due to the failure of individual-level interventions to curb the epidemic of obesity, it is increasingly recognized that multipronged strategies that combine policy-level interventions (eg, removing sugar-sweetened beverages or unhealthy snacks from school vending machines) with individual or family behavior change strategies are needed.²⁹

The third theme concerns strategies for implementation, and the need for multi-disciplinary approaches to effectively promote system-level change. Two case studies, one from Colorado³⁰ and one from Maine,³¹ provide a grass-roots understanding of the

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