Start Time and Sleep Research Summary

March 20, 2017, UPDATED May 10, 2017
Note: new information is marked “Added May 10, 2017”

This is a collection of references to important research about the adolescent sleep and school start time, elementary sleep and start time, and the many risks associated with sleep deprivation. It also folds in data gathered for students at the Masconomet Regional School District and a handful of articles on the topic, but the focus is on published research. This collection is intended to be a companion and reference for the discussion about a start time change in our districts. It was prepared by Hagan Rivers, a member of the Start Times Advisory Committee and a member of the Masconomet School Committee. For more information contact her at hrivers@masconomet.org

As you look through this research, is very important to keep in mind the process of scientific discovery. It’s always possible to find one or two scientific papers to support a particular point of view. Science isn’t about individual bits of research, it is about the accumulation of findings. Instead, we have to ask: What is the consensus? What have multiple researchers found in common? The topic of adolescent sleep has been studied for decades now and the scientific consensus achieved through thousands of studies is overwhelming. The following facts are supported again and again by the research (much of which is cited within this collection):

- Adolescents need 8-10 hours of sleep, with an average need of 9 hours and 20 minutes.
- Adolescents experience a sleep phase delay that begins with the onset of puberty and continues until puberty ends. The delay means that they get sleepy later in the evening, and the delay increases until adolescence ends. A typical adolescent is sleepy from 11pm to 8am.
- Masconomet school starts at 7:35am with most students reporting rising between 6am and 6:30am. In order to get enough sleep at wake at 6am, Masconomet students would need to be asleep in bed by 9:00pm.
- Poor sleep habits, screen use, over scheduling, and stress can exacerbate sleep deprivation and need to be addressed, however school start time is the primary driver of poor adolescent sleep.
- Masconomet students report they are getting less than 7 hours of sleep on school nights, which means that in the average week they are losing 10 hours of sleep.
- Chronic sleep deprivation leads to a host of poor outcomes including: negative effect on academic achievement; more risk taking, more violence and delinquency; higher rates of anxiety, depression, suicide, mental and emotional health problems; high rates of alcohol and drug use; higher rates of obesity; more automobile accidents; and more injury in athletics and poorer athletic performance. All of these effects are documented in this collection.

Although this document is large, it represents only a fraction of the total research available on this topic. Links are provided to source material throughout. However, any source material that you read will contain even more links to related research, so if you wish to dive deeper on a topic, check the references. A few items are marked with the phrase KEY READING because they are foundational materials for this topic.

**Given that the primary focus of education is to maximize human potential, then a new task before us is to ensure that the conditions in which learning takes place address the very biology of our learners.** – Dr. Mary Carskadon, 1999

For the remainder of this document, text in red is written by the author of this document (Hagan Rivers). Black text is directly quoted from the specific research articles listed. Emphasis may be added.
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The Effect of Acute Sleep Deprivation on Visual Evoked Potentials in Professional Drivers
Adolescent Crash Rates and School Start Times in Two Central Virginia Counties

Sleep Deprivation and Athletic Performance
Chronic Lack of Sleep is Associated With Increased Sports Injuries in Adolescent Athletes
The Impact of Sleep Quality on Health & Injury Susceptibility
Connecticut Interscholastic Athletic Conference (CIAC)
Lack of Sleep Tied to Teen Sports Injuries
Effects of sport specific training intensity on sleep patterns and psychomotor performance
It's Practice, with Sleep, that Makes Perfect: Implications of Sleep-Dependent Learning and Plasticity for Skill Performance
The Effects of Sleep Extension on the Athletic Performance of Collegiate Basketball Players
Performance Point: Sleep Your Way to a Better Performance
Faster, Higher, Stronger – Sleep and Athletic Performance
Sleep or Sports: Which Is More Important for Teens?
How do we make athletics work?
Athletics and School Start Times
Organizing Schools to Improve Student Achievement: Start Times, Grade Configurations, and Teacher Assignments
Sports Injuries and School Start Times - Doing the Math
Biddeford, Maine

Articles and results from Massachusetts
CDC School Start Times for Middle School and High School Students
Ashland, MA
Boston, MA: City Councilors push for later start time at Boston Public Schools
Boston: Councilors: It's past time to let high-school kids sleep in
Burlington, MA
Carver, MA
Concord Carlisle, MA
Duxbury and Sharon MA
Duxbury and Sharon MA 1-year Follow-up Survey
Georgetown, MA
Hanover, MA
Hingham, MA
Mashpee, MA: Mashpee Exploring School Start Time Changes
Melrose, MA
Natick, MA
Nauset, MA
Newburyport, MA
Newton, MA: Insist on later high school start in Newton
North Andover, MA
Plymouth, MA: Sleeping through the dark ages of high school
Reading, MA: Reading superintendent mulls later start times
Sudbury, MA: The benefits of a later school start time
Taunton, MA Taunton School Committee to study later school start times
Statements in support for later start time

This is a collection of statements in support of an 8:30am or later start time for adolescents. In reading these statements it’s easy to become glazed over, but consider that every one of these organizations reviewed the research, spoke to the experts, and then agreed on a recommendation. It’s easy to understand why not everyone would want to read through the research: it’s daunting. However, if you don’t feel like reading the research, the next best thing would be to look to these organizations to see what they say. These are groups of pediatrics, health experts, doctors, psychologists, school nurses, and even athletic organizations have all agreed: an 8:30am or later start is healthier and safer for adolescents. As school committee members it is our responsibility to respond.

**AMERICAN ACADEMY OF PEDIATRICS: SCHOOL START TIMES FOR ADOLESCENTS**


http://pediatrics.aappublications.org/content/early/2014/08/19/peds.2014-1697

...the evidence strongly implicates earlier school start times (ie, before 8:30 am) as a key modifiable contributor to insufficient sleep, as well as circadian rhythm disruption, in this population. Furthermore, a substantial body of research has now demonstrated that delaying school start times is an effective countermeasure to chronic sleep loss and has a wide range of potential benefits to students with regard to physical and mental health, safety, and academic achievement.

**AMERICAN ACADEMY OF SLEEP MEDICINE**

Added May 10, 2017

Journal of Clinical Sleep Medicine, Vol 13, No 4


Full position statement is only available through journal access and has been attached to this document.

During adolescence, internal circadian rhythms and biological sleep drive change to result in later sleep and wake times. As a result of these changes, early middle school and high school start times curtail sleep, hamper a student’s preparedness to learn, negatively impact physical and mental health, and impair driving safety. Furthermore, a growing body of evidence shows that delaying school start times positively impacts student achievement, health, and safety. Public awareness of the hazards of early school start times and the benefits of later start times are largely unappreciated. As a result, the American Academy of Sleep Medicine is calling on communities, school boards, and educational institutions to implement start times of 8:30 am or later for middle schools and high schools to ensure that every student arrives at school healthy, awake, alert, and ready to learn.

The AASM asserts that middle school and high school start times should be 8:30 am or later to support:

- An adequate opportunity for adolescents to obtain sufficient sleep on school nights
- Optimal alertness in the classroom environment to facilitate peak academic performance
- Reduced tardiness and school absences to foster improved opportunities for learning
- Adolescent mental health and psychological well-being
- Adolescent driving safety
Schools that have a start time of 8:30 AM or later allow adolescent students the opportunity to get the recommended amount of sleep on school nights. “Getting enough sleep is important for students’ health, safety, and academic performance,” said Anne Wheaton, Ph.D., lead author and epidemiologist in CDC’s Division of Population Health. “Early school start times, however, are preventing many adolescents from getting the sleep they need.”

“Among the possible public health interventions for increasing sufficient sleep among adolescents, delaying school start times has the potential for the greatest population impact by changing the environmental context for students in entire school districts.”—Anne G. Wheaton, Ph.D., Division of Population Health, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention (CDC).

The new policy specifically calls on school districts across the United States to implement middle and high school start times no earlier than 8:30 a.m. “Sleep deprivation is a growing public health issue affecting our nation’s adolescents, putting them at risk for mental, physical and emotional distress and disorders,” said AMA Board Member William E. Kobler, M.D.

Delegates approved a policy stating that a school start time no earlier than 8:30 a.m. would be a beneficial change to the overall health and well-being of middle and high school adolescents. The policy encourages advocacy on the state legislative level, as well as with the Massachusetts Association of School Committees, in support of a later start time.

“Sufficient sleep is essential for good mental health,” said Joshi, an endowed professor and chair of psychiatry and behavioral sciences at Children’s National Medical Center in Washington, D.C. Adolescents who get sufficient sleep report fewer symptoms of depression and anxiety and lower suicidal ideation than those who sleep less, she pointed out. They have more energy and are less likely to overeat and become obese.
Adolescence is a time when sleep patterns change and biological clocks alter, often leading to poor quality and insufficient sleep. Their ability to concentrate, problem-solve and assimilate new information is impaired. SPN and NASN encourage all parties involved to consider implementing later school start times for teens.

While implementation may be complex, particularly when a change would bring a school’s schedule out of sync with neighboring systems, delaying school start times so that adolescents begin their instructional day later provides numerous benefits to the students and their broader community alike.

While this does offer substantial upfront cost savings to school budgets, it comes with a burden that far outweighs the benefit. The American Sleep Association position on school start times is that middle school and high school should not start before 08:00. A time closer to 09:00 or later would be preferable.

For adolescents we suggest that school start times be delayed to align with physiological circadian propensity of this age group. "These recommendations are based on a comprehensive review of the literature and the experience of a panel of clinicians and scientists with expertise in sleep health," said Atul Malhotra, MD, president of the American Thoracic Society and a member of the team that produced the statement. "They provide an important framework for promoting healthy sleep on a wide scale, which would in turn generate a number of additional health and other benefits."

The National Education Association believes that overall health and performance are best achieved with adequate rest on a regular basis. The Association supports school schedules that follow research-based recommendations regarding the sleep patterns of age groups.

Teens are among those least likely to get enough sleep; while they need on average 9 1/4 hours of sleep per night for optimal performance, health and brain development, teens average fewer than 7
hours per school night by the end of high school, and most report feeling tired during the day (Wolfson & Carskadon, 1998). The roots of the problem include poor teen sleep habits that do not allow for enough hours of quality sleep; hectic schedules with afterschool activities and jobs, homework hours and family obligations; and a clash between societal demands, such as early school start times, and biological changes that put most teens on a later sleep-wake clock. As a result, when it is time to wake up for school, the adolescent’s body says it is still the middle of the night, and he or she has had too little sleep to feel rested and alert.

NATIONAL INSTITUTES OF HEALTH: ADOLESCENT SLEEP NEEDS AND PATTERNS
National Sleep Foundation Sleep and Teens Task Force, National Institutes of Health, 2000

This research report and field guide looks at the available research and lays out the case for a later start time, as well as other interventions to improve adolescent sleep. Circadian timing systems are also very resistant to change. Behavioral methods, such as controlled light exposure and chronotherapy, can sometimes help shift circadian timing to more socially appropriate sleep and wake times. Because the circadian rhythms in teenagers are typically highly sensitive to erratic schedules, to effectively adjust them requires making gradual, persistent and consistent changes. Adapting to an early school schedule following summer or other vacation periods during which very late schedules are typically kept, for example, can take several days to several weeks.

BOXFORD, MASSACHUSETTS BOARD OF HEALTH
Added May 10, 2017

Full position statement is attached to the end of this document.

The Board agrees with the conclusions of the AAP Policy Statement and unanimously supports the STAC's consideration of delaying the Masconomet High School start time. We support efforts to help students achieve 8.5-9.5 hours of sleep per night and recommend that if a delay in start time is considered that it should be more than a 30-minute change, and closer to 1-hour, enabling a school start time around 8:30 am.

MIDDLETON, MASSACHUSETTS BOARD OF HEALTH
Added May 10, 2017

Full position statement is attached to the end of this document.

At the Middleton Board of Health meeting held on February 1, 2017, the board discussed the start time for Middle and High School students and assessed the need to support a change in start time to no earlier than 8:30am. It was the decision of the Middleton Board of Health to recommend and support the timeframe of no earlier than 8:30am for Middle and High School students.

LETTER: LATER START TIMES WOULD BENEFIT STUDENTS
Tri Town Transcript, Dr. David Danis (chair of Pediatrics at Beverly Hospital), March 3, 2017
http://boxford.wickedlocal.com/opinion/20170303/letter-later-start-times-would-benefit-students

The full letter from the chair of Pediatrics at Beverly Hospital (MA) is included here:

Dear Masconomet School Administration,

The Department of Pediatrics at Beverly Hospital was asked to weigh in on the topic of high school start time. We discussed this topic initially at our monthly departmental meeting on Friday, Oct. 15, 2016, and then there was further discussion at our monthly Pediatric Grand Rounds Nov. 4th which serendipitiously was given by Judith Owens, MD, a sleep expert from Boston Children's Hospital Ferber Sleep Center.
As you probably already know, adolescents require nine hours of sleep per night, and most of our adolescent youth do not come close to getting their required sleep. The repercussions are widespread and include increased infectious illness, increased anxiety and depression, poor academic performance, worsening of ADHD symptoms in those that have this disorder, and perhaps even an increase in sports related injuries (like concussions) because a sleep-deprived athlete has slower reaction time.

Traditionally many of our local high schools (like Masconomet) have had a start time of 7:30 a.m., which often require the students wake up between 5:30 and 6 a.m. to make the bus. For these students to get nine hours of sleep they would have to be sleeping by 8:30 or 9 p.m. the night before (of course with their extracurricular demands, homework, and adolescent culture, this is highly unlikely to occur). The result is a generation of sleep deprived adolescents and all of the problems that that results in. Many of our local private high schools have a start time nearly an hour later. St. John’s Prep, for example, starts at 8:21 each morning.

Many experts in the field of pediatric sleep medicine (like Judith Owens, MD) recommend that high schools nationwide move their start times back to 8:30 a.m. and the pediatricians at Beverly Hospital completely support that recommendation. We realize that this will require a lot of work re-organizing bussing schedules and afternoon athletic schedules, but the benefits to our youth in the long run will be far reaching. We hope that all of the public high schools in Essex County work together to change their start times to 8:30, and if they do that would make the athletic scheduling much easier as "an entire athletic league moves timing at the same time." We are happy to encourage other local schools as we are encouraging Masconomet.

We realize that high school starting time isn't the ONLY factor contributing to sleeplessness in youth. We realize that fixing this problem will require a multi-pronged approach. We recognize that electronics and social media is having a huge negative influence on sound sleep. The pediatricians at Beverly Hospital all support and preach to our youth and their parents that all computers, TV's, iPads, and phones be removed from an adolescent's room at night while they sleep. We also support adolescents avoiding all caffeinated beverages in the afternoon and evening.

It is not our intention to single out Masconomet School System and we intend on encouraging all of the other local high schools to take the same measures to improve adolescent sleeplessness.

The Department of Pediatrics at Beverly Hospital is in complete and full agreement with the above letter.

Sincerely,
David O. Danis, MD
Chief of Pediatrics
Beverly Hospital

**Massachusetts Interscholastic Athletic Association**

MIAA Sports Medicine Committee, Alan Ashare MD, December 2016


The full statement is included here:

The Massachusetts Interscholastic Athletic Association (MIAA) Sports Medicine Committee is made up of physicians, athletic trainers, chiropractors, dentists, coaches and administrators. We serve as an advisory board setting standards for the health and safety of student athletes in member schools across Massachusetts.

We are in agreement with and in full support of the 2014 American Academy of Pediatrics policy statement for later high school start times. We have read the research regarding improved mental and physical health for all students who get adequate sleep with later school start times.
Student-athletes in these schools are more likely to perform better which can lead to reduced incidence of injury; therefore, less time away from class. Importantly, later school start times have not appeared to result in decreased participation of competitiveness of school athletic teams in districts who have proactively made this change.

The MIAA Sports Medicine Committee supports education reform to include changes to later start times for high schools across our state.

Respectfully,
Alan Ashare, MD
Chairman, MIAA
Sports Medicine Committee

MIDDLESEX ATHLETIC LEAGUE’S SUPERINTENDENTS
August 17 2015

All schools in the Middlesex Athletic League signed a letter pledging to adjust start time as a region, which has been the practice in other areas, as well. Their letter reads: The purpose of this collaborative statement is not to make a case for later high school start times. The research is clear on this topic that later start times best support the social and emotional needs of our high school students. The Middlesex League Superintendents collectively wanted to express our clear support for later high school start times. Our intention is to commit to a deadline and to the necessary consensus building required to make a change in long-standing practice. Doing what is right for adolescents will mean changing adults schedules and behaviors. **Ultimately, the choice to change will distill down to what communities value most.**

To the end, our League goals are as follows:
- High School start times between 8:00 a.m. and 8:30 a.m. for all Middlesex League High Schools by the start of the 2018-2019 school year. (Current start times range from 7:30 a.m.-8:00 a.m.)
- After-school competitions will be scheduled so that students do not routinely miss academic time.

The expression of our intentions and our timetable should provide ample opportunity to address all stakeholder concerns and to reallocate existing funding or commit to the new funding that may be needed to implement later start times. Moreover, by setting a timeline for Fall 2019, we believe districts, families, and organizations that oversee athletic competitions, academic competitions and other student activities will have sufficient time to prepare for a change that will benefit all our students.

We hope this joint statement is the first of many as we work together across our respective communities to implement practices that are in the best interest of children.

Sincerely,

Bodie (Arlington), Taymore (Melrose), Fitzgerald (Watertown), Phelan (Belmont), Doherty (Reading), DeLai (Wilmington), Conti (Burlington), Olson (Stoneham), Evans (Winchester)
Healthy Sleep and Adolescent Sleep Patterns

Changing start time is **not just about the duration of the sleep, but also the timing** of sleep. All humans have natural circadian rhythms and trying to be awake and alert when your body doesn’t want to is unnatural and unhealthy. This research specifically talks about the differences in adolescent sleep versus the sleep of younger children or adults. More research can be found here:

- [https://schoolstarttime.org/adolescent-sleep-biology-basics/](https://schoolstarttime.org/adolescent-sleep-biology-basics/)

**WHEN WORLDS COLLIDE: ADOLESCENT NEED FOR SLEEP VS. SOCIETIAL DEMANDS**

Phi Delta Kappan Mary Carskadon, 1999
[https://teensneedsleep.files.wordpress.com/2011/03/carskadon-when-worlds-collide.pdf](https://teensneedsleep.files.wordpress.com/2011/03/carskadon-when-worlds-collide.pdf)

Dr. Carskadon did some of the earliest work to understand how adolescent sleep was different from sleep at any other age. This paper provides a complete introduction to the biology of adolescent sleep. She writes: The problem of inadequate sleep affects more segments of our society than adolescents; however, adolescents appear be particularly vulnerable and face difficult challenges for obtaining sufficient sleep. Even without the pressure of biological changes, if we combine an early school starting time — say 7:30 a.m., which, with a modest commute, makes 6:15 a.m. a viable rising time — with our knowledge that optimal sleep need is 9 1/4 hours, **we are asking that 16-year-olds go to bed at 9 p.m. Rare is the teenager of the 1990s who will keep such a schedule.** School work, sports practices, clubs, volunteer work, and paid employment take precedence. When biological changes are factored in, the ability even to have merely “adequate” sleep is lost. ...

**ASSOCIATION BETWEEN PUBERTY AND DELAYED PHASE PREFERENCE**

Sleep, Carskadon MA, Vieira C, Acebo C, 1993

This is one of the first papers discussing the different sleep of adolescents, and you can see where researchers begin to understand the link between melatonin production and sleep, and how melatonin production is different for adolescents: **Our previous MSLT data from youngsters at various pubertal stages showed a midpubertal phase delay in the timing of daytime sleep tendency. In isolation, this finding was not thought to be of significance; however, in light of the present result, the pubertal delay of peak sleep tendency provides additional support for a biologically mediated phase delay linked to pubertal development. The source of such a biological process likely involves biological timing mechanisms. A link between the brain mechanisms controlling circadian rhythms and pubertal timing has been suggested principally due to the inverse relationship of melatonin and luteinizing hormone (LH) secretion across pubertal development. The potential links of melatonin to circadian as well as maturational processes make it a candidate to mediate a biological influence on a change in sleep phase position, which may influence phase preference.**
This is a great place to understand sleep drive, the body’s alerting signal, and how all the biology of adolescents is different from other age groups. It clearly explains why adolescents cannot fall asleep at 9 pm, get 9 hours of sleep, and wake at 6 am and uses the diagram (right) to explain sleep. Physiology of sleep and wake in an adolescent. Sleep Drive (downward arrows) is the physiologic pressure to return to sleep that begins to build upon waking from sleep. This drive is satisfied by normal sleep, and reduced to near zero at the end of a full night’s sleep. If less than a full night’s sleep occurs, residual sleep drive (a.k.a., sleep debt) remains upon waking, and is carried forward along with the additional sleepiness that builds normally during wakefulness. The effect of the sleep drive is opposed by the increasing Circadian Drive for Alertness (upward arrows), which increases in intensity as the day progresses, with a short mid-afternoon lessening (the “siesta”). The onset timing of the Circadian Drive is cued by the brain’s circadian rhythm pacemaker, the suprachiasmatic nucleus (SCN), a hard-wired pacemaker that determines whether one is an “evening-type” or ‘morning-type’. Note that the Alerting Drive is maximally effective in the evening up until the biologic bedtime when the support for alertness is rapidly withdrawn, allowing night time sleep to occur. The cumulative effect of both these opposing drives manifests as one’s Effective Wakefulness. In this example, biologic bedtime allows sleep onset by 11:30 p.m. and Sleep Drive is not fully satisfied (residual sleepiness remaining) by the early rise time of 6:00 a.m. Note also that the Effective Wakefulness in this teen is low at school start time of 8:00 a.m., rising rapidly to more effective levels by 10–11 a.m. [...]

In brief, there are two features of the circadian rhythm especially important to understand regarding sleep in teenagers: (1) the drowsy signal that cues bedtime is dependent on the dampening of circadian-dependent alertness; and (2) the physiology of puberty causes a shift in the circadian rhythm which delays the timing of this biological bedtime by about an hour. These two biological factors underlie the main difficulties faced by adolescents attending school before 9:00 a.m.: the general problem that one cannot easily fall asleep before their biological bedtime, and the additional problem that puberty creates a tendency for even later bedtimes.

The authors look at data regarding sleepiness in teens across countries. They write: These data show that adolescents report going to bed later as they get older. Studies from such countries as Canada, Poland, Belgium, Australia, Finland, and Brazil show similar trends. Investigators associate this age-related change in bedtime on school nights with a number of environmental factors, including reduced parental influence on bedtimes, increased homework, and extra-curricular activities, such as sports, musical groups, clubs, and service groups, or part-time work. Other environmental, usu-
ally stimulating activities, that often affect bedtime include watching TV, playing video games, and using the computer. The authors go on to establish the notion of a process of sleep drive and alerting signal that remains the foundation of our understanding of sleep today.

The circadian timing system undergoes developmental changes during adolescence. Although sleep/wake patterns have long been known to delay in adolescents, behavioral factors (e.g., social and scholastic obligations) were assumed to be entirely responsible. The notion that circadian timing may change was noted by Carskadon and colleagues in a study of circadian phase preference in young adolescents. ... Carskadon and colleagues found that phase preference was correlated with self-assessed pubertal development, especially in girls. Subsequent studies confirmed that more mature and older adolescents prefer later timing of activities than younger, less mature adolescents.

**ADOLESCENT CHANGES IN THE HOMEOSTATIC AND CIRCADIAN REGULATION OF SLEEP**

Added May 10, 2017
Developmental Neuroscience, Hagenauer et al, 2009

It turns out that circadian phase delay is not limited to humans. In this study, the same phase delay was observed in adolescent rhesus monkeys, degus, laboratory rats, laboratory mice, and the fat sand rat. Other studies have found that this delay appears to occur across most mammals. Sleep delay is not caused by iPhones, or light, or homework. It may be exacerbated by those things, but sleep delay is a normal part of mammalian development.

Abstract: Sleep deprivation among adolescents is epidemic. We argue that this sleep deprivation is due in part to pubertal changes in the homeostatic and circadian regulation of sleep. These changes promote a delayed sleep phase that is exacerbated by evening light exposure and incompatible with aspects of modern society, notably early school start times. In this review of human and animal literature, we demonstrate that delayed sleep phase during puberty is likely a common phenomenon in mammals, not specific to human adolescents, and we provide insight into the mechanisms underlying this phenomenon.

A delay in circadian phase has been observed around the time of puberty in six mammalian species

<table>
<thead>
<tr>
<th>Species</th>
<th>human (Homo sapiens)</th>
<th>rhesus monkey (Macaca mulatta)</th>
<th>degu (Octodon degus)</th>
<th>laboratory rat (Rattus norvegicus)</th>
<th>laboratory mouse (Mus musculus)</th>
<th>fat sand rat (Psammomys obesus)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnitude of delay</td>
<td>1–3 h</td>
<td>2 h</td>
<td>3–5 h</td>
<td>1–4 h</td>
<td>1 h?</td>
<td>0–3 h under a long photoperiod*, 10–14 h under a short photoperiod</td>
</tr>
<tr>
<td>Sex difference</td>
<td>males &gt; females</td>
<td>only females examined</td>
<td>males &gt; females</td>
<td>males &gt; females</td>
<td>only females examined</td>
<td>sex unspecified</td>
</tr>
</tbody>
</table>

This review found evidence for delayed circadian phase during puberty in all five species studied: Macaca mulatta (rhesus macaque), Octodon degus, Rattus norvegicus (laboratory rat), Mus musculus (laboratory mouse), and Psammomys obesus (fat sand rat). Overall, this evidence indicated that the delayed timing of sleep during human adolescence is likely to represent a developmental change common across mammalian species.
The authors studied 25,000 individuals to look at sleep changes by age. Specifically, they found that boys and men tend to have later chronotypes (they are owls) and girls and women tend to have earlier chronotypes (they are larks). The graph (right) shows the changes in chronotypes as we age, and the differences in gender. Areas with a gray background have a statistically significant difference in gender. Between the ages of 10-20, boy’s bedtimes will shift 3h later and girl’s bedtimes will shift 2h later. The authors write:

Children are early chronotypes and become progressively later (delaying) during development, reaching a maximum in their 'lateness' at around the age of 20. After 20, they become earlier again (advancing) with increasing age. The general tendency of females to develop earlier than males is also seen in chronotype where young women are already more delayed than young men, and women reach their maximum in lateness earlier (19.5 y). Men continue to delay their sleep until around the age of 21 (20.9 y) and are, on average, later chronotypes for most of their adulthood... The sharp maximum of lateness in chronotype at around the age of 20 coincides with the suggested end of adolescence. Accordingly, one could define when individuals enter adulthood as the age at which their chronotype stops delaying and starts advancing.

Write up this study, by the AAP: http://pediatrics.aappublications.org/content/early/2014/08/19/peds.2014-1696

For example, Roenneberg et al measured the mid-point of weekend sleep in European schoolchildren and revealed a marked linear delay of 2 hours for girls to 3 hours for boys across the second decade, roughly 12 to 18 minutes later with each year of age. The reversal of this delayed weekend sleep pattern may be a “biological marker for the end of adolescence

THE GREAT SLEEP RECESSION: CHANGES IN SLEEP DURATION AMONG US ADOLESCENTS

Pediatrics, Katherine M. Keyes, Julie Maslowsky, Ava Hamilton, John Schulenberg, February 2015
http://pediatrics.aappublications.org/content/early/2015/02/10/peds.2014-2707

Adolescent sleep generally declined over 20 years; the largest change occurred between 1991–1995 and 1996–2000. Girls were less likely to report getting ≥7 hours of sleep compared with boys, as were racial/ethnic minorities, students living in urban areas, and those of low socioeconomic status (SES). However, racial/ethnic minorities and adolescents of low SES were more likely to self-report adequate sleep, compared with white subjects and those of higher SES. Conclusions: Declines in self-reported adolescent sleep across the last 20 years are concerning. Mismatch between perceptions of adequate sleep and actual reported sleep times for racial/ethnic minorities and adolescents of low SES are additionally concerning and suggest that health education and literacy approaches may be warranted.
AMONG TEENS, SLEEP DEPRIVATION AN EPIDEMIC
Stanford Medicine News Center, October 8, 2015
This Stanford article does a nice job of laying out the background information on adolescent sleep and all the factors that contribute, including start time. The article says: While studies show that both adults and teens in industrialized nations are becoming more sleep deprived, the problem is most acute among teens, said Nanci Yuan, MD, director of the Stanford Children’s Health Sleep Center “With academic demands and extracurricular activities, the kids are going nonstop until they fall asleep exhausted at night. There is not an emphasis on the importance of sleep, as there is with nutrition and exercise,” she said. “They say they are tired, but they don’t realize they are actually sleep-deprived. And if you ask kids to remove an activity, they would rather not. They would rather give up sleep than an activity.”

INSUFFICIENT SLEEP IN ADOLESCENTS AND YOUNG ADULTS: AN UPDATE ON CAUSES AND CONSEQUENCES
Pediatrics, Owens and Adolescent Sleep Working Group, September 2014
http://pediatrics.aappublications.org/content/134/3/e921.long
A great report if you want to follow all the research links in the References: an overview of information. Abstract: Chronic sleep loss and associated sleepiness and daytime impairments in adolescence are a serious threat to the academic success, health, and safety of our nation’s youth and an important public health issue. Understanding the extent and potential short- and long-term repercussions of sleep restriction, as well as the unhealthy sleep practices and environmental factors that contribute to sleep loss in adolescents, is key in setting public policies to mitigate these effects and in counseling patients and families in the clinical setting. This report reviews the current literature on sleep patterns in adolescents, factors contributing to chronic sleep loss (ie, electronic media use, caffeine consumption), and health-related consequences, such as depression, increased obesity risk, and higher rates of drowsy driving accidents. The report also discusses the potential role of later school start times as a means of reducing adolescent sleepiness.

As has been described elsewhere in the present report, a multitude of changes occur over the course of adolescence that can affect the quality and quantity of sleep in adolescents and young adults. One of the most salient and arguably most malleable is that of school start times, a systemic countermeasure.

SYNCHRONIZING EDUCATION TO ADOLESCENT BIOLOGY
http://www.tandfonline.com/doi/pdf/10.1080/17439884.2014.942666
When social time and biological time are more closely aligned, as in the early years of education, this distinction is not critical. In contrast, in late adolescence the conflict between social time and biological time is greater than at any point in our lives. During adolescence biological changes dictate both a sleep duration of nine hours and later wake and sleep times, a phenomenon found in other mammals (Hagenauer et al. 2009; Rüger et al. 2012). At its peak the combination of these two biological changes leads to a loss of two to three hours sleep every school day. Thus, a 07:00 alarm call for older adolescents is the equivalent of a 04:30 start for a teacher in their 50s. Failure to adjust education timetables to this biological change leads to systematic, chronic and unrecoverable sleep loss. This level of sleep loss causes impairment to physiological, metabolic and psychological health in adolescents while they are undergoing other major physical and neurological changes. The impact of early school times on adolescents is not understood by most educators: a common belief is that adolescents are tired, irritable and uncooperative because they choose to stay up too late, or are difficult to wake in the morning because they are lazy. Educators tend to think that adolescents learn best in the morning and if they simply went to
*sleep earlier, it would improve their concentration.* These assumptions reflect societies' prejudice in favour of early risers in adulthood, exemplified by the proverb: Early to bed, early to rise, makes a man healthy, wealthy and wise.

This belief finds expression in many cultures, and even in today's business world (Czeisler 2006; Roenneberg 2012). Such conventional wisdom lies behind the misconception that adolescents need to be trained to rise early and to go to sleep early. *The truth is that adults need to be educated to adjust to another significant change in adolescents during puberty: a major biological shift in their sleep patterns.*

**SLEEP, RECOVERY, AND PERFORMANCE: THE NEW FRONTIER IN HIGH-PERFORMANCE ATHLETICS**

Samuels C, Neurol Clin, 2008


The sleep hypnogram of a 17-year old female ice hockey goalie shows: The key factor in the hypnogram is to note that rising at 5:30 AM (A) for early morning training clearly eliminates a large REM period on a daily basis and restricts the sleep chronically by 1–2 hours per day. The patient’s sleep is ending at the mark "A" on the graph below. This is significant because the patient is missing out on the REM sleep that occurs after that point. REM sleep is the period in which we consolidate memory and new things that we’ve learned. So when students miss out on morning sleep, they are missing out on the very sleep that supports learning.

![Staging graph](http://www.the-scientist.com/?articles.view/articleNo/45375/title/Go-To-Bed/)

**KEY READING: GO TO BED!**

The Scientist, Kerry Grens, March 1 2016


This is not research, it’s an article that looks at the available research to tackles a very specific question that we’re still struggling to understand: what are the long term health effects of chronic sleep deprivation, particularly for our teens. The author finds very disturbing evidence that the consequences are dire:

Sigrid Veasey’s team at Penn has also noticed changes in the brains of mice after several days of sleep loss—in this case, *locus ceruleus neurons* (LCNs), which are active during waking, were found to *degenerate*. A short bout of sleep deprivation—three hours kept awake—sparked a protective mitochondrial response in the cells, but disrupting the animals’ sleep for a few days was damaging.

[...] For 10 weeks, Carol Everson of the Medical College of Wisconsin subjected rats to repeated cycles of 10 days of disrupted and limited sleep followed by two days without disturbance. During the first half of the experiment, the animals seemed perfectly healthy. But after about five weeks, problems emerged. “All of a sudden their food intake took off progressively and they weren’t gaining weight,” Everson says. In addition, the rodents’ fur lost its luster, their *adipocytes were smaller and of a different phenotype than control animals*, and their small intestines were longer by 30 percent.

[...] unexpected changes, such as increased lysosomal activation and undigested cellular debris, signs of *cellular aging* that are unusual to see in the neurons of young, healthy mice. “The number of debris granules] was small, but it’s worrisome because it’s *only four to five days* of sleep
“deprivation,” says Cirelli. And after 36 hours of sleep recovery—an amount of time in which she expected normalcy to resume—those changes remained.

This is just one study and there are many others... The real point here is that we don’t understand the effects of long term sleep deprivation. We are running a 50 year experiment and the subjects haven’t aged enough to be able to see what the outcomes are. However, sleep health is brain health and the possible long term consequences suggested by this early animal research are frightening.

SCHOOL START TIME AND ADOLESCENT SLEEP PATTERNS

Added May 10, 2017
Results From the U.S. National Comorbidity Survey--Adolescent Supplement
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4463387/

Objective: We estimated associations between school start time and adolescent weekday bedtime, weekday sleep duration, and weekend compensatory sleep and assessed whether associations differ by age, sex, or urbanicity.

Results. Start time was positively associated with weekday bedtime. Associations between start time and weekday sleep duration were nonlinear and were strongest for start times of 8:00 am and earlier. Associations differed by sex and urbanicity, with the strongest association among boys in major metropolitan counties. Start time was negatively associated with sleep duration among boys in nonurban counties. Start time was not associated with weekend compensatory sleep.

Conclusions. Positive overall associations between school start time and adolescent sleep duration at the national level support recent policy recommendations for delaying school start times. However, the impact of start time delays may differ by sex and urbanicity.
Won’t they Just Stay Up Later?

This question is so common it deserves its own section and discussion. First, it’s very important to understand that the issue of start time is related to aligning school hours with adolescent biology in order to provide them with the opportunity to get more sleep. In other words, it’s not just about how much sleep they get, but when they are sleeping. An adolescent rising at 6am to attend school at 7:35am is as tired as an adult rising at 3:00am to go to work at 4:00am. The hours of our school do not align with adolescent biology. The idea that kids will just stay up later has not proven true in studies of students who have had their school shift to later start times. When schools move to later morning starts, student consistently got more sleep per school night because they went to bed at or near the same time each night and were able to rise later in the morning. When teens sleep and wake up in their more natural sleep/wake cycles, they are less drowsy and more focused in morning classes, and more efficient in getting their assignments done. They are no longer struggling to keep up with their homework due to fatigue. More research on this specific question can be found here:

- [https://schoolstarttime.org/delaying-school-start-times/will-students-squander-opportunity-extra-sleep/](https://schoolstarttime.org/delaying-school-start-times/will-students-squander-opportunity EXTRA-sleep/)

**KEY READING: EXAMINING THE IMPACT OF LATER HIGH SCHOOL START TIMES ON THE HEALTH AND ACADEMIC PERFORMANCE OF HIGH SCHOOL STUDENTS: A MULTI-SITE STUDY**

Center for Applied Research and Educational Improvement, Wahlstrom et al, February 2014
[http://conservancy.umn.edu/handle/11299/162769](http://conservancy.umn.edu/handle/11299/162769)

This is the foundational study for start time research. It’s findings have been supported in study after study, however this is one of the first large studies of over 9,000 students in eight public high schools in 3 states. If you only read ONE document from this entire packet, make it this one. The abstract says:

The results from this three-year research study, conducted with over 9,000 students in eight public high schools in three states, reveal that high schools that start at 8:30 AM or later allow for more than 60% of students to obtain at least eight hours of sleep per school night. Teens getting less than eight hours of sleep reported significantly higher depression symptoms, greater use of caffeine, and are at greater risk for making poor choices for substance use. Academic performance outcomes, including grades earned in core subject areas of math, English, science and social studies, plus performance on state and national achievement tests, attendance rates and reduced tardiness show significantly positive improvement with the later start times of 8:35 AM or later. Finally, the number of car crashes for teen drivers from 16 to 18 years of age was significantly reduced by 70% when a school shifted start times from 7:35 AM to 8:55 AM.

<table>
<thead>
<tr>
<th>School Year</th>
<th>Total Number of Hours High School Students Sleep on School Nights</th>
<th>Total Number of Hours High School Students Sleep on School Weekends</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Change</td>
<td>After Change</td>
<td>Before Change</td>
</tr>
<tr>
<td>All Other Schools Surveyed</td>
<td>Unknown</td>
<td>7.8</td>
</tr>
<tr>
<td>Jackson Hole High School</td>
<td>7.5</td>
<td>8.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>School Start Time</th>
<th>7:30 AM</th>
<th>7:35 AM</th>
<th>8:00 AM</th>
<th>8:05 AM</th>
<th>8:20 AM</th>
<th>8:35 AM</th>
<th>8:50 AM</th>
</tr>
</thead>
<tbody>
<tr>
<td>School</td>
<td>Fairview High School</td>
<td>Jackson Hole High School</td>
<td>Fairview High School</td>
<td>St. Louis Park High School</td>
<td>Woodbury High School</td>
<td>East Ridge High School</td>
<td>Park High School</td>
</tr>
<tr>
<td>Sample Size</td>
<td>333</td>
<td>446</td>
<td>1379</td>
<td>884</td>
<td>1333</td>
<td>902</td>
<td>1249</td>
</tr>
<tr>
<td>Sleep ≥ 8 hours/night</td>
<td>33.6%</td>
<td>44.2%</td>
<td>44.5%</td>
<td>49.7%</td>
<td>42.5%</td>
<td>49.8%</td>
<td>57.0%</td>
</tr>
</tbody>
</table>
In Canada, researchers at McGill University looked at 29,635 kids between 10 and 18 years old, pulling data from the Canadian 2013/2014 "Health Behaviour in School-aged Children" study. Bedtimes and wake times were self-reported, as were tiredness levels. They compared responses to school start times for each respondent. Canadian schools start anywhere between 8 a.m. to 9:30 a.m. By crunching the numbers, the authors found that later school start times did indeed mean more sleep for teens, which—according to other studies—means better performance in school, as well as better health. In the summary, the authors write:

Insufficient sleep is a serious problem in adolescents and school start time is thought to be a key contributor. This study provided the first comprehensive assessment of school start times across Canada and examined whether school start times were associated with sleep duration and tiredness among adolescents. We collected information on school start times from 362 schools that participated in the 2013/2014 Health Behaviour in School-aged Children study. We calculated sleep duration from weekday bedtime and wake time reported by 29,635 students (aged 10–18 years). We classified weekday sleep as sufficient if it met national recommendations, and used data on self-reported tiredness at school in the morning.

Every 10-min delay in school start time corresponded with 3.2 additional minutes of sleep, a 1.6% greater probability of sufficient sleep and a 2.1% smaller probability of feeling tired at school in the morning. **Students from schools that started later slept longer, were more likely to meet sleep recommendations and were less likely to report feeling tired in the morning.** The study adds weight to the mounting evidence that delaying school start time benefits adolescent sleep. **In media coverage, the reporter included the following quote:** “We found a strong association between later school start times and better sleep for teens,” says Prof. Frank Elgar, co-author of the study.”

**KEY READING: SCHOOL START TIME AND SLEEP IN CANADIAN ADOLESCENTS**


In a study of 29,635 students from 362 schools across Canada, students from schools that started later in the morning slept longer and were less likely to be tired than students from schools that started early.

Look hard at this graph. There is a **linear relationship between start time and more sleep**. Does this line continue indefinitely? No, but this study doesn’t tell us when it ends because Canadian schools don’t start after 9:30 am. We don’t know when that line levels off, but it’s very clear from this that later start = more sleep.
A longitudinal study looks at people over a long period of time. In this study Dr. Wahlstrom examined data from a number of study to look at the sleeping habits of 50,962 students in grades 9-12 over a period of 5 years. Before the later school start time was instituted, many parents and administrators expressed a fear that students would merely use the later morning start time as an excuse to stay up an hour later on school nights. The data, however, show that this did not happen. **Students continued to go to bed at the same time** (approximately 15 minutes before 11 p.m.). This finding makes sense from a biological perspective, as it is likely that nighttime circadian rhythms were contributing to feelings of sleepiness around 11 p.m., regardless of what time the students woke up in the morning. Minneapolis students slept about an hour more each school night (due to the later school start time) than their peers whose school began at 7:30 a.m.

In describing the Sleep Comparison table (next page), the author writes: Many of the benefits of the later start time were similar for both urban and suburban students, with their actual scores being nearly identical despite the differences in their local economic conditions. Again, if the need for and the benefits of more sleep are a biological phenomenon of the human body during the adolescent years, then one would expect those kinds of results, which are not related in any way to socioeconomic status.

The study goes on to get perspectives from teachers, as well, writing: Seventeen school counselors and 3 school nurses also provided personal comments, noting that significantly fewer students were coming to them to report peer relationship problems and/or difficulties with their parents. They echoed the principals’ perceptions that the overall mood in their schools was calmer, with the students’ temperaments seeming much more even.

### Table 3. A Comparison of Selected Sleep Survey Mean Scores From Minneapolis and District B High School Students

<table>
<thead>
<tr>
<th>Survey items/scales</th>
<th>Minneapolis high schools (8:40 a.m. start)</th>
<th>District B (7:30 a.m. start)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N = 467</td>
<td>N = 169</td>
</tr>
<tr>
<td>School day rise time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1997–1998</td>
<td>7:12 a.m.***</td>
<td>6:13 a.m.***</td>
</tr>
<tr>
<td>2000–2001</td>
<td>6:40 a.m.</td>
<td>6:19 a.m.</td>
</tr>
<tr>
<td>School night bedtime</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1997–1998</td>
<td>11:19 p.m.*</td>
<td>11:05 p.m.*</td>
</tr>
<tr>
<td>2000–2001</td>
<td>10:41 p.m.</td>
<td>11:18 p.m.</td>
</tr>
<tr>
<td>School night sleep total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1997–1998</td>
<td>7 hr, 53 min***</td>
<td>7 hr, 7 min***</td>
</tr>
<tr>
<td>2000–2001</td>
<td>7 hr, 59 min</td>
<td>7 hr, 1 min</td>
</tr>
<tr>
<td>Daytime sleepiness</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.21**</td>
<td>2.50**</td>
</tr>
<tr>
<td>Sleepiness (10-item total)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15.38***</td>
<td>17.37***</td>
</tr>
<tr>
<td>Struggled to stay awake or fell asleep</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading, studying, doing homework</td>
<td>1.97***</td>
<td>2.39***</td>
</tr>
<tr>
<td>During a test</td>
<td>1.32**</td>
<td>1.48**</td>
</tr>
<tr>
<td>In a class at school</td>
<td>2.06***</td>
<td>2.45***</td>
</tr>
<tr>
<td>Doing work on a computer or typewriter</td>
<td>1.23</td>
<td>1.34</td>
</tr>
</tbody>
</table>
These early start times have been clearly linked with reductions in student performance, stemming from increased absences and fatigue. [...] While later start times would not be without costs for most school systems, the authors’ calculations show that the benefits of later starting times would overwhelmingly outweigh these costs. Even in school systems where buses would have to be added, costs are not expected to exceed $150 per student per year. Later start times would lead to higher student achievement—the authors estimate a cumulative increase of \(0.175\) standard deviations in test scores by the time the student finishes high school. This impact is equivalent to an additional two months of schooling. When translated into earnings, the average student who starts school later would make about $17,500 more over the course of her life. These lifetime earnings gains are substantially more than the costs of changing transportation systems.

EXCESSIVE SLEEPINESS IN ADOLESCENTS AND YOUNG ADULTS: CAUSES, CONSEQUENCES, AND TREATMENT STRATEGIES
Richard Millman, AAP News and Journals, June 2005
http://pediatrics.aappublications.org/content/115/6/1774

Epstein and colleagues compared a 7:10 am with an 8:00 am school start time. In their survey, children with early start times reported significantly shorter mean sleep times (ie, approximately 25 minutes less) than did children who started school after 8:00 am.

IMPACT OF DELAYING SCHOOL START TIME ON ADOLESCENT SLEEP, MOOD, AND BEHAVIOR
Pediatric Adolescent Medicine, Owens Belon and Moss, July 2010

A school delayed start time from 8:00am to 8:30am and students got more sleep. The authors write: After the start time delay, mean school night sleep duration increased by 45 minutes, and average bedtime advanced by 18 minutes; the percentage of students getting less than 7 hours of sleep decreased by 79.4%, and those reporting at least 8 hours of sleep increased from 16.4% to 54.7%. Students reported significantly more satisfaction with sleep and experienced improved motivation. Daytime sleepiness, fatigue, and depressed mood were all reduced. Most health-related variables, including Health Center visits for fatigue-related complaints, and class attendance also improved.

SOCIODEMOGRAPHIC AND BEHAVIORAL PREDICTORS OF BED TIME AND WAKE TIME AMONG US ADOLESCENTS AGED 15 TO 17 YEARS
Journal of Pediatrics, Knutson et al, March 2009
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2783185/

While all studies mention the need for good sleep habits and interventions, this study specifically looked at whether start time is the primary factor in determining the amount of sleep that teens get. The authors write: On school days, school start time was the strongest predictor of wake time. Every hour earlier that school started, wake time was about 25 minutes earlier. ... Adolescents spent less than the recommended 9 hours in bed on school days. There is no evidence that this is a recent change in bed times and wake times, however. Although many factors influence bed time, school start time is the strongest determinant of wake time on school days. Increased computer use and earlier school days may be contributing to insufficient sleep in adolescents.
The author explains the case for why early start times interfere with sleep in several analyses, writing: The perfect storm metaphor applies to sleep patterns of adolescents in the sense that developmental trajectories of biopsychosocial factors conspire to limit the quantity of sleep for many adolescents resulting in a number of negative consequences. A reduction in sleep amount from late childhood through the second decade has long been known; however, the weight of current evidence holds that sleep need does not decline across this span. Nevertheless, parents, pediatricians, and school teachers, it seems, long assumed that this sleep decline was an inevitable part of growing up and a normative expectation. **We shall see below that the loss of sleep through adolescence is not driven by lower need for sleep but arises from a convergence of biological, psychological, and socio-cultural influences.**

Actigraphically monitored sleep data across two weeks confirmed that, **although the students woke up significantly earlier on school nights in tenth than ninth grade, they did not go to sleep earlier and consequently experienced less sleep on average.** The general level of sleepiness in these students is shown with the daytime sleep latency data, showing a moderate level of sleepiness in ninth grade, and a significant decline in tenth grade to a level considered severely sleepy for the sleep latency at 0830. The 0830 assessment was also associated with the occurrence of REM sleep within 10 or 15 minutes of sleep onset, (a finding often used to aid in the diagnosis of narcolepsy) in about one half of the participants. Let me unpack that last bit for you: Dr. Carskadon administered a test to students at 8:30am in the morning (after they had arrived at school). In the test, she found that students were so tired that they feel back to sleep and directly into REM sleep, in a pattern similar to narcolepsy.

### Sleep Patterns Reported by Adolescent School Children:
**National Sleep Foundation 2006 Sleep in America Poll**

<table>
<thead>
<tr>
<th></th>
<th>Grade 6</th>
<th>Grade 7</th>
<th>Grade 8</th>
<th>Grade 9</th>
<th>Grade 10</th>
<th>Grade 11</th>
<th>Grade 12</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bed time</strong></td>
<td>9:24 PM</td>
<td>9:52 PM</td>
<td>9:53 PM</td>
<td>10:15 PM</td>
<td>10:32 PM</td>
<td>10:51 PM</td>
<td>11:02 PM</td>
</tr>
<tr>
<td><strong>Avg sleep</strong></td>
<td>8h 24m</td>
<td>8h 6m</td>
<td>8h 6m</td>
<td>7h 36m</td>
<td>7h 18m</td>
<td>7h</td>
<td>6h 54m</td>
</tr>
</tbody>
</table>

The author included this table (and I created the chart), which shows how sleep declines through the grades. As students age, their bedtimes get later and later but their wake time remains bounded by the school day. The result is less sleep overall, with seniors suffering the most sleep loss.

Won't they Just Stay Up Later?
The author then drew this figure (right), writing: This figure illustrates the timing of sleep from preadolescence through adolescent development highlighting the factors that affect sleep as described in the text. Thus, sleep is relatively long and timed at an early hour for preadolescents, but maturational changes to intrinsic bioregulatory factors—the circadian phase delay arising from the circadian timing system and a slowed rise of sleep pressure stemming from sleep-wake homeostasis—put for a delay of the timing of sleep. Such psychosocial factors as self-selected bedtimes, response to academic pressure, and the availability and use of technology and social networking in the evening also push for a delay in the timing of sleep. Note that the length of sleep is not affected by these processes. Societal pressures that push for an early rise time—most notably an early start to the school day—are the forces that limit amount of time available for sleep. As a consequence, adolescents sleep too little and are asked to be awake at an inappropriate circadian phase. I’ve re-drawn this figure (below) in a chart we’ve used to explain sleep in our community meetings.

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**Adolescent Development & Sleep: The Perfect Storm**

![Adolescent Development Diagram](image)

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*Source: Sleep in Adolescents, The Perfect Storm*  
Dr. Mary Cardenas, June 2017  
[http://tinyurl.com/hrspG7b](http://tinyurl.com/hrspG7b)
THE EFFECTS OF THE REMOVAL OF ELECTRONIC DEVICES FOR 48 HOURS ON SLEEP IN ELITE JUDO ATHLETES
Journal of Strength & Conditioning Research, Duncan et al, January 2017

Finally, this small study asked a group of participants to give up electronic devices and try to go to bed earlier than normal. As you might expect, based on teen biology, they found it very difficult to fall asleep early. The researchers found that although athletes tried to go to bed earlier when the devices were removed, they fell asleep at the same time as those who has access to electronic devices. Removal of the devices did not affect their sleep quality, or next-day physical performance compared to those who continued to use electronic devices. The authors write: This study has shown that the removal of electronic devices for a period of 48 hours two nights during a judo camp does not affect sleep quality or quantity or influence athletic or cognitive performance.

DELAYING SCHOOL STARTING TIME BY ONE HOUR: SOME EFFECTS ON ATTENTION LEVELS IN ADOLESCENTS
Journal of Clinical Sleep Medicine, Lufi et al April 2011
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3077340/

The purpose of the study was to assess the attention level of middle-school students by providing a group of students with the opportunity for an additional one hour of sleep in the morning by delaying school starting time by one hour, as compared to another group received no additional sleep. The results showed that in the first week the experimental group slept an average of 55 minutes longer each night, for 5 nights (total 275 minutes). Students who slept longer performed better in measures of attention as assessed by the “Mathematics Continuous Performance Test” and the “d2 Test of Attention,” indicating better performance in attention level, impulsivity, and the rate of performance.

LONGITUDINAL OUTCOMES OF START TIME DELAY ON SLEEP, BEHAVIOR, AND ACHIEVEMENT IN HIGH SCHOOL
Updated May 10, 2017
Sleep, Thacher et al, February 2016
Research: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4712391/
Article about this research: https://thejournal.com/Articles/2016/02/05/Study-Finds-Late-School-Start-Improves-Teen-Behavior.aspx

This study is so interesting because of its findings. They looked at one school who advanced start time by 45 minutes. They found that in the short term, teens slept more but in the long term their sleep returned to the same total sleep as it had before the start time change. You might say: ah hah! This proves they don’t actually sleep more. No other study has had this finding, so it’s unique in that respect. Here’s the kicker, though. The authors also found that even though the kids slept the same amount before and after the change, there were marked differences in behavior and achievement. So, really, this study shows that it’s just as much about the timing of the sleep than it is about the duration of the sleep. The authors write: Students delayed but did not extend their sleep period; we found lasting improvements in tardiness and disciplinary violations after the start-time delay, but no changes to other variables. At the first follow-up, students reported 20 minutes longer sleep, driven by later rise times and stable bed times. At the second follow-up, students maintained later rise times but delayed bedtimes, returning total sleep to baseline levels. A delay in rise time, paralleling the delay in the start time that occurred, resulted in less tardiness and decreased disciplinary incidents, but larger improvements to sleep patterns may be necessary to affect health, attendance, sleepiness, and academic performance. Conclusion: Later start times improved tardiness and disciplinary issues at this school district. A delay in start time may be a necessary but not sufficient means to increase sleep time and may depend on preexisting individual differences.
The author of this study, Dr. Pamela Thacher, was interviewed about this study on a radio program and she makes it clear that her take-away from this study is that start time is more about the timing of sleep than the duration. She fully supports the AAP’s recommendation of an 8:30am start time for schools and adds that: “just because we didn’t get 100% results that were consistent with what we hoped for. We got lots of positive changes. My recommendation would be also 8:30. I think the bravest schools would move it to 9:00”. If you listen to the interview, the story starts at 22:00. Dr. Thacher speaks at 27:10, 31:13, 37:18 and 39:20.
What is the best learning window for Elementary Students?

In STAC Option D, a swap of elementary and Masconomet start times is proposed. What is the potential effect of a change in start time for elementary students? Is 8am too early to start learning? Does it have an adverse effect on student health. While there are not hundreds of studies on elementary-aged children (as there are for adolescents), the studies that do exist suggest that at 8am elementary students will be ready and able to learn, and that it will have no adverse effects on their health. Other elementary districts in Massachusetts and around the country start at or before 8:00am, including Nauset which made a swap in schedules almost 10 years ago.

While more studies would help, we can only work with the information that we have now: which shows definitively and overwhelmingly that adolescents are harmed by an early start.

According to Dr. Creeden (retired superintendent of TTU) we once had start times between 8:00am and 8:10am in the three towns, before Ed Reform (1991). I don't have the exact date for when that ended, but some time in the late 80's when busing was combined with Masconomet. Currently the Tri-Town elementary schools have multiple programs that begin at 8am or earlier, including Nauset which made a swap in schedules almost 10 years ago.

More research is available here:


STARTING TIME AND SCHOOL LIFE: REFLECTIONS FROM EDUCATORS AND STUDENTS
PhD Delta Kappan, Kubow P et al, 1999

https://www.researchgate.net/publication/234638013_Starting_Time_and_School_Life_Reflections_from_Educators_and_Students - access to this report is paid, members of STAC have seen the report in full

In this study, 14 elementary schools changed their start times. In Findings from the Elementary Schools the report says that: 9:40 is too late (kids already exhausted), 8:40am start was positive, and 7:40 was positive (particularly for students with ADHD). The authors write: "Teachers from the three elementary schools that moved from 8:40 to 7:40 commented on a number of positive effects. Children appeared to be more alert at the beginning of the day and stayed more energized throughout the day. Students experienced fewer morning transitions and were more ready to learn. Teachers perceived themselves and their students to be more patient and productive in the afternoon, Fewer behavior problems contributed to a calm, positive school environment, and student participation in after-school activities seemed to have increased. Being first on the tiered busing schedule meant that buses arrived promptly at the beginning and end of the school day. The early start was also considered beneficial for afternoon kindergarten classes because children actually arrived at school late in the morning as opposed to the afternoon. Support and administrative staff members at the schools stating at 7:40 a.m. concurred with the teachers and had relatively few complaints about moving to the earlier time."

SCHOOL START TIME CHANGES AND SLEEP PATTERNS IN ELEMENTARY SCHOOL STUDENTS
Sleep Health, Appleman E et al, June 2015


"Students changed start time from 8:20am to 7:45am as they moved from K-2 building to the grade 3-5 building. Prechange, wake time across all grades was similar; postchange, fourth and fifth graders woke on average 30-40 minutes earlier than children in those grades the year before, and third graders woke on average 8 minutes later. Compared to prechange, third graders reported longer average total sleep times (24 minutes); fourth and fifth graders reported average sleep times 4 and 9 minutes shorter, respectively, than students in those grades the previous year. The
percentage of students in each grade reporting later weekend wake and bed times decreased postchange. Reports of sleepiness somewhat increased for fifth graders postchange. Conclusion: *School start time change did not decrease total amount of sleep. This is the first study of its kind to report on the effects of a start time change in elementary school students.*

The following table is taken from the study results and clearly shows that students in grades 3 got more sleep with the change and those in grades 4 and 5 had about the same sleep. The student in Grade 10 – who was able to wake 33 minutes later also got 35 minutes of extra sleep – showing, again, that when they can wake up later they do not just go to bed later.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Grade 3</th>
<th>Grade 4</th>
<th>Grade 5</th>
<th>Grade 10</th>
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</thead>
<tbody>
<tr>
<td>Old Wake up time</td>
<td>6:49am</td>
<td>6:56am</td>
<td>6:59am</td>
<td>6:20am</td>
</tr>
<tr>
<td>New Wake up time</td>
<td>6:57am</td>
<td>6:22am</td>
<td>6:23am</td>
<td>6:53am</td>
</tr>
<tr>
<td>Wake up time Difference</td>
<td>+8min</td>
<td>-34min</td>
<td>-36min</td>
<td>+33min</td>
</tr>
<tr>
<td>Old Bed time</td>
<td>8:37pm</td>
<td>8:52pm</td>
<td>9:10pm</td>
<td>10:36pm</td>
</tr>
<tr>
<td>New Bed Time</td>
<td>8:22pm</td>
<td>8:22pm</td>
<td>8:43pm</td>
<td>10:36pm</td>
</tr>
<tr>
<td>Bed Time Difference</td>
<td>+15min</td>
<td>+30min</td>
<td>+27min</td>
<td>0min</td>
</tr>
<tr>
<td>Old Total Sleep Time</td>
<td>10h 11m</td>
<td>10h 3m</td>
<td>9h 49m</td>
<td>7h 42m</td>
</tr>
<tr>
<td>New Total Sleep Time</td>
<td>10h 35m</td>
<td>9h 59m</td>
<td>9h 40m</td>
<td>8h 17m</td>
</tr>
<tr>
<td>Total Sleep Time Difference</td>
<td>+24m</td>
<td>-4m</td>
<td>-9m</td>
<td>+35m</td>
</tr>
</tbody>
</table>

In this table you’ll see that when start time changed, sleep time for Grades 4 and were basically unchanged. Sleep time for Grade 3 actually went up, as did Grade 10. This study shows, again, that it is much easier to get an elementary student to go to bed earlier than it is an adolescent and that an earlier start time will have no effect on their total sleep. Obviously, there is a limit on how early they can go to school, but a 7:45-8:00am start time should be no problem.

RISE AND SHINE: THE EFFECT OF SCHOOL START TIMES ON ACADEMIC PERFORMANCE FROM CHILDHOOD THROUGH PUBERTY

Heissel J and Norris S, April 20, 2016


In the conclusion the authors write: Despite growing medical and physiological evidence that current school start times are too early for optimal adolescent cognitive functioning, there has been little policy response to move start times later. We add to this debate with direct evidence that more sunlight before school — or a later relative start time — increases academic achievement for children of all ages. The increase in scores is much larger for adolescents, implying that even when parental schedules preclude later start times for all children, districts can improve academic performance by adjusting the order in which school types open to correspond with students’ changing sleep schedules. *Specifically, high school students should begin school later in the day to compensate for pubertal changes that shift their circadian rhythm later, while elementary students should begin school the earliest.* Despite the low costs of adopting this policy, the gains are quite large.

KEY READING: IMPACT OF SCHOOL START TIME ON STUDENT LEARNING

Hanover Research report February 2013


The report writes: While research on start times for young students is sparse, it has shown elementary school students do not benefit from a later start time. Some experts suggest academic
achievement of elementary school students would not be adversely impacted by an earlier start time, as young students are alert earlier in the day than adolescent students and start school at a later time than secondary students. ... The report goes on to cite research suggesting that an early elementary start (7:30am) would have no adverse effect on elementary students, saying: Dr. Richard Schwab at the University of Pennsylvania [says that] “Right now, high schools usually start earlier in the morning than elementary schools. But if school start times were based on sleep cycles, elementary schools should start at 7:30 and high schools at 8:30 or 8:45—right now it’s the reverse. School systems should be thinking about changing their start times. It would not be easy...but it would increase their students’ sleep time and likely improve their school performance.” ... Dr. David Sousa, author of How the Brain Learns, suggests that pre-adolescents (i.e., virtually all elementary-aged students) are more focused earlier in the morning than adolescent students. Specifically, he shows pre-adolescent students having the same degree of focus at 7 a.m. that adolescent students have at 8 a.m.

The report authors suggest that a single tier of busing is more desirable than a swap: While a shift in start times is considered a low-cost systemic change when, say, earlier high school start times are swapped with later elementary school start times, there is relatively little evidence discussing the effects of such a change on the younger students. As such, simply swapping times may not be recommendable. Moreover, it is clear that moving from a tiered/staggered start time system (where schools districts can maximize the repeated use of buses and other transportation equipment) to a unified start time for all grades would require increased spending to make up for the loss of overlap.

A LONGITUDINAL ASSESSMENT OF SLEEP TIMING, CIRCADIAN PHASE, AND PHASE ANGLE OF ENTRAINMENT ACROSS HUMAN ADOLESCENCE
http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0112199

A longitudinal study of adolescent sleep. Participants had melatonin levels measured and wore an actigraph to measure sleep every six months over 2.5 years. In the discussion, the authors write: The developmental trajectories observed in these two cohorts indicate that sleep/wake timing shifted later as youngsters aged, except in the case of weekday wake times, for which school schedules likely dictated the morning schedule. ... Participants in the older cohort fell asleep later relative to their melatonin rhythm compared to the younger cohort, as evidenced by a wider phase angle of DLMO (salivary dim light melatonin onset) to sleep onset.

This chart takes a little explanation. The researchers found that sleep drive accumulates slower for teens: what that means is that they continue to feel more alert in the evening, up until melatonin production starts. This is different from younger children, who get progressively more tired. They also found that adolescents can ignore the sleepy signal for longer than younger children, until they rather abruptly become very sleepy. All this adds up to adolescents naturally being more alert in the evening and falling asleep later than younger children and adults.
DO SCHOOLS BEGIN TOO EARLY?
Education Next, Finley Edwards, Summer 2012
http://educationnext.org/do-schools-begin-too-early/

The author reviews multiple studies and examines their findings. He writes: To further investigate how the effect of later start times varies with age, I estimate the effect of start times on upper elementary students (grades 3–5). *If adolescent hormones are the mechanism through which start times affect academic performance, preadolescent elementary students should not be affected by early start times. I find that start times in fact had no effect on elementary students.* However, elementary schools start much later than middle schools (more than half of elementary schools begin at 9:15, and almost all of the rest begin at 8:15). As a result, it is not clear if there is no effect because start times are not a factor in the academic performance of prepubescent students, or because the schools start much later and only very early start times affect performance. ... If elementary students are not affected by later start times, as my data suggest (albeit not definitively), it may be possible to increase test scores for middle school students at no cost by having elementary schools start first. Alternatively, the entire schedule could be shifted later into the day.

LESS SLEEP, MORE STRUGGLES FOR ELEMENTARY AND MIDDLE SCHOOL STUDENTS
SLEEP, November 10, 2005
http://www.brown.edu/Administration/News_Bureau/2005-06/05-046.html

The study asked children age 6-12 to restrict sleep (6.5 hours for grade 3 and up, 8 hours for those up to grade 2) and asked teachers to complete a survey about their children’s behavior and performance in the classroom. This study did not look at start time, only the total sleep per night. The result is not surprising: children at any age who have restricted sleep suffer in the classroom: *Teachers reported significantly more academic problems for students whose sleep was restricted*, compared to weeks where they followed their own bedtime routine or the optimized schedule. Severity of attention problems also spiked when students’ sleep was restricted... With more children being diagnosed with attention disorders and learning disabilities, Fallone said the results act as a reminder that sleep should be forefront in the minds of school psychologists, pediatricians and other professionals responsible for diagnosing and treating these problems.

EARLIER SCHOOL START TIMES ARE ASSOCIATED WITH HIGHER RATES OF BEHAVIORAL PROBLEMS IN ELEMENTARY SCHOOLS
Journal of Educational Psychology, Keller et al, February 2017
Research: [https://www.apa.org/pubs/journals/releases/edu-a0037195.pdf](https://www.apa.org/pubs/journals/releases/edu-a0037195.pdf)
Article about Research: [https://www.psychologytoday.com/blog/child-sleep-zzzs/201702/earlier-school-start-times-elementary-school-students](https://www.psychologytoday.com/blog/child-sleep-zzzs/201702/earlier-school-start-times-elementary-school-students)

This is one of the studies that indicates that there may be problems associated with an earlier start time for elementary aged children. The study looked at data from the Kentucky Department of Education, and compared it to school start times. 48.8% of the schools surveyed started before 8:00am, 31.2% between 8:00am and 8:30am, 5.7% between 8:30am and 9:00am and 14.2% started between 9:00am and 9:10am. In the results, the authors write: *Associations between early school start time and greater behavioral problems* (harassment, in-school removals, suspensions, and expulsions) *were observed*, although some of these associations were found only for schools serving the non-Appalachian region. However, they go on to add: The current study is also limited by its cross-sectional design and data from only one state. Although we controlled for a number of potential confounding factors, including the racial composition of the schools and teacher–student ratio, *we cannot infer that early school start times were the cause of school performance measures.*
How much sleep are Masconomet children getting?

This is a fundamental question. Do we have a sleep problem at Masconomet? Is sleep deprivation something that is happening to other children, but not ours? The data suggests that Masconomet students are experiencing the same levels (if not more) sleep deprivation than national numbers.

YRBS AND STAC SLEEP SURVEY

STAC Sleep Survey Results are here: http://www.masconomet.org/Page/463

The 2016 Youth Risk Behavior Survey that was administered to our students asked this question for the first time, which will enable us to compare this data to national data. However, those results are not yet available. What we do have is the results of the STAC sleep survey, in which both parents and students were asked to report on total sleep time for high school students. We can compare what students reported (an average of 6h 30m) to what parents reported (an average of 7h 18m) to the national YRBS data collected by the CDC. The results are shown in the chart below. In general, our findings at Masconomet are consistent with national trends, with more Masconomet kids reporting 7h of sleep.

Recall that the average adolescent needs 8-10 hours of sleep, with an ideal average sleep time of 9h and 20m. Just as with children nationwide, Masconomet high school students are experiencing sleep deprivation.

PREVALENCE OF INSUFFICIENT, BORDERLINE, AND OPTIMAL HOURS OF SLEEP AMONG HIGH SCHOOL STUDENTS

Journal of Adolescent Health, Eaton et al, April 2010

The research team found that nearly 70% of adolescents reported less than or equal to 7 hours of sleep per night. They found that only 23.5% reported 8 hours of sleep and only 7.6% reported “optimal sleep” of 9 hours or greater per night. We describe the prevalence of insufficient, borderline, and optimal sleep hours among U.S. high school students on an average school night. Most students (68.9%) reported insufficient sleep, whereas few (7.6%) reported optimal sleep. The prevalence of insufficient sleep was highest among female and black students, and students in grades 11 and 12.
Comparing this information to the STAC Sleep Survey Results, we find Masconomet sleep reports are consistent with national findings:

PREVALENCE OF SLEEP DURATION ON AN AVERAGE SCHOOL NIGHT AMONG 4 NATIONALLY REPRESENTATIVE SUCCESSIVE SAMPLES OF AMERICAN HIGH SCHOOL STUDENTS

Journal of Adolescent Health, Basch et al, 2014
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4264412/

The author reviewed the results of the Youth Risk Assessment Survey (YRBS) from 2007-2013 to see how reported sleep is changing over time. The bad news is that despite calls to address sleep deprivation among adolescents, the total amount of sleep for adolescents continues to be well below doctor’s recommendations. They break sleep out across grade, showing that seniors in high school are highly sleep deprived. The authors write: Across the 4 waves of data collection, 6.2% to 7.7% of females and 8.0% to 9.4% of males reported obtaining 9 or more hours of sleep. Insufficient duration of sleep is pervasive among American high school students. Despite substantive public health implications, intervention research on this topic has received little attention. [...] The Centers for Disease Control and Prevention recommends that adolescents obtain 9 or 10 hours of sleep each day. In our study, a large majority of American high school students did not meet this recommendation. Among 12th graders, approximately 95% of males and females did not meet this recommendation. Data on students that report sleeping 7 hours or fewer on an average school night show that a substantial proportion of American high school students are not even close to obtaining the recommended amount of sleep.
Table 1

<table>
<thead>
<tr>
<th>Group</th>
<th>2007</th>
<th>2009</th>
<th>2011</th>
<th>2013</th>
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</thead>
<tbody>
<tr>
<td>Overall</td>
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<td>25.2</td>
<td>29.1</td>
<td>22.5</td>
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<tr>
<td>Race/ethnicity</td>
<td></td>
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<td>15.0</td>
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<td>28.9</td>
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</table>

Table 2

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<td>9th</td>
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<td>18.1</td>
<td>28.4</td>
<td>31.9</td>
<td>16.9</td>
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</tbody>
</table>

STAC SLEEP SURVEY

STAC Sleep Survey Results are here: http://www.masconomet.org/Page/463

No single chart can illustrate our sleep problems more than this one, which shows sleep/wake times at different ages for school days vs. weekend days. The charts below show the times, according to our children, that they fall asleep (on the left) and wake up (on the right). Each row of charts represents a different age group. Green regions represent sleep and wake patterns on school nights and school mornings. Blue regions represent sleep and wake patterns on "natural" nights and mornings, when children are able to fall asleep and wake when they want to.
The charts on the left indicate falling asleep times. As our children age, they fall asleep later. Children in Grades 9-12 fall asleep about 1 hour later than their counterparts in Grades PreK-2. This difference is consistent with the sleep research, nationwide.

Under ideal circumstances, the graphs for natural and school night sleep would overlap and appear nearly identical. In grades 5-6, the graph averages differ by 43 minutes between natural and school night fall asleep times. In grades 7-8, the difference is 28 minutes. In grades 7-12 the difference is 16 minutes. Researchers point out that adolescents become sleepy naturally at approximately 11pm, on average (older teens and boys trend later).

The charts on the right indicate waking times. Under ideal circumstances, the graphs for natural and school night sleep would overlap and appear nearly identical. In grades 5-6, there is a 1hr 26min difference between natural and school night waking times. In grades 7-8 our children experience the earlier start times at Masconomet and the difference becomes 2hr 48min, exactly what their parents report. In grades 9-12 the difference is 3hr 19min.

While children in grades 5-6 reported an average of 8h and 42m of sleep, those in grades 7 and 8 (when early start times begin) report an average of 7h and 30m of sleep. As they age and their bedtime drifts later (due to biological changes), high school students report an average of 6h and 30m of sleep. The survey also asked students how they felt about the amount of sleep they were getting.
Sleep deprivation and Academic performance, and attendance for adolescents

Let’s examine the academic effects of sleep deprivation, and conversely the academic effects of getting enough sleep. This is probably one of the most difficult things to study, because each student is different, each school is different, and there are so many possible factors in an individual student’s outcome. How can we really understand the academic effects? There are studies, that look at it.

One fascinating finding that is repeated again and again is that the changes in start time have the biggest improvements for children who are struggling. Examples include children lower socio-economic class, children with an unsupportive home life, children with ADHD, children with a C or D average. These groups get the biggest boost from start time change, making it a key way to close the performance gap.

Many more articles on the relationship between sleep deprivation and academic performance are available at these locations:


KEY READING: A’S FROM ZZZZ’S? THE CAUSAL EFFECT OF SCHOOL START TIME ON THE ACADEMIC ACHIEVEMENT OF ADOLESCENTS

American Economic Journal, Carrell et al, August 2011

Perhaps the single most rigorous study on the academic effects comes from the military, where it is important to squeeze every last bit of performance out of each and every member of the force. At the Air Force Academy incoming cadets (equivalent to college freshman) take the same courses, have the same activities, and the same home life. The Air Force decided to take one group and start their day later and measure the results. The authors write in the introduction:

Recent sleep research finds that many adolescents are sleep-deprived because of both early school start times and changing sleep patterns during the teen years. This study identifies the causal effect of school start time on academic achievement by using two policy changes in the daily schedule at the US Air Force Academy along with the randomized placement of freshman students to courses and instructors. Results show that starting the school day 50 minutes later has a significant positive effect on student achievement, which is roughly equivalent to raising teacher quality by one standard deviation.

The report includes the following: To visualize how academic achievement changed across start time cohorts, we look at the distribution of achievement measures across cohorts in Figure 2 (shown below). The distribution of scores in all class periods and first period courses shifts to the right with later start times. To assure us that the difference in scores across start time cohorts is not a result of differences in course difficulty across years, we look at the distribution of normalized grades as well. The same pattern holds for the normalized grade, wherein the later-start cohorts have a higher distribution of grades in all class periods and an even higher distribution of grades in 1st period courses compared to the earlier-start cohorts.
KEY READING: LATER START TIME FOR TEENS IMPROVES GRADES, MOOD, AND SAFETY
Phi Delta Kappan, Kyla Wahlstrom, 2016
http://www.kappанonline.org/later-start-time-for-teens/

This report is Dr. Wahlstrom’s look back at research over the last 20 years and what we’ve learned. She covers a number of topics, but in writing about academic outcomes, she says: The analysis involved examining student data by school and grade level before and after the time change. We found significant decreases in absences and tardiness in all grades 9-12 in the school districts that had instituted the latest school start times of 8:35 and 8:55 a.m. — in one district, there was a 66% drop in tardiness. An interesting difference emerged when we compared the outcomes of schools starting at 8:00-8:30 a.m. with those of the school with the latest start time of 8:55 a.m. Examining grades earned before and after the time change, we found:

Statistically significant increases in the 1st-period grade point average in one or more core courses of English, math, social studies, and science in three districts with start times from 8:00-8:35 a.m.

Significant increases in grade point average in all 1st-period core courses for all semesters in all grades in Jackson Hole High School in Wyoming, with a start time of 8:55 a.m.

The evidence shows that the later the start time, the greater the academic benefits.
TEENS AND SLEEP: LINKING DISCOVERY, PRACTICE AND POLICY
University of Minnesota, Dr. Kyla Wahlstrom, 3/10/2014

Significant increase in attendance rates (pre-post) were identified for 9th, 10th, and 11th grade students in all Minneapolis high schools. Graduation rates significantly improved over the three years after the later start time was initiated in Minneapolis. A positive trend line was found for pre-post comparisons on actual GPAs of Minneapolis high school students, but were not statistically significant.

SNOOZE OR LOSE: HIGH SCHOOL START TIMES AND ACADEMIC ACHIEVEMENT
US Department of Labor, Groen and Pabilonia, October 2015
https://www.bls.gov/osmr/pdf/ec150060.pdf

Abstract: Many U.S. high schools start classes before 8:00 A.M., yet research on circadian rhythms suggests that teenagers’ biological clocks shift to later in the day. This paper conducts the first study using a nationally representative dataset to examine the effect of high school start times on long-run academic outcomes, including college-entrance exam scores and college attendance. Results indicate that female students who attend schools with later start times get more sleep and score higher on the SAT. Male students also get more sleep when their schools start later, but they are less likely to attend a four-year college.

SLEEP HABITS, ACADEMIC PERFORMANCE, AND THE ADOLESCENT BRAIN STRUCTURE
Urrila, A. S. et al., February 9 2017
http://www.nature.com/articles/srep41678

The authors of this study found that adolescents who don’t get enough sleep have smaller brains than those who do. From the conclusion: “We found that, among adolescents, later weekend bedtimes correlated with smaller brain GMVs in frontal, anterior cingulate, and precuneus cortex regions. Later weekend bedtimes were associated with poorer school grade average, and both of these were further associated with small GMV in the medial PFC region. Shorter weekday time in bed correlated with smaller GMVs in frontal regions. These results highlight especially the possible adverse link of late timing of weekend sleep with the maturing adolescent brain and school performance.”

DELAYING SCHOOL STARTING TIME BY ONE HOUR: SOME EFFECTS ON ATTENTION LEVELS IN ADOLESCENTS
Journal of Clinical Sleep Medicine Lufi D et al, April 15 2011
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3077340/

For the first week of the study, the school starting time was delayed 1 h for the experimental group. In the second week, these students returned to their regular school schedule. The results showed that in the first week the experimental group slept an average of 55 minutes longer each night. Students who slept longer performed better in measures of attention [...] indicating better performance in attention level, impulsivity, and the rate of performance. The study strongly recommends that middle schools should consider delaying the school starting time by at least
one hour. Such a change could enhance students' cognitive performance by improving their attention level, increasing rate of performance, as well as reducing their mistakes and impulsivity.

COGNITIVE PERFORMANCE, SLEEPINESS, AND MOOD IN PARTIALLY SLEEP DEPRIVED ADOLESCENTS
Sleep, Lo J. et al, 2015
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4763363/

Conclusion: A week of partial sleep deprivation impairs a wide range of cognitive functions, subjective alertness, and mood even in high-performing high school adolescents. Some measures do not recover fully even after 2 nights of recovery sleep. [...] Partial sleep deprivation in adolescents of comparable duration and severity to that examined in studies on young healthy adults elicited equivalent or greater neurobehavioral deficits across several cognitive domains. Residual effects on sustained attention, speed of processing, and subjective alertness can still be observed even after 2 nights of recovery sleep. That even students from top high schools are susceptible to neurobehavioral deficits following partial sleep deprivation should cause policymakers and parents to reconsider if sleep should continue to be sacrificed for the sake of academic achievement.

SLEEP EXPERT URGES LATER SCHOOL START TIMES, LESS HOMEWORK
Davis Enterprise, Anne Ternus-Bellamy, November 10, 2015

Classes should start no earlier than 8:30 a.m., there should be a minimum of 11 hours between the end of the last scheduled school-sponsored activity and the start of school the next day, and homework needs to be limited. Those were the recommendations of renowned sleep expert Dr. Charles Czeisler, who spoke to parents, students and school administrators on Monday night about the sleep deprivation crisis facing America's youth. "One in five high school boys in the United States is diagnosed with ADHD," Czeisler noted. "Undoubtedly, some of them have ADHD, but the symptoms of sleep deficiency are indistinguishable from the symptoms of ADHD." And ADHD, he noted, is treated with amphetamines, which in a teen who doesn't actually have ADHD, serves only to further interfere with sleep, creating a vicious cycle. The bottom line, Czeisler said, is students "are going to school to learn." And sleep deprivation "is a key thing interfering with that."

KEY READING: DELAYED HIGH SCHOOL START TIMES LATER THAN 8:30 AM AND IMPACT ON GRADUATION RATES AND ATTENDANCE RATES
Sleep Health, Malaspina and Clark, 2017

Conclusions: The results of this study lend empirical evidence and add rigor to the argument that a shift to later school start times for high school students results in more favorable outcomes, such as attendance rates and graduation rates. ... The overall findings from this study are consistent with, and extend the evidence in the literature. Improved attendance rates increase the likelihood of graduation completion. Every student should have an equal opportunity to graduate from school. If a delayed start time of later than 8:30 AM promotes improved student access to attending, learning, and graduating, then all of society benefits because increased graduation completion impacts quality of life. ... Given the many impacts of improved attendance and graduation rates, educators and officials responsible for setting school start times should be
obliged to consider a shift to later bell times if it improves adolescent well-being and daytime performance. Gaining an understanding about the underlying biological underpinnings of adolescent sleep needs is the first step to making change. The brain and the nervous system require optimal sleep to function, and adolescents have a unique set of sleep needs that should be considered before school start times are determined. The decision to start high school later requires a shift in mindset. With support of empirical investigations such as this study, educators are in a pivotal position to become change agents and advocates for high school students by teaching all stakeholders about adolescent sleep. These changes accomplish what all educators and educational leaders aspire to: student success.

ASSOCIATIONS OF EXECUTIVE FUNCTION WITH SLEEPINESS AND SLEEP DURATION IN ADOLESCENTS

Conclusion: Decrements in selected executive function scales are associated with subjective sleepiness, but not sleep duration, in adolescents. The association between sleepiness and executive functioning is strongest among adolescents with primary caregivers who have lower levels of education, suggesting an increased susceptibility. Pediatricians and public health officials should consider sleepiness as a potentially important contributor to adolescent functioning.

LET THE TEENS SLEEP

Cost Effectiveness Of Delaying School Start Times: Middle School: Dr Chen explained that the current benchmark for improving academic achievement is reducing class size. Research has found that to achieve 4% point improvement in math/reading scores by reducing class size, it would cost $2151/student per year. In comparison, by starting middle school start times one hour later (at ~8:30 AM) it can result in a 3%tile point increase in math/reading scores. This effect is equivalent or comparable to having gained an additional year of parental education, a known positive association with academic achievement! High School: starting high school one hour later around 9am can result in an average increase in student achievement by 0.175 standard deviations, which is further increased in those at the most socioeconomic disadvantage. In addition, later starts result in about $17,500 in increased lifetime future earnings per student (at then current time).

DO SCHOOLS BEGIN TOO EARLY?

The author reviews multiple studies and examines their findings. He is a skeptic it’s important to see what he’s comfortable saying. For the impact on academics, the author writes: I find that delaying school start times by one hour, from roughly 7:30 to 8:30, increases standardized test scores by at least 2 percentile points in math and 1 percentile point in reading. The effect is largest for students with below-average test scores, suggesting that later start times would narrow gaps in student achievement.
Sleep Deprivation and Anxiety, Depression, Suicide, Mental Health, and Emotional Health

There is a wide-ranging research on the relationship between poor sleep and depression, far beyond the work on adolescents. However, just focusing on teens there are many studies showing that poor sleep is leading to depression and suicidal thoughts. You can find more research here:


MASCONOMET HIGH SCHOOL YOUTH RISK BEHAVIOR ASSESSMENT, 2014

Are Masconomet students experiencing anxiety, depression, and having suicidal thoughts or making suicidal plans? To get the answer, we can examine the YRBS data for our high school students from 2014, 2012, and 2010 and compare it to the state and national data. In general, Masconomet students are experiencing these things in levels similar to national numbers, with a worrisome number in “attempted suicide”.

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SLEEP PATTERNS AND MENTAL HEALTH CORRELATES IN US ADOLESCENTS

Added May 10, 2017
Journal of Pediatrics, Zhang et al, March 2017

The authors write: Later weeknight bedtime, shorter weeknight sleep duration, greater weekend bedtime delay, and both short and long periods of weekend oversleep were associated with increased odds of mood, anxiety, substance use, and behavioral disorders, as well as suicidality, tobacco smoking, and poor perceived mental and physical health. Suboptimal sleep patterns were associated with an array of mental disorders and other health-related outcomes among adolescents. Abnormal sleep patterns may serve as markers of prodromal or untreated mental disorders among adolescents, and may provide opportunities for prevention and intervention in mental disorders.
SLEEPLESS IN FAIRFAX: THE DIFFERENCE ONE MORE HOUR OF SLEEP CAN MAKE FOR TEEN HOPELESSNESS, SUICIDAL IDEATION, AND SUBSTANCE USE

http://winslerlab.gmu.edu/pubs/WinslerSleep.pdf

The authors find that as little as one more hour of sleep can have a big effect on feelings of hopelessness. They write: *An important community factor that contributes to adolescent sleep deprivation is the time high schools start in the morning* (Andrade et al. 1993; Kirby et al. 2011). The shift that takes place with the circadian rhythms of adolescents makes it difficult for adolescents to fall asleep early at night and more critical for them to be asleep in the early hours of the morning (Crowley et al. 2007). *For around 40% of teens, this natural tendency toward an eveningness chronotype is so severe that it is practically impossible for them to fall asleep much before midnight even under the most supportive of parental/familial conditions and bedtime routines* (Giannotti et al. 2002), and such children appear to be at particular risk of mental health problems (Wolfson and Carskadon 1998). High school start time is a stronger predictor of adolescent sleep quantity, than bedtimes, bedtime routines, and time spent doing homework (Knutson and Lauderdale 2009). [...] The present study found that the odds of teen hopelessness, suicidal ideation and suicide attempts, and substance use are sizeably reduced with one more hour of weeknight sleep. Thus, it appears that one does not have to make a huge leap from obtaining, say, 6 h to getting nine hours of sleep as a teen in order to see the positive health benefits of increased sleep. Attention to, and intervention for, reduced adolescent sleep is critically needed at multiple levels (individual, family, school, and community) in order to optimize the mental health and wellbeing of adolescents.

Media Coverage of this research by Cathy Cruise, May 18 2016
https://www2.gmu.edu/news/237521

While the National Institutes of Health recommends teenagers get around nine hours of sleep a night, only 3 percent of Fairfax County students reported getting that much sleep, and 20 percent said they got five hours or less of sleep per weeknight. On average, respondents reported getting only six-and-a-half hours of sleep each weekday night. The consequences of skipping sleep can be dire. Accounting for variables such as family composition and income, gender, and ethnic and community-level differences, *Winsler determined each hour of sleep lost was associated with a 38-percent increase in feelings of sadness and hopelessness among teens, a 23-percent increase in substance abuse, a 42-percent increase in suicidal thoughts and a 58-percent increase in actual suicide attempts.*

NEW CENTER FOR COLLEGE SLEEP SAYS A GOOD NIGHT’S REST IS KEY TO BETTER MENTAL HEALTH

Andy Steiner, May 4, 2016
https://www.minnpost.com/mental-health-addiction/2016/05/new-center-college-sleep-says-good-night-s-rest-key-better-mental-he

Roxanne Prichard, associate professor of neuroscience and psychology at the University of St. Thomas, has been investigating the state of youth sleep in America. ”Society is failing teens. We have a whole generation who do not know what it feels like to get enough sleep. Teens need eight to 10 hours of sleep a night. They’re not getting that. I’m not surprised we are seeing rising rates of depression and anxiety alongside their decreasing sleep.” And sleep deprivation aggravates mental illnesses like depression and anxiety, Prichard explained. “*People who are chronically sleep deprived are nine times more likely to show depression symptoms and 17 times more likely to show anxiety symptoms.* Research has shown that a lack of sleep ramps up your stress response so that you are much more likely to view normal behavior as a threat.” When a person is behind on their sleep, Prichard continued, “They are much more likely to become stressed about life.”
SLEEP RESTRICTION WORSENS MOOD AND EMOTION REGULATION IN ADOLESCENTS
Journal of Child Psychology and Psychiatry, Baum et al, 2014
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4047523/

In this study, the authors practice extreme sleep restriction to see if they can study the effects on mood. A number of researchers have wondered whether the idea that “teens are always in a bad mood” is actually a result of sleep deprivation, rather than age. The authors write: Participants averaged 2.5 more hours of sleep per night during HS relative to SR. Compared to HS [healthy sleep], adolescents rated themselves as significantly more tense/anxious, angry/hostile, confused, and fatigued, and as less vigorous (p = .001–.01) during SR [sleep restriction]. Parents and adolescents also reported greater oppositionality/irritability and poorer emotional regulation during SR compared to HS (p < .05). There were no cross condition differences in depression or hyperactivity/impulsivity (p > .05). Findings complement prior correlational study results to show that after only a few days of shortened sleep, at a level of severity that is experienced regularly by millions of adolescents on school nights, adolescents have worsened mood and decreased ability to regulate negative emotions.

THE PROSPECTIVE ASSOCIATION BETWEEN SLEEP DEPRIVATION AND DEPRESSION AMONG ADOLESCENTS
Sleep, Roberts et al 2013
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3900610/

These results are the first to document reciprocal effects for major depression and sleep deprivation among adolescents using prospective data. The data suggest reduced quantity of sleep increases risk for major depression, which in turn increases risk for decreased sleep. [...] When we turned to the association between sleep deprivation and major depression, we found the two were correlated at baseline. We also found that baseline sleep deprivation increased risk for subsequent major depression, by a factor of more than 3.

WEEKEND WEEKDAY ADVANCES IN SLEEP TIMING ARE ASSOCIATED WITH ALTERED REWARD RELATED BRAIN FUNCTION
Biological Psychology, Hasler BP et al, 2012
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3490026/

In conclusion, these preliminary data suggest that adolescents who pursue a later sleep schedule on the weekend, only to have return to a much earlier sleep schedule during the school week, show an altered pattern of brain reactivity to the anticipation and receipt of rewards. Notably, the results suggest that larger disparities between weekday and weekend sleep timing, as a proxy for circadian misalignment, are associated with reduced activation in both cortical and subcortical reward-related brain regions. These effects could reflect reduced regulatory response, and reduced reward sensitivity, which could result in compensatory reward-seeking behavior. Circadian misalignment associated with weekend shifts in sleep timing may contribute to reward-related problems such as depression, substance abuse and other risk-taking behavior.

INSUFFICIENT SLEEP AND SUICIDALITY IN ADOLESCENTS
Sleep, Lee Y. et al, 2012
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3296786/

BISS [Adolescents with behaviorally induced insufficient sleep syndrome] was found to be associated with increased suicidality. Weekend oversleep was associated with suicidality independently of depression, daytime sleepiness, snoring, and insomnia. The study findings suggest that chronic sleep restriction among adolescents may increase suicidal risk. [...] Adolescents with
behaviorally induced insufficient sleep syndrome (BISS) had higher SSI [Beck Scale for Suicidal Ideation] scores than those who slept ≥ 7 hours on weekdays, even after controlling for age, sex, and BDI [Beck Depression Inventory] score (F = 11.71, P < 0.001).

**SLEEP AND ITS IMPORTANCE IN ADOLESCENCE AND IN COMMON ADOLESCENT SOMATIC AND PSYCHIATRIC CONDITIONS**

*International Journal of General Medicine, Brand et al 2011*

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3119585/

Restoring sleep is strongly associated with a better physical, cognitive, and psychological well-being. By contrast, poor or disordered sleep is related to impairment of cognitive and psychological functioning and worsened physical health. These associations are well documented not only in adults but also in children and adolescents. Importantly, adolescence is hallmarked by dramatic maturational changes in sleep and its neurobiological regulation, hormonal status, and many psychosocial and physical processes. Thus, the role of sleep in mental and physical health during adolescence and in adolescent patients is complex. However, it has so far received little attention. This review first presents contemporary views about the complex neurobiology of sleep and its functions with important implications for adolescence. Second, existing complex relationships between common adolescent somatic/organic, sleep-related, and psychiatric disorders and certain sleep alterations are discussed. *It is concluded that poor or altered sleep in adolescent patients may trigger and maintain many psychiatric and physical disorders or combinations of these conditions, which presumably hinder recovery and may cross into later stages of life.* Therefore, timely diagnosis and management of sleep problems appear critical for growth and development in adolescent patients.

**SLEEP DEPRIVATION LEADS TO MOOD DEFICITS IN HEALTHY ADOLESCENTS**

*Sleep Medicine, Short MA and Louca M, August 2015*


More evidence that teenage mood swings may be a result of sleep restriction: The subscales of depression, anger, confusion, anxiety, vigour, and fatigue were compared across days. All mood states significantly worsened following one night without sleep. Females showed a greater vulnerability to mood deficits following sleep loss, with greater depressed mood and anxiety following sleep deprivation only witnessed among female participants. While both males and females reported more confusion following sleep deprivation, the magnitude of this effect was greater for females.

**EPIDEMIOLOGY OF INSOMNIA, DEPRESSION, AND ANXIETY**


There are literally thousands of studies linking poor sleep with depression, in children and adults. I've included just one. Results: People with insomnia had greater depression and anxiety levels than people not having insomnia and were 9.82 and 17.35 times as likely to have clinically significant depression and anxiety, respectively. Increased insomnia frequency was related to increased depression and anxiety, and increased number of awakenings was also related to increased depression. These were the only 2 sleep variables significantly related to depression and anxiety. People with combined insomnia (ie, both onset and maintenance insomnia) had greater depression than did people with onset, maintenance, or mixed insomnia. There were no differences between other insomnia types. African Americans were 3.43 and 4.8 times more likely to have clinically significant depression and anxiety than Caucasians, respectively. Women had higher levels of depression than men. Conclusion: *These results reaffirm the close relationship of insomnia,*
depression, and anxiety, after rigorously controlling for other potential explanations for the relationship.

**CHRONIC SLEEP DEPRIVATION TIED TO MORE DEPRESSION FOR YOUNG WOMEN**

Kathryn Doyle, May 27 2016
http://www.reuters.com/article/us-health-sleep-depression-idUSKCN0Y12FL

“The overall message that poor quality and insufficient sleep lead to poor mood, which, in turn, worsens sleep was not surprising,” said lead author David A. Kalmbach of the University of Michigan Medical School in Ann Arbor. More noteworthy, he added, was that these relationships were evident in healthy, young women, not just insomniacs or depressed people. Women who averaged less sleep per night over the two-week period tended to report greater “anhedonic” depression symptoms, or the inability to enjoy pleasurable things. But they also tended to report more of these symptoms the day after a night of particularly long sleep, as reported in Sleep Medicine.

**SCHOOLS STRUGGLE TO COPE WITH RISING MENTAL HEALTH NEEDS**

https://www.bostonglobe.com/metro/2016/05/16/schools-confront-students-rising-mental-health-toll/J4nGkaSYWZ3qDmbQ2PmjLO/story.html

Massachusetts, like the rest of the country, has a shortage of child psychologists and psychiatrists, creating long waiting lists for care. The shortage is particularly severe in the spring when mental health issues among teenagers spike. Mental health experts say it may be linked to sleep deprivation and the mounting pressure students face to excel in school and get into the best colleges. ... Over the last decade, many schools have seen the number of cases grow from just a few a year to upwards of several dozen, often transforming guidance offices into de facto psychiatric wards, educators say.

Masconomet’s own enrollment projections show that while student population is declining, the number of students who need services from guidance, psychologists, SPEA teachers, Language and Literacy intervetnion, and our adjustment counselors is rising, becoming a greater and greater percentage of the Masconomet population.
Sleep Deprivation and Risk Taking Behaviors

One important set of data that’s been collected by researchers is to examine the Youth Risk Behavior Survey, administered to adolescents all over the country each year. By analyzing data from thousands of students, the CDC can look for important correlations. These correlations on their own do now show causation, but the findings support the causative-research done by other researchers.

The CDC’s analysis is not the only source of information about sleep and risk taking behaviors. More research can be found in these locations:

- http://startschoollater.pbworks.com/w/page/60412558/Sleep%20Loss%20and%20Accidents%20or%20Injury

RELATIONSHIPS BETWEEN HOURS OF SLEEP AND HEALTH-RISK BEHAVIORS IN US ADOLESCENT STUDENTS

Preventative Medicine, Eaton et al, August 2011

A study of over 12,000 students by McKnight-Eily et al., 2011. The authors write: Insufficient sleep on an average school night was reported by 68.9% of students. Insufficient sleep was associated with higher odds of current use of cigarettes, marijuana, and alcohol; current sexual activity; seriously considered attempting suicide; feeling sad or hopeless; physical fighting, not being physically active at least 60min ≥ 5 days in the past 7 days, using the computer ≥3h/day, and drinking soda/pop ≥ 1time/day.

Prevalence and adjusted likelihood of selected health-risk behaviors by sleep status on an average school night—Youth Risk Behavior Survey, United States 2007.

<table>
<thead>
<tr>
<th>Health-risk behavior</th>
<th>&lt;8 h sleep on an average school night (N=8370)</th>
<th>≥8 h on an average school night (N=3784)</th>
<th>Adjusted OR (≥8 h is the referent)</th>
<th>(95% CI)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinked a caffeine containing beverage</td>
<td>35.7 (33.0–38.6)</td>
<td>33.5 (30.1–37.0)</td>
<td>1.14</td>
<td>(1.03–1.28)</td>
<td>0.02</td>
</tr>
<tr>
<td>Did not participate in 60 min of physical activity on ≥5 of 7 days</td>
<td>67.3 (60.2–69.3)</td>
<td>62.2 (59.0–64.4)</td>
<td>1.10</td>
<td>(1.04–1.29)</td>
<td>0.01</td>
</tr>
<tr>
<td>Watched television ≥3 h/day</td>
<td>35.6 (33.3–37.5)</td>
<td>35.9 (32.8–38.1)</td>
<td>1.02</td>
<td>(0.99–1.16)</td>
<td>0.79</td>
</tr>
<tr>
<td>Used computers ≥3 h/day</td>
<td>28.9 (23.8–32.8)</td>
<td>20.3 (16.5–23.9)</td>
<td>1.59</td>
<td>(1.33–1.83)</td>
<td>0.00</td>
</tr>
<tr>
<td>In a physical fight ≥1 time/week</td>
<td>36.0 (35.0–38.0)</td>
<td>32.0 (30.0–33.9)</td>
<td>1.46</td>
<td>(1.24–1.68)</td>
<td>0.00</td>
</tr>
<tr>
<td>Current cigarette user</td>
<td>24.0 (21.3–27.0)</td>
<td>15.0 (12.8–17.4)</td>
<td>1.67</td>
<td>(1.45–1.93)</td>
<td>0.00</td>
</tr>
<tr>
<td>Current alcohol use</td>
<td>50.3 (48.0–52.7)</td>
<td>36.7 (34.4–39.0)</td>
<td>1.64</td>
<td>(1.46–1.84)</td>
<td>0.00</td>
</tr>
<tr>
<td>Current marijuana use</td>
<td>23.3 (21.3–25.5)</td>
<td>15.6 (13.8–17.7)</td>
<td>1.52</td>
<td>(1.31–1.76)</td>
<td>0.00</td>
</tr>
<tr>
<td>Current sexually active</td>
<td>23.3 (21.3–25.5)</td>
<td>15.6 (13.8–17.7)</td>
<td>1.52</td>
<td>(1.31–1.76)</td>
<td>0.00</td>
</tr>
<tr>
<td>Felt sad or hopeless</td>
<td>31.1 (29.7–32.5)</td>
<td>21.6 (19.7–23.6)</td>
<td>1.82</td>
<td>(1.43–2.34)</td>
<td>0.00</td>
</tr>
<tr>
<td>Seriously considered attempting suicide</td>
<td>16.8 (15.5–18.2)</td>
<td>9.8 (8.8–11.0)</td>
<td>1.86</td>
<td>(1.60–2.16)</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Less than 8 hours of sleep | More than 8 hours of sleep

- Used 1+ cigarettes daily
- Used alcohol in past 30 days
- Used marijuana in past 30 days
- Currently sexually active
- Felt sad or hopeless

A study of over 12,000 students by McKnight-Eily et al., 2011. The authors write: Insufficient sleep on an average school night was reported by 68.9% of students. Insufficient sleep was associated with higher odds of current use of cigarettes, marijuana, and alcohol; current sexual activity; seriously considered attempting suicide; feeling sad or hopeless; physical fighting, not being physically active at least 60min ≥ 5 days in the past 7 days, using the computer ≥3h/day, and drinking soda/pop ≥ 1time/day.
SLEEP DURATION AND INJURY-RELATED RISK BEHAVIORS AMONG HIGH SCHOOL STUDENTS

Centers for Disease Control Morbidity and Mortality Weekly Report, Wheaton et al, April 8 2016
https://www.cdc.gov/mmwr/volumes/65/wr/mm6513a1.htm?s_cid=mm6513a1_w

The CDC also examined YRBS data to look for risky behaviors among teens. The authors write:

Unintentional injuries are the leading cause of death for adolescents, with approximately two thirds of these fatalities related to road traffic crashes. Excessive sleepiness, which is most often a result of not getting adequate sleep, has been shown to increase the risk for motor vehicle crashes and other unintentional injury among adolescents. Although insufficient sleep contributes to injury risk directly by slowing reaction time, impairing ability to pay attention, or causing a driver to fall asleep, this study provides evidence that some of the increased risk associated with insufficient sleep might be caused by engaging in injury-related risk behaviors. In addition to a higher likelihood of engaging in injury-related risk behaviors among students who reported typically sleeping ≤7 hours on school nights, infrequent seatbelt use, riding with a drinking driver, and drinking and driving were also more likely for students sleeping ≥10 hours compared with 9 hours. Although short and long sleep might simply be associated with other adolescent risk behaviors, insufficient sleep might cause persons to take more risks and disregard the possibility of negative consequences. However, depression might contribute to both sleep problems and participation in risk behaviors. Sleep problems, including both not sleeping enough and sleeping too much, are common symptoms of depression; one study found that adolescents who reported more depressive symptoms were more likely to engage in several injury-related risk behaviors, including infrequent seatbelt use, infrequent bicycle helmet use, and drinking and driving.

CENTERS FOR DISEASE CONTROL AND PREVENTION, NATIONAL CENTER FOR HEALTH STATISTICS. COMPRESSED MORTALITY FILE 1999-2010

Dr. Owens’ presentation: https://youtu.be/MsDoe6h4QFM?t=21m28s

During Dr. Owens’ talk at Masconomet, she brought up the statistics on the leading causes of adolescent mortality. The primary causes are unintentional injury, homicide, and suicide. All three of these risks are increased by lack of sleep.
Sleep Deprivation and Violence and Delinquency

More research can be found here:

•  https://schoolstarttime.org/early-school-start-times/risk-taking-behaviors/

MASCONOMET HIGH SCHOOL YOUTH RISK BEHAVIOR ASSESSMENT, 2014

Are Masconomet students experiencing violence? We can examine the YRBS data for our high school students from 2014 and look at violent behavior and bullying for some answers:

Responses were not different from 2012 – slightly less and 10% carried a gun; about 1 in 7 had been in a fight.

There were few differences across age but many differences across gender with boys were likely than girls to engage in these behaviors.

About 20% of youth report having been bullied at school and slightly more than 10% on the internet with girls more likely than boys to report this.

Social media is by far the most commonly reported location for bullying and girls are 3 times more likely than boys to report experiencing or having seen bullying on social media (37% vs 12%).

SLEEP DEPRIVATION, LOW SELF-CONTROL, AND DELINQUENCY
Journal of Youth and Adolescence, Meldrum RC et al, February 2015

The results from regression models using latent factors indicate: sleep deprivation is positively related to low self-control; low self-control is positively related to delinquency; and the relationship between sleep deprivation and delinquency is indirect and operates through low self-control. Impressively, these relationships emerged when accounting for potential background sources of spuriousness, including neighborhood context, depressive symptoms, parenting practices, unstructured socializing with peers, and prior delinquency.

SLEEP AND DELINQUENCY: DOES THE AMOUNT OF SLEEP MATTER?
Journal of Youth and Adolescence, Clinkinbeard et al, 2011

A 2011 study published in the Journal of Youth and Adolescence found that teenagers sleeping seven or fewer hours per night had a significantly higher rate of property crimes such as vandalism, shoplifting, and breaking and entering than their peers who had 8-10 hours of sleep. This study references dozens other studies, for more information. Teenagers sleeping five or fewer hours per night had a significantly higher rate of violent crimes such as being involved in a physical fight or threatening someone with a weapon than those teenagers who had slept 8-10 hours. The authors write: “Our analysis provides preliminary evidence that sleep-deprived adolescents participate in a greater volume of both violent and property crime…. Further, our results indicate that every little bit of sleep may make a difference. That is, sleeping 1 (hour) less (i.e., 7 hours) than the recommended range increased the likelihood of property delinquency, and this risk increased for each hour of sleep missed.”
INCREASED RISK FOR SCHOOL VIOLENCE RELATED BEHAVIORS AMONG ADOLESCENTS WITH INSUFFICIENT SLEEP

*Journal of School Health, Hildenbrand et al, 2013*


This study examined the relationship between insufficient sleep and school violence behaviors in a nationally representative sample of high school students. [...] *Students with insufficient sleep had higher odds of engaging in the majority of school violence-related behaviors examined compared to students with sufficient sleep.* Males with insufficient sleep were at increased risk of weapon carrying at school, a finding not observed for females with insufficient sleep. White students with insufficient sleep had higher odds of missing school because of safety concerns, a pattern that did not emerge among Black and Hispanic/Latino students.

INTERPARENTAL CONFLICT AND EARLY ADOLESCENTS' AGGRESSION

*Journal of Adolescence, Lemola et al, 2011*


We investigated whether (a) short and irregular sleep are related to aggressive behavior in early adolescence and (b) whether they moderate the relation between interparental conflict and aggressive behavior. 176 early adolescents (mean age 11.6 years, 89 girls) reported their bed and wake times on weekdays and on weekends and their aggressive behavior. Interparental conflict was rated by their mothers and adolescents reported whether they felt threatened by the conflict. No direct association between early adolescents’ sleep and aggression was found. *However, short sleep duration on weekday nights, long sleep duration on weekends, and a large weekday to weekend difference in sleep duration moderated the relation between interparental conflict and early adolescents' aggression.* Findings are consistent with the hypothesis that irregular sleep is a vulnerability factor for early adolescents’ aggression and underscore the importance of sufficient and regular sleep for resilience.

JUVENILE VIOLENT CRIME TIME-OF-DAY PROFILES


One side effect of our early school start and end times is that some teens will have long, unsupervised afternoons while their parents are still at work. The Office of Juvenile Justice and Delinquency Prevention has found that juvenile violence peaks during after school hours on school days, and in the evenings on nonschool days. Furthermore, even though the number of school days and nonschool days is roughly equivalent, *most violent crimes (63%) committed by juveniles occur on school days, with 19% of all juvenile violent crimes occurring between the hours of 3 p.m. and 7 p.m. on school days.*
Sleep Deprivation and Alcohol and Drug Use

As already mentioned, poor sleep results in poor decision making and risk taking behaviors, and that includes the use of alcohol and drugs. But another dimension is that students who are struggling with sleep problems often try to manage them by using stimulants (to wake up) and depressants (to fall asleep). Researchers now understand that using caffeine can lead to more drug use later. More research can be found here:


**DR. OWENS’ PRESENTATION ON SLEEP AND GATEWAY DRUGS**

Dr. Owens’ presentation on gateway drugs: [https://youtu.be/MsDoe6h4QFM?t=31m28s](https://youtu.be/MsDoe6h4QFM?t=31m28s)

Association of early coffee use (<12yo) with later use illicit drugs and alcohol

Low risk vs high (>6 cups/month) 7th grade users 1.5-2.5x less likely to use alcohol, tobacco at 1 yr followup

Association twin studies alcohol/cigarettes: Caffeine increases reinforcing effects nicotine; increased caffeine metabolism smokers

Possible role as “gateway drug?” Energy drink consumption college students predicts subsequent non-medical stimulant use

**MASCONOMET HIGH SCHOOL YOUTH RISK BEHAVIOR ASSESSMENT, 2014**


Are Masconomet students using alcohol and drugs? The YRBS found that our students are using caffeine and energy drinks.

Caffeine: 10% reported having caffeine at least once a day, and only 29.9% reported not having a caffeinated beverage in the past 7 days (29.9%).

Energy Drinks: Slightly more than 1 in 10 indicated they had an energy drink in the past 30 days (11.3% - with boys more likely than girls to say they did so (15.5% vs 6.8%).

We can examine the YRBS data for our high school students from 2014, 2012, and 2010 and compare it to the state and national data:
THE PROSPECTIVE ASSOCIATION BETWEEN SLEEP AND INITIATION OF SUBSTANCE USE IN YOUNG ADOLESCENTS

Journal of Adolescent Health, Miller MB Janseen T Jackson KM, February 2017

Controlling for participant age at sleep assessment, gender, and internalizing and externalizing behaviors, shorter sleep duration and greater daytime sleepiness in year 1 were associated with increased odds of having had a full drink of alcohol, having engaged in heavy episodic drinking, and having experienced alcohol-related consequences by year 4. Shorter sleep duration was also associated with increased odds of marijuana use by year 4. No sleep parameter was uniquely associated with increased odds of cigarette use (first puff or first full cigarette). Effects were evident for both males and females. Age at sleep assessment did not moderate effects. Conclusion: Sleep health is a prospective predictor of the onset of alcohol and marijuana use among adolescents. Increased efforts to prevent and intervene in sleep problems among adolescents are warranted.

CIRCADIAN MISALIGNMENT, REWARD-RELATED BRAIN FUNCTION, AND ADOLESCENT ALCOHOL INVOLVEMENT

Alcoholism, Clinical and Experimental Research, Hasler et al 2013
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3843484/

The timing of sleep shifts later throughout adolescence, in part due to developmental changes in endogenous circadian rhythms, which tend to become more delayed. This tendency for delayed sleep and circadian rhythms is at odds with early school start times during secondary education, leading to misalignment between many adolescents' sleep-wake schedules and their internal circadian timing. Circadian misalignment is associated with increased alcohol use and other risk-taking behaviors, as well as sleep loss and sleep disturbance. Growing evidence indicates that circadian rhythms modulate the reward system, suggesting that circadian misalignment may impact adolescent alcohol involvement by altering reward-related brain function. Neurocognitive function is also subject to sleep and circadian influence, and thus circadian misalignment may also impair inhibitory control and other cognitive processes relevant to alcohol use. Specifically, circadian misalignment may further exacerbate the cortical-subcortical imbalance within the reward circuit, an imbalance thought to explain increased risk-taking and sensation-seeking during adolescence. Adolescent alcohol use is highly contextualized, however, and thus studies testing this model will also need to consider factors that may influence both circadian misalignment and alcohol use.

LONGITUDINAL BI-DIRECTIONAL RELATIONSHIPS BETWEEN SLEEP AND YOUTH SUBSTANCE USE

Journal of Youth and Adolescence, Pasch et al, 2012
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3431186/

The findings of this study provide support for a bi-directional association between sleep and substance use among adolescent. Specifically, sleep patterns and duration are important precursors to adolescent substance use. Furthermore, adolescent substance use can impact future sleep patterns and duration, which could have a lasting impact on psychological and physical well-being. These relationships have significance for the optimal growth and development of adolescents.
THE SPREAD OF SLEEP LOSS INFLUENCES DRUG USE IN ADOLESCENT SOCIAL NETWORKS

Mednick et al, March 19 2010
http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0009775

In a study of over 8,000 students the authors conclude: “The results indicate that interventions should focus on healthy sleep to prevent drug use.” This study looks at how improving one student’s length of sleep can positively impact other students up to four degrees of separation. It is a complex study looking at multiple variables, and yet the final recommendation was to target sleep to prevent drug misuse/abuse. The authors write: The evidence suggests that poor sleep leads to drug use in adolescents, and that both sleep and drug use spread through social networks. We show (for the first time, to our knowledge) a mediation effect in which the spread of one health behavior affects the spread of another. Specifically, a person’s risk of drug use increases if his friends sleep poorly, and this effect is mediated in part by the spread of poor sleep behavior from one person to another.
Sleep Deprivation and Obesity

This is not a topic that is widely discussed in relation to sleep, but it’s an important one. The sleep rhythms of the body also help to set up other bodily rhythms, such as hunger. When we are sleep deprived, we eat more – likely because our bodies regard sleep deprivation as a sign of a stressful or dangerous environment. Children who are not sleeping are at risk for higher levels of obesity for life, particularly girls. More reading is here:

• https://schoolstarttime.org/early-school-start-times/excessive-weight-gain/
• http://startswithlater.pbworks.com/w/page/113465368/Sleep%20Loss%20and%20Physical%20Health

"FIGHTING THE CLOCK: HOW AMERICA'S SLEEP DEFICIT IS DAMAGING LONGTERM HEALTH"
Harvard School of Public Health, March 6 2012
Video: https://www.youtube.com/watch?v=XkCzQ8Hop2o
Information: https://sleep.med.harvard.edu/news/460/FIGHTING+THE+CLOCK+How+America+s+Sleep+Deficit+is+Damaging+Longterm+Health

This video is an hour long, but in it Harvard Professor of Nutrition and Epidemiology Frank Hu observes that there is a close relationship between dietary habits and sleep habits. Sleep is as important as diet and exercise. Sleep-deprivation serves to increase production of the appetite-stimulating hormone, ghrelin, sending a signal to the brain to eat, particularly high calorie, high sugar-content foods. By contrast, restricted sleep diminishes the production of leptin, a hormone which suppresses appetite. Production of a third hormone, cortisone, is increased by sleep loss, elevating heart rate and blood pressure. Chronic elevation of cortisone levels increases the risk of weight gain and obesity, with the latter being particularly dangerous for type 2 diabetes and cardiovascular disease.

PREVALENCE OF HIGH BODY MASS INDEX IN US CHILDREN AND ADOLESCENTS
JAMA, Ogden, et al, January 10 2010
http://jamanetwork.com/journals/jama/fullarticle/185233

High body mass index (BMI) among children and adolescents continues to be a public health concern in the United States. Children with high BMI often become obese adults,1 and obese adults are at risk for many chronic conditions such as diabetes, cardiovascular disease, and certain cancers. High BMI in children may also have immediate consequences, such as elevated lipid concentrations and blood pressure. Since 1980, the prevalence of BMI for age at or above the 95th percentile (sometimes termed "obese") has tripled among school-age children and adolescents, and it remains high at approximately 17%.

THE ASSOCIATION OF SLEEP DURATION WITH ADOLESCENTS' FAT AND CARBOHYDRATE CONSUMPTION
Sleep, Weiss et al, September 2010

A study published in the September 2010 issue of the journal “Sleep” found that teenagers who slept less than eight hours per weeknight ate more fatty foods and snacks than adolescents who slept eight hours or more. Conclusion: Quantitative measures of macronutrient intake in adolescents were associated with objectively measured sleep duration. Short sleep duration may increase obesity risk by causing small changes in eating patterns that cumulatively alter energy balance.
ASSOCIATION BETWEEN SHORT TIME IN BED, HEALTH RISK BEHAVIORS AND POOR ACADEMIC ACHIEVEMENT AMONG NORWEGIAN ADOLESCENTS

Sleep Medicine, Stea TH et al, June 2014

A total of 32.3% of the students reported short time in bed (<8h/day) on an average school night. Several health-risk behaviors were associated with short sleep duration, including not being physically active for > or =60 min for > or =5 days/week; using television/computer >2 h/day; being a current smoker or sniffer; having an irregular meal pattern; intake of sweets/candy > or =4 times/week; and poor academic achievement.

SELF REPORTED SLEEP DURATION AND WEIGHT CONTROL STRATEGIES AMONG US HIGH SCHOOL STUDENTS

Sleep, Wheaton et al, 2013
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3700710/

Self-reported short sleep duration was associated with dieting and three unhealthy weight-control behaviors in this population [...] 12,087 Students were asked if they had engaged in several weight-control behaviors during the 30 days before the survey to lose or maintain weight. Self-reported sleep duration categories included very short (≤ 5 h), short (6 or 7 h), referent moderate (8 or 9 h), and long (≥ 10 h). Sex-specific logistic regression analyses with race/ethnicity, grade, and body mass index category as covariates were conducted using SUDAAN to account for complex study design. Approximately half the students reported short sleep duration (51.8% of males and 54.3% of females), whereas very short sleep durations were reported by another 14.8% of males and 16.9% of females. Among males, very short sleepers were significantly (P < 0.05) more likely than moderate sleepers to report dieting (36.3% versus 26.1%), fasting (14.2% versus 4.3%), and purging (4.3% versus 1.1%) to lose or maintain weight during the 30 days before the survey. Among females, the respective very short, short, and moderate sleepers varied (P < 0.05) in dieting (59.9%, 55.0%, and 47.5% respectively), fasting (28.3%, 15.2%, and 10.3%, respectively), and taking diet pills (13.3%, 6.8%, and 4.3%, respectively). Prevalence of purging was significantly higher only for very short sleepers (12.3%, 6.0%, and 3.9%, respectively).
Sleep Deprivation and Automobile Accidents

While parents would never allow their teenagers to drive drunk, they routinely allow teens to drive while sleep deprived. Ample research shows that sleepy driving and drunk driving are equivalent and that each time our children get behind the wheel, they are running a high risk. Sleep deprivation contributes to between 15% and 20% of all motor vehicle crashes worldwide. More research is available here:


MODERATE SLEEP DEPRIVATION PRODUCES IMPAIRMENTS IN COGNITIVE AND MOTOR PERFORMANCE EQUIVALENT TO LEGALLY PRESCRIBED LEVELS OF ALCOHOL INTOXICATION

Occup Environ Med, Williamson, 2000
[https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1739867/pdf/v057p00649.pdf](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1739867/pdf/v057p00649.pdf)

The short version of this study: driving while sleepy is equivalent to driving while drunk. The author writes: Response speeds were up to 50% slower for some tests and accuracy measures were significantly poorer than at this level of alcohol. After longer periods without sleep, performance reached levels equivalent to the maximum alcohol dose given to subjects (Blood Alcohol Content of 0.1%). These findings reinforce the evidence that the fatigue of sleep deprivation is an important factor likely to compromise performance of speed and accuracy of the kind needed for safety on the road and in other industrial settings.

DROWSY DRIVING AND AUTOMOBILE CRASHES

National highway Traffic Safety Administration

A 1990 study found boys with the greatest extracurricular time commitments most likely to report falling asleep at the wheel. The subgroup at greatest risk “comprised the brightest, most energetic, hardest working teens.”

TEEN DRIVERS: GET THE FACTS

CDC, Injury Prevention & Control: Motor Vehicle Safety
[https://www.cdc.gov/MotorVehicleSafety/Teen_Drivers/teendrivers_factsheet.html](https://www.cdc.gov/MotorVehicleSafety/Teen_Drivers/teendrivers_factsheet.html)

According to the CDC, “young people ages 15-24 represent only 14% of the U.S. population. However, they account for 30% ($19 billion) of the total costs of motor vehicle injuries among males and 28% ($7 billion) of the total costs of motor vehicle injuries among females. [T]he risk of motor vehicle crashes is higher among 16- to 19-year-olds than among any other age group.” Per mile driven, teen drivers ages 16 to 19 are three times more likely than drivers aged 20 and older to be in a fatal crash.

CRASHES INVOLVING TEENS TRIPLE DURING BACK-TO-SCHOOL

Ohio Department of Transportation, August 2011

In fact, seven o’clock in the morning is the most dangerous time for teens driving to school. From 2006 to 2010, the study found early morning crashes involving teens (ages 15-18) nearly tripled from 42 in the first week of August to 118 the last week in August – which is attributed to the start of the new school year.
ADOLESCENT SLEEP, SCHOOL START TIMES, AND TEEN MOTOR VEHICLE CRASHES

Journal of Clinical Sleep Medicine, Danner and Phillips, December 2008
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2603528/

In 1999, school districts in Fayette County, Kentucky (Lexington metropolitan area), delayed start times for high school students county-wide by one hour to 8:30 a.m. Average crash rates for 16-18 year olds in the study county in the 2 years after the change in school start time dropped 16.5%, compared with the 2 years prior to the change, whereas crash rates for 17-18 year olds increased 7.8% in the state over the same time period. The authors wrote:

Moving the school start time 1 hour later for all of the adolescents in 1 large county school district (the only county to do so during the period of this study) resulted in meaningful increases in sleep time, an increase in the percentage of students who got an adequate amount of sleep, and a decrease in catch-up sleep on weekends. It was also associated with a significant drop in auto collision rates for high school-aged drivers in that county, whereas crash rates increased in the rest of the state during the same time period. These findings are not necessarily causal, since they are not the result of a direct assessment of the sleep habits and miles driven of drivers who did and did not have crashes. However, these data are consistent with the idea that allowing adolescents to sleep more on school nights by delaying the start of school not only results in them sleeping more, but also may have a measurable positive effect on their driving safety.

SCHOOL START TIMES AND TEENAGE DRIVER MOTOR VEHICLE CRASHES

US Department of Transportation National Highway Traffic Safety Administration, December 2015

This report takes a hard look at crash data from Forsyth County, North Carolina and Fayette County, Kentucky and dissects the claims carefully. They found: We conclude that there is mild evidence that the change in school start times in Forsyth County, NC had a beneficial effect, but there is no corresponding evidence for Fayette County, KY. The authors go on to add: There is a fairly clear pattern of change during the day, with crashes shifting in time corresponding to the change in school start and finish times. However, the critical question for school board policy is whether the change in school start time has produced an overall decrease in the rate of school-age driver crashes. The analysis shows a statistically significant decrease in standard crash rates for Forsyth County associated with the change in school start time.

CLINICAL GUIDE TO PEDIATRIC SLEEP: DIAGNOSIS AND MANAGEMENT OF SLEEP PROBLEMS

Mindell and Owens, 2010 (Lippincott Williams & Wilkins, 2nd ed. 2010) p. 258.)
https://books.google.com/books?id=2-soMHyJVYgC&printsec=frontcover&dq=Clinical+Guide+to+Pediatric+Sleep:+Diagnosis+and+Management+of+Sleep+Problems&hl=en&ei=pLuTTrzzEKKKsQKN-N3WBg&sa=X&oi=book_result&ct=result&resnum=1&ved=0CDEQ6AEwAA#v=onepage&q=false

“Teenagers, especially older teenage boys, are at the highest risk for falling asleep at the wheel. The most common drowsy driving accident involves a single vehicle with a single driver who drives off the road. These accidents happen most often late at night and in the middle of the afternoon. So don’t be fooled that just because it is bright daylight, your teen won’t fall asleep at the wheel. In
addition, all teens who are not getting enough sleep are at risk, especially when a beer or two, marijuana, and relative driving inexperience compound lack of sleep.”

**THE EFFECT OF ACUTE SLEEP DEPRIVATION ON VISUAL EVOKED POTENTIALS IN PROFESSIONAL DRIVERS**

Sleep, Jackson et al, September 2008
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2542966/#!po=82.1429

This study is looking at the effects on adults, but there is nothing to suggest that a teenage driver would have any different result. In fact, if anything, teen drivers may be at higher risk due to their lack of experience. The authors write: "Both motor and mental acuity suffer when we are sleep deprived, which can lead to dangerous human errors and accidents. Studies done on test subjects with occupations associated with sleep deprivation—including pilots, truck drivers, and medical residents—typically show a greater risk for fatigue-related mistakes and crashes. Accidents related to lost lives and billions of dollars in costs.”

**ADOLESCENT CRASH RATES AND SCHOOL START TIMES IN TWO CENTRAL VIRGINIA COUNTIES**

2009-2011: A Follow-up Study to a Southeastern Virginia Study, 2007-2008

Insufficient sleep increases the risk of crashes in younger drivers. Sleepy crashes are common in the United States, and adolescents are likely to be an especially at-risk population. One study revealed that 7% of all crashes were drowsy crashes, and that 16.5% of fatal crashes involved drowsy drivers. Younger adults aged 16-24 years were most apt to be involved in drowsy crashes. Another study revealed that 55% of sleepy crashes occurred in those younger than 26 years. …

This study adds to the body of research that suggests that **early high school start times may be disadvantageous for teen driving safety.** As teens are a vulnerable population this is an especially relevant issue.
Sleep Deprivation and Athletic Performance

Rather than being in opposition to one another, healthy sleep and athletics should go hand in hand. These articles focus on the relationship between sleep deprivation and athletic performance. In order to learn new skills (including athletic skills), athletes need sleep. Many studies showing the link between poor sleep and poor athletic performance. This research is now so widely accepted that national professional sports leagues regularly consider sleep to be part of training. Many more links to research are available here:


CHRONIC LACK OF SLEEP IS ASSOCIATED WITH INCREASED SPORTS INJURIES IN ADOLESCENT ATHLETES

The research: https://www.researchgate.net/publication/263971781_Chronic_Lack_of_Sleep_is_Associated_With_Increased_Sports_Injuries_in_Adolescent_Athletes

Results: Multivariate analysis showed that hours of sleep per night and the grade in school were the best independent predictors of injury. Athletes who slept on average < 8 hours per night were 1.7 times more likely to have had an injury compared with athletes who slept for >= 8 hours. For each additional grade in school, the athletes were 1.4 times more likely to have had an injury.

Conclusion: Sleep deprivation and increasing grade in school appear to be associated with injuries in an adolescent athletic population. Encouraging young athletes to get optimal amounts of sleep may help protect them against athletic injuries.


I included this coverage of the article because of the spectacular chart they created. This is an article covering the research by This study reveals the association between insufficient sleep and sports injuries. The strongest predictors of sports injuries in adolescents are insufficient sleep and higher age/grade. The research showed that 65% of those students getting less than 8 hours of sleep at night had injuries. This is a 1.7 times greater risk of injury than those teenagers getting more than 8 hours of sleep. Even more striking is the data in Figure 1 (below) showing 4x more injuries in players reporting 6 hours of sleep per night compared to those getting 9 hours of sleep… ouch!

![Likelihood of Injury Based on Hours of Sleep per Night](image)

**FIGURE 1.** Likelihood of injury over 21-month period based on hours of sleep per night. Used with permission from Children’s Orthopaedic Center at Children’s Hospital, Los Angeles. Adaptations are themselves works protected by copyright. So in order to publish this adaptation, authorization must be obtained both from the owner of the copyright in the original work and from the owner of copyright in the translation or adaptation.
More recent evidence by Milewski and colleagues (2014) highlights the association between reduced sleep and injury incidence. This team of researchers had athletic students complete an online survey of training practices. Subjects were 54 male and 58 female athletes with a mean age of 15 years and a range from 12 to 18. **The results showed that the strongest predictor of injury was <8 hours of sleep per night.**

Sixty-five percent of athletes (56/86) who reported sleeping <8 hours per night were injured, compared with 31% of athletes (8/26) who reported sleeping approximately 8 hours per night.

**CONNECTICUT INTERSCHOLASTIC ATHLETIC CONFERENCE (CIAC)**

http://www.casciac.org/pdfs/ciachandbook_1617.pdf

This below information is the stated policy position of CIAC - Connecticut Interscholastic Athletic Conference which Greenwich High School is a participating member. Published in their text Section 10.10 on page 221

The CIAC believes that high school students should have the opportunity to learn in an optimum learning environment. While some students succeed academically within the existing and traditional school day, research shows that switching to later school start times does create a more optimal learning environment and improves student achievement for high school athletes.

High School sports and extra-curricular activities have been perceived barriers to later start times. It is the position of the CIAC that sports are an extremely important component of a high school student’s education.

However, interscholastic athletic activities can continue to be offered, with appropriate accommodations, within any reasonable school day structure.

**LACK OF SLEEP TIED TO TEEN SPORTS INJURIES**

American Academy of Pediatrics


Adolescent athletes who slept eight or more hours each night were 68 percent less likely to be injured than athletes who regularly slept less … Hours of sleep per night was significantly associated with a decreased likelihood of injury, according to the study results. In addition, the higher the grade level of the athlete, the greater the likelihood of injury – 2.3 times greater for each additional grade in school.
Weekend total sleep time was longer than weekdays along with a delay in bedtime, and waketimes. Psychomotor vigilance reaction times on Monday were faster than on Thursday and Friday, with reaction times on Tuesday also faster than on Friday. False starts and lapses were greater on Friday compared with Monday. Conclusion: There was a negative impact of sleep debt on student-athletes' psychomotor performance.

This study looks at the relationship between sleep and learning, as it relates to athletics. The short summary is that sleep improves learning. In the conclusion, the authors write: The implications for learning skilled movements and actions are considerable, and nowhere is this more important than in the learning of procedural memory required for athletic sports. It is not uncommon to train athletes consistently across the day, only to rouse them early the next morning for the purpose of further practice. Based on current evidence, however, such a regime would appear detrimental, and by curtailing sleep durations, one runs the risk of short-changing the brain of sleep-dependent consolidation and plasticity. Instead, building sufficient sleep periods, or even daytime sleep epochs, into training programs may offer the biologically necessary periods of sleep required to maximize skill potential, advancing learning beyond that achieved during initial practice without the need for further task engagement. If efficient skill learning is the goal, long-held beliefs may need to be modified, and the realization made that it is practice, with sleep, that ultimately leads to perfection.

The authors looked at members of a basketball team to judge the performance when they had at least 10h of sleep each night. The author notes that the athletes do a poor job of estimating the amount of sleep they are getting and writes: Total objective nightly sleep time increased during
Sleep extension compared to baseline. Subjects demonstrated a faster timed sprint following sleep extension. Shooting accuracy improved, with free throw percentage increasing by 9% and 3-point field goal percentage increasing by 9.2%. ... Extended sleep beyond one's habitual nightly sleep likely contributes to improved athletic performance, reaction time, daytime sleepiness, and mood. Improvements in shooting percentage, sprint times, reaction time, mood, fatigue, and vigor were all observed with increased total sleep time.

**PERFORMANCE POINT: SLEEP YOUR WAY TO A BETTER PERFORMANCE**

Canadian Sport Centre, Dr. Sleivert G

Sleep Requirement: *Athletes should aim for 10 hours of sleep per night.* Sleep experts suggest that this is ideal for training athletes. Adolescent athletes may need more sleep. Interestingly, a recent study (Samuels, 2008) reported that the majority of athletes studied at a sports school were getting less than 8 hours sleep.

**FASTER, HIGHER, STRONGER – SLEEP AND ATHLETIC PERFORMANCE**

Dr. Mike Bracko, 2008

This report has a roundup of research on the relationship between sleep and positive athletic performance. It’s a good opening into further research... Dr. Christopher Winter works with pro baseball, basketball, hockey, NCAA teams, USA Soccer and USA Hockey. “Circadian Advantage” – 2009 he studies baseball teams – a team that crosses a time zone has a flight disadvantage over a team that isn’t crossing a time zone. If a team crossed three time zones, they have only a 40% chance of victory. Dr. Winter, “Our research shows that sleepy players don’t tend to stay in major league baseball as long as well-rested players.” “You need sleep to do all kinds of things: to produce growth hormone, to fight off infections and to heal.”

Mah (2008) found that when college swimmers got extra sleep (10 hours per night for six to seven weeks) they swam a 15-meter sprint 0.51 seconds faster, reacted 0.15 seconds quicker off the start blocks, improved turn time by 0.10 seconds, and increased kick strokes by 5.0 kicks.

Schwartz & Simon (2015) ... 7 females 5 males, college varsity tennis team. Normal sleep-wake schedule for 1-week - 7.25 hrs sleep. Then one-week sleep extension – 9 hrs sleep. Serving accuracy tested during "normal" sleep and during sleep extension. Tennis serve accuracy improved - 35.7% vs. 41.8% = 6.1% (statistically significant).

**SLEEP OR SPORTS: WHICH IS MORE IMPORTANT FOR TEENS?**

[http://www.huffingtonpost.com/sharon-peaslee/sleep-or-sports-which-is-_b_9811120.html](http://www.huffingtonpost.com/sharon-peaslee/sleep-or-sports-which-is-_b_9811120.html)

Growing evidence shows that **30 minutes of more sleep is better for athletic performance than 30 minutes of more practice.** It’s indisputable that sleep has enormous impact on athletic performance. One study found that even moderate sleep deprivation has the same impact on reaction time as being legally drunk. Another study found that athletes who slept less than 8 hours were 1.7 times more likely to suffer injury compared with athletes who slept more than 8 hours. The bottom line is sleep enhances athletic performance and participation. Students need both. Sports are not a substitute for adequate sleep, and it’s not in the best interest of students to power through fatigue. The ravages of sleep deprivation are real and proven, as are the benefits of adequate sleep. It’s the single most cost effective way to enhance athletic and academic performance, while also reducing stress, injury, accidents and even teen pregnancy. **Districts need to power through the challenges of changing sports schedules and give sleep a chance.**
HOW DO WE MAKE ATHLETICS WORK?

The reality is that when most schools sit down to actually make this change, they find they are able to reschedule and manage most co-curricular and extra-curricular activities just fine. Schools that have made the change report that participating in athletic programs has continued to thrive and teams continue to win championships. When schools work regionally, it is even easier to reschedule games.

While the Cape Ann League has not indicated that it is ready to move on start time as a group, Georgetown has proposed a start time change for the fall of 2018, and Newburyport is investigating a change. Below are articles citing examples where districts were able to make changes to their schedules to accommodate athletics and other co- and extra-curricular activities. While it is a lot of work to make these changes, change is possible. The following articles illustrate how this could be done.

ATHLETICS AND SCHOOL START TIMES
Start School Later, 2009
http://www.startschoollater.net/uploads/9/7/9/6/9796500/athletics_and_school_start_times_012116.pdf

Because of the links between early school start times and chronic sleep loss among teens, myriad national health groups recommend middle and high schools start after 8:30am. However the logistics of changing school day start (and end) times create a worry for many school athletics directors. Sports and physical activity is an important part of child health and well-being, so to get input directly from the sidelines representatives from the national non-profit Start School Later, Inc contacted schools that changed start times to hear how the adjustments impacted athletics. ADs and coaches from Ohio to Kentucky to Rhode Island were positive about changes made in their schools (even though many were skeptical before the changes were made).

ORGANIZING SCHOOLS TO IMPROVE STUDENT ACHIEVEMENT: START TIMES, GRADE CONFIGURATIONS, AND TEACHER ASSIGNMENTS
The Hamilton Project, September 2011

After estimating that the lifetime earning gains per student for a 1-hour later start would be $17,500, the study writes that the cost of installing field lights is far outweighed by the value to the students: Districts might even consider installing lights for athletic fields that allow students to practice later in the day. While this would certainly be an additional expense, a back-of-the-envelope calculation suggests that the benefits of later starting times would outweigh the costs. Officials in the Ann Arbor Public Schools, for example, estimate that it costs roughly $110,000 to erect lights for an athletic field, and $2,500 annually to operate such lights. Even if a district had to construct and maintain lights at multiple high schools, this investment certainly seems worthwhile compared with the estimated $17,500 per student benefit of later start times.

SPORTS INJURIES AND SCHOOL START TIMES - DOING THE MATH
Kent Patch, Stacy Simera, March 6 2013

This isn’t research, it’s an article, but it does a nice job of summarizing the information in injuries. The author writes: To get the straight scoop I e-mailed Athletics Directors from schools around the country that adopted later start times to ask them how much it impacted sports, and I was pleasantly surprised by the comments that ranged from ’it worked out better than we anticipated’ to ‘our teams are among the best in the state’. In Fayette County, Kentucky, where high schools moved from 7:30 am to 8:30 am and in the two years afterwards the county noted a reduction in teen auto accidents, the AD told me the time change ‘has never been an issue’. In St. George’s
school, which hosts 48 teams in 22 sports and most students are required to participate in 2 sports per season, the AD told me the change was ‘one of the best things our school has ever done’ – a sentiment echoed by administration and teachers given the documented improvement in attention and grades.

**BIDDEFORD, MAINE**  

At Biddeford, Maine, the Athletic Director went through sport by sport, practice by practice, and game by game to adjust start times. After extensive review, he found that he was unable to reschedule about 5% of the total competitions. For these competitions, they allowed students to be dismissed early until such a time as they are able to create a better schedule with other schools. An excerpt from this work is shown here, with games that could not be rescheduled in red. Only a handful of sports were affected.
This is the end of the section on research. The research included here is only a fraction of the available materials – look in the references for each of these papers to find even more research. From here on, we’ll discuss start time changes in Massachusetts and put our school into state context. The remaining materials include some published research, but are mostly articles.
Articles and results from Massachusetts

This section contains information about start time change around the country and in Massachusetts and in the United States. There is a list of some media coverage of school districts looking at start time changes across the world available here:

- [https://schoolstarttime.org/2011/06/12/school-recently-advancing-start-times-etc/](https://schoolstarttime.org/2011/06/12/school-recently-advancing-start-times-etc/)

CDC SCHOOL START TIMES FOR MIDDLE SCHOOL AND HIGH SCHOOL STUDENTS

United States, 2011–12 School Year, Morbidity and Mortality Weekly report, August 7 2015
[https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6430a1.htm](https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6430a1.htm)

What time does school actually start around the country? This is a hard question to answer, it turns out, as the data is not collected regularly. This CDC report surveyed start times at middle and high schools nation wide in 2011. This is our best snapshot of this information. The CDC writes: Multiple contributors to insufficient sleep in this population might exist. In puberty, biological rhythms commonly shift so that adolescents become sleepy later at night and need to sleep later in the morning. These biological changes are often combined with poor sleep hygiene (including irregular bedtimes and the presence of televisions, computers, or mobile phones in the bedroom). During the school week, the chief determinant of wake times is school start time. The combination of delayed bedtimes and early school start times results in inadequate sleep for a large portion of the adolescent population. ... Among the possible public health interventions for increasing sufficient sleep among adolescents, delaying school start times has the potential for the greatest population impact by changing the environmental context for students in entire school districts.

According to data on all US high schools from the National Center for Education Statistics (NCES n.d.), the average high school start time in the US is 8:00 a.m., with only 9% of high schools nationwide starting before 7:30 a.m.

ASHLAND, MA


Ashland, MA joins many towns in Massachusetts looking to move start time forward. "Saying that students will be healthier, the School Committee agreed Wednesday night to push back the starting time for students in grades 7-12 for the 2017-2018 academic year. "Change is always hard and there's no easy way to change what we do," said Jane Greenstein, member of the School Start Times Committee. "Our decision was not made in a vacuum." The motion to adopt the change, made by School Committee member Marc Terry, said classes would not start earlier than 8:15 a.m. The
committee chose to vote on a range of time rather than a specific set of times to allow the public the opportunity to adjust to the idea.”

**BOSTON, MA: CITY COUNCILORS PUSH FOR LATER START TIME AT BOSTON PUBLIC SCHOOLS**  

**BOSTON: COUNCILORS: IT’S PAST TIME TO LET HIGH-SCHOOL KIDS SLEEP IN**  

City Councilors want Boston to join the ranks of communities pushing back high-school start times to give sleep-deprived students a better jump on the day. The council unanimously approved holding a hearing on the idea of starting high school as late as 8:30 a.m. Nearly half the city’s high schools currently start at 7:20 or 7:30 a.m., councilors said. At-large Councilor Annissa Essaibi-George, a former teach at East Boston High School, says giving kids even just an extra hour of shuteye could reduce tardiness, absenteeism and even obesity and depression.

**BURLINGTON, MA**  
**MA: Superintendents support later start time for high schools**  
http://homenewshere.com/middlesex_east/article_1bcc3688-0c8d-11e6-8f9d-4f9a92123201.html

“Looking at research in terms of sleeping patterns, there seems to be a benefit not only in terms of academics, but also in risky behavior. Anything that could be good for kids should be something we should be taking a look at,” Burlington Superintendent Dr. Eric Conti commented during a phone interview with Middlesex East. “We know the research is out there supporting the benefits, so on that issue alone, I can support the statement,” said Stoneham Superintendent Dr. Les Olson in a separate interview. In particular, the Middlesex League superintendents, which meets regularly to discuss common interests and areas of concern, unanimously agrees that adolescents should report to school sometime between 8 a.m. and 8:30 a.m.  

Dr. Conti affirmed numerous times during the meeting that by signing the joint statement in no way commits Burlington to changing its start times, as the objective now to is to start the conversation to see if each district wants it. “The whole point of putting a 2-year window on this is it is going to take some time,” declared Dr. Conti. “Many changes may result if it moves forward and a lot of people would be impacted, such as parents and teachers. For now, let’s start to get serious, identify the obstacles, and identify the solutions to those obstacles.”

**CARVER, MA**  
http://halifax.wickedlocal.com/article/20160217/NEWS/160217230/?Start=1

Three months ago, the prestigious Massachusetts Medical Society adopted a resolution that supports prohibiting middle and high school students from starting school earlier than 8:30 a.m. Local pediatrician and Carver resident Dr. Terence McAllister proposed that resolution after becoming concerned about the potential impacts of early school start times. As a pediatrician with a number of patients who attend area schools and the parent of a Carver sixth-grader, he said he’s concerned about sleep deprivation leading to serious health issues and wants to see a community-wide discussion started on school times. “From a medical and scientific standpoint, it’s best for an important part of our population,” he said. Adolescents who have proper sleep are more likely to be successful academically and athletically, have good attendance at school, are involved in fewer automobile accidents, are less likely to tend toward obesity and depression, and less apt to suffer other impacts of sleep deprivation. McAllister said it’s also important to note the connection between the current opioid addiction crisis and sleep deprivation. Teens who are sleep deprived
can be misdiagnosed with ADHD and may be prescribed stimulants, a known factor in increasing a teen or young adult’s long-term addiction problems.

CONCORD CARLISLE, MA
Wicked Local, February 28, 2017

CCHS Athletic Director Barry Haley said all of the logistical issues connected to athletics haven’t been worked out, and stated, "none of the changes are so critical that adjustments can’t be made between approval of the budget at Town Meeting and the start of school next year. (The later start time) is an educational decision, not an athletic decision," Haley said. "We’ll adjust, and make the best of it."

http://concord.wickedlocal.com/article/20160323/NEWS/160328152

Concord-Carlisle forms a start time committee. "Dr. Charles Czeisler, chief of the Division of Sleep and Circadian Disorders at Brigham and Women’s Hospital, told The Concord Journal last month that earlier start times have resulted in a loss of 50 hours of sleep monthly for students, which "induces harmful biological effects," including a reduction in a sleep stage called Rapid Eye Movement (REM), when students integrate new information from the day's learning with previous learning. Other harmful effects, according to Czeisler, include higher risk of traffic accidents because students are drowsy, physiological effects like chronic sleep deficiency, which can lead to higher glucose levels that increase the risk of diabetes and high blood pressure, and mental health issues such as compromised attention spans, increased levels of distractibility, higher risk of substance abuse and greater risk of depression and suicide."

DUXBURY AND SHARON MA
Boston Globe, May 11 2014
http://www.bostonglobe.com/metro/regionals/west/2014/05/10/natick-considers-starting-high-school-later/I5tPABS64ZWHtikZ54UvwO/story.html

Duxbury High principal Andrew Stephens said he faced a similar sentiment before his school moved its start time in 2009, but he has not had one complaint from a parent since the switch. “You have to put your cavalier on and you take your arrows,” he said. “But there is going to be a process. Any place that’s had the conversation about start time, it’s always a controversial conversation.”

JAMA Medical News and Perspectives, June 3 2009
http://jamanetwork.com/journals/jama/article-abstract/184011

Despite the challenges, once the Duxbury school committee concluded that a later start time would be in students’ best interest, “we had to find a way to make it happen,” said Sysan Skeiber, superintendent of Duxbury public schools. Duxbury flipped its bus schedule to bring older students to school later and younger ones earlier. Research shows younger children are ready for school earlier than adolescents are, Skeiber said. School officials are exploring after-school programs for families that now depend on older students to babysite younger ones in the afternoon. They plan to assess sleep and other behavior after the schedule change.


The principal from Sharon High School in Massachusetts came to the forum on pushing back school start times Monday night to talk about his school's experience doing just that. His message? It's hard, it's courageous, but Sharon would never go back. “Once the School Committee made the decision,” said Sharon Principal Jose Libano, “where there’s a will there’s a way. And if this is the right thing for our students and their growth, we had to find a way to make that happen.” High school students in Sharon used to start their day at 7:25 a.m. Today they start at 8:05 a.m. “If we polled our [high school] kids then, there was resentment, there was anger. ‘We can’t do this.’ ‘How are we going to do athletics?’ ‘How am I going to get extra help?’ ‘How am I going to do clubs?’ ‘How
am I going to get to work?“ Libano said. “If I polled 1,200 students now, I’d get 1,200 kids saying, ‘I would never go back to school at 7:25.”

**DUXBURY AND SHARON MA 1-YEAR FOLLOW-UP SURVEY**


The Sharon school district changed high school start time to 8:05AM in the fall of 2011. One year later the Task Force conducted a survey to see how the change was affecting the community. Some highlights from that survey are included here.

Most would agree that there is no one schedule that would perfectly suit all types of high school students. The goal of the Start Time Committee was to evaluate the experimental research evidence to try to determine the schedule that would benefit most students, with the understanding that not every student would experience higher satisfaction with a time change. Further, the goal of such a change would be to maximize academic learning for the greatest number of students possible. A third goal is to identify challenges that result from, or even pre-exist, any start time change and to work, when possible, to come up with innovative solutions or mitigations.

Unexcused Tardies declined as a result of the change. Note that in March there is a spike in tardiness, likely due to the daylight savings’ time change.

For every grade, students in each grade at the High School found the new start time to be positive more frequently than they found it to be negative or neutral.

Parents were decidedly in favor of the new start time, with 63% indicating that it was a positive change. 63% of parents cited “no issues or problems” with the new start time. The most common problem cited was sports conflicts, with 20% of parents indicating that the impact of the new start time on sports was a problem.

In the Conclusion the Task Force writes:

Students are not a monolithic group in terms of their academic learning styles or sleeping needs. Some students function best with a dense schedule beginning early in the morning, with activities continuing until late at night. Other students would function best by starting school late in mid-morning, permitting a longer period for sleep.
However, the majority of students function in the middle of these two extremes and this fact is amply reflected in the field of research conducted on sleep cycles and academic learning outcomes. **No study found that 100% of every type of student would find learning maximized by later start times**, and the Committee did not expect to find that any schedule - either the pre-2010 schedule or the new schedule - would benefit every single student. The data from students and parents supports the conclusion that the new start time is a beneficial change for most students. Many of the faculty agree that the students are less sleepy and more engaged in the mornings, and unexcused tardiness has dropped significantly. Among faculty, who were more split about the benefits of the new start time, the problems cited had more to do with faculty needs than with student outcomes (e.g., feeling at their best early in the morning, commuting problems).

There is no doubt that **the new schedule has rushed after-school sports and impacted it**. Mr. Sondheim reported to the Committee that after seeing this impact on after school sports, he phoned one of the schools that had been consulted when the Committee was engaging in its research, to ask if that school district also experienced this type of rushed and abbreviated preparation time for sports. The answer was yes, this had also impacted their school district, but their conclusion was that the consequence simply was accepted because academics had been identified as the priority. **It appears to be the case that at the present time, there is no way to completely maximize both academic learning schedules and sports schedules. This may change as more high schools adopt later start times.**

Meanwhile, Sharon, like other towns, may need to identify priorities and seek other means of minimizing consequent problems. **The Committee’s position is that schedules should be arranged to maximize academic learning rather than to maximize sports participation, although all in attendance agree that after-school sports are important and worthwhile programs.** Therefore, we should not simply accept inherent difficulties but work to find solutions that can help address or minimize the impact upon after school sports. One viable possibility is that more training and orientation of the coaches may help mitigate this issue.

Some of the difficulties brought up in comments reflect academic issues, such as later sports times impacting homework time, students being unaccustomed to utilizing optional before-school time as homework time and unaware that the school library was available before and after school, and athletes concerned about limits on their after-school time with teachers on game days. It appears that the new schedule may have increased the difficulty some students experience in accommodating sports, clubs and academics. As more faculty begin to utilize “flex” schedules, this problem may lessen.

**GEORGETOWN, MA**

Wicked Local, March 17 2016

http://georgetown.wickedlocal.com/article/20160317/NEWS/160316284

"The schedules we have discussed are 8:40 a.m. to 3:15 p.m. or 8:30 a.m. to 3:05 p.m. for Georgetown Middle High School, and 7:45 a.m. to 1:45 p.m. or 7:55 a.m. to 1:55 p.m. for Penn Brook," SSL Committee Chair Barbie Linares said. Linares noted that these are not the final options and depend on further discussion and bus route details. ... Linares said Penn Brook Principal Margaret Maher and GMHS Principal Peter Lucia are supporting the committee and the research into whether a later start time can work in Georgetown.

http://georgetown.wickedlocal.com/article/20160317/NEWS/160316284

Georgetown, Massachusetts has joined other communities across the state in planning to move start time to 8:30 or 8:40 for its high school students in the fall of 2016. “Evidence shows that starting middle and high schools before 8:30 is not compatible with adolescents’ biological clocks,” Linares said. "Starting school too early has been linked to physical, psychological, and educational problems. Districts that have implemented a later start time have reported improved alertness, attention, cognitive processing skills, and reduction in tardiness, depression and drop-out rates, plus improved academic and athletic performance."
HANOVER, MA

Administrators advocate later starting time for Hanover High School
http://www.wickedlocal.com/article/20160512/NEWS/160518489

High school students could be getting an extra half-hour of sleep if school officials adopt a plan to push the first bell to 7:55 a.m. Teenagers perform better when they are able to sleep later, Principal Matthew Paquette said. Later high school start times have been linked to increased attendance, improved academic performance and decreased disciplinary issues in high schools nationwide, he said. “Mental well-being and physical well-being are valid, proven benefits, and that’s the single driving force behind this possibility,” Paquette said.

“This is not to benefit our teachers or administrators, it’s because it’s in the best interest of students here at Hanover High School.”

Wicked Local, February 21, 2017

After Hanover school officials saw trends from other schools showing that students were more likely to come to school on time, have higher academic achievement, and be better rested for the school day, they came to the conclusion that moving the high school to a later start time in the morning was the right move, according to Hanover High School Principal Matthew Paquette.


The Principal shared an update on how start time has affected Hanover High School (right) along with a few highlights: 22% decrease in student tardy to school, in period 1 class a 32% decrease in D’s and F’s and a 10% increase in A’s in Term 1, and many anecdotal benefits.

HINGHAM, MA

Boston Globe, May 11 2014
http://www.bostonglobe.com/metro/regionals/west/2014/05/10/natick-considers-starting-high-school-later/IS1PAB564ZWHiKZ54UvwO/story.html

One of the most notable data points is Hingham High’s 31 point bump on total SAT scores since the district switched the school’s start time in 2009.
MASHPEE, MA: MASHPEE EXPLORING SCHOOL START TIME CHANGES
http://www.capecod.com/newscenter/mashpee-exploring-school-start-time-changes/

The process is in the early stages as a 16 member School Start Time Committee was formed and has held three meetings to discuss the benefits and drawbacks of having older students start school later.

MELROSE, MA
http://melrose.wickedlocal.com/article/20160328/NEWS/160326392

“There is no 100 percent agreeable solution here,” Superintendent of Schools Cyndy Taymore told the committee. “But I think the bottom line here is this is in the best interest of our children, especially our young adolescents, and the scientific proof is there.

NATICK, MA

Boston Globe, May 11 2014
http://www.bostonglobe.com/metro/regionals/west/2014/05/10/natick-considers-starting-high-school-later/I5tPABS64ZWHtkZ54UvwO/story.html

“The school system has a responsibility to evaluate anything that potentially could help students with achievement,” the Natick district’s superintendent, Peter Sanchioni, said. “That’s what we’re after.” Several Massachusetts school systems have already made the change, including Duxbury, Hingham, Nauset Regional, and Sharon. Ashland High recently created a committee to consider it.

“It’s been on the radar and we noticed communities like Natick that are pretty close by” are considering it,” Ashland School Committee chairwoman Laurie Tosti said. “Student well-being, just overall well-being, is something that fits into the bigger picture of what we are trying to accomplish.”

NAUSET, MA

Cape Cod Times, January 10 2012
http://www.capecodtimes.com/article/20120110/NEWS/201100313

The high school now starts its day at 8:35 a.m., more than an hour later than last year. A preliminary report about the first two months of school seems to indicate the change has paid off with big improvements in academics as well as a huge drop in the number of days students were suspended from school. Tardiness also declined by nearly 30 percent. "I think the tone of the day has changed dramatically. That's reflected in the overall (mood) of the student body," said Nauset High School Principal Tom Conrad. "It's very clear to me it's a more relaxed opening of school than with the 7:25 a.m. start time. Students seem to be more alert and they don't seem to be rushing to get to class within seconds of getting to school." For years, Conrad had advocated moving to a later school day based on studies that showed positive effects on student health and well-being, as well as academics. Although only the first two months of the school year were analyzed, there was a 53 percent drop in the number of failing grades, from 221 last September and October to 104 in the same time period this year. The number of D's and F's also dropped, from 597 to 368, a 38 percent decline. The number of days students were suspended for disciplinary reasons plummeted from 166 in the first two months last year to 19 days in September and October of this year.
NEWBURYPORT, MA

This week Tara Sullivan, Alex Coir and a group of other concerned parents went before the School Committee to provide an update on their efforts to examine a later start time and its impacts. After delivering their message, which included details related to busing, sports schedules and how other towns in the commonwealth have made the move, the group was encouraged to dig deeper to provide a concrete proposal for the committee to consider so the initiative can be taken to the next level.

Though their effort won’t likely result in a change for the coming year, there was talk among some on the committee of prioritizing the schedule change for the 2017-2018 school year. “I really encourage you to continue your work,” committee member Dave Hochheiser said. “I would love to see a report with recommendations. It’s not going to happen for next year. So we’re thinking about 2017 or 2018 possibly.”


As asked to study the issue and present to the committee, Sullivan reported this week that looking at game and meet schedules from the past year, there were very few instances where a later start time would have posed a problem. “The whole reason we started looking at this is because it was academically better for students in this age group,” Sullivan said. “It didn’t seem like it impacted that many games.”

NEWTON, MA: INSIST ON LATER HIGH SCHOOL START IN NEWTON
http://newton.wickedlocal.com/article/20160521/OPINION/160529575/?Start=1

Families in Newton are beginning to understand how serious sleep deprivation is for our teens, and what a start time change might mean for them: “High school is a time of enormous learning and growth, but as we have seen in Newton and other communities around the country, these years can also lead to vulnerability and stress in our students. When we ask ourselves what we can do, as parents and as a community, to best support teens during their high school years starting school later in the morning is one of the obvious answers. The scientific evidence demonstrates without a doubt that adjusting school start times benefits students physically, intellectually and emotionally. We understand that in a large district like Newton, a change in school start time affects many other aspects of the school day for students, teachers, parents and the community at large. The recent survey by the Newton Public Schools focused on understanding how changes to the school day may affect early morning and afternoon routines for school families. These effects, however, need to be weighed against the best interests of our children. The inconveniences of a new routine — something many are quick to point out — would be quickly outweighed by improved physical and emotional health and learning. New routines are uncomfortable at first, but by mid-year, most families will have adjusted to the new routines. This is the experience of the hundreds of school districts nationwide that have moved their start time.”

https://www.bostonglobe.com/metro/regionals/west/2016/01/26/newton-debates-letting-high-school-students-sleep/QCrX8Zy9gNZWzEWPgWkzL/story.html

“Because what I don’t want to do is to debate the cost of light bulbs for the athletic fields versus worrying whether my kids are having car crashes, considering suicide, or getting cancer later in life.” - Heidi Gardner, a mother of two elementary aged students, echoed what a majority of the parents at the meeting had to say about weighing the logistics of the plan with the health benefits.
**NORTH ANDOVER, MA**

The school committee of North Andover looked at start time in 2010, and failed to make a change. They have decided to reopen the issue, in light of the discussion around Massachusetts and the nation. However, the superintendent does not consider it a high priority.

**PLYMOUTH, MA: SLEEPING THROUGH THE DARK AGES OF HIGH SCHOOL**
http://plymouth.wickedlocal.com/article/20160320/NEWS/160329719

Plymouth, MA joins many other towns in the state in examining start time. "McAllister said he has seen teens who are sleep deprived being misdiagnosed with ADHD and may be prescribed stimulants, a known factor in possibly increasing a teen or young adult’s long-term addiction problems. School districts on the South Shore have been contemplating switching high school start times for many years. Carver and Silver Lake have formed committees to look at the issue and lead discussion in those communities. ... But we should be looking for ways to take the scientific and medical research on sleep patterns and apply that knowledge help students – especially high school students – succeed in meeting the increased demands on their plate in the classroom, sports, extracurricular activities, as well as greater expectations and responsibilities outside of school."

**READING, MA: READING SUPERINTENDENT MULLS LATER START TIMES**
http://reading.wickedlocal.com/article/20160316/NEWS/160316364/?Start=1

Reading Massachusetts joins the growing wave of schools in the state working to change start time for the health of our kids. "After talking for some time about the possibility of moving to later school start times for the town’s adolescents, the school department is moving forward with the process. The first step is the formation of a working group to discuss the execution of the change with the plan to implement it for the 2017-18 school year."

**SUDBURY, MA: THE BENEFITS OF A LATER SCHOOL START TIME**
http://sudbury.wickedlocal.com/article/20160309/NEWS/160305800

While it sounds daunting to change our school start times, twenty-one schools in Massachusetts have already done so and more intend to follow suit. Most recently Ashland announced it will change for the 2017-18 school year. Our neighboring towns are already making preparations to delay start times or are actively exploring the issue, including Newton, Weston, Wayland, Concord, Framingham, and Westborough.

**TAUNTON, MA TAUNTON SCHOOL COMMITTEE TO STUDY LATER SCHOOL START TIMES**
http://taunton.wickedlocal.com/article/20160508/NEWS/160506590

It’s only under discussion, so don’t set your alarm clocks for a later start to the school day, Taunton students. Not yet, anyway. The Taunton School Committee is exploring whether or not to start classes later than the current schedule. Pediatrician Dr. Eric J. Ruby spoke to school board members and school administrators about the need for children and teens to get 8½ to 9½ hours of sleep a night, the doctor said. Recently, Easton joined other Massachusetts communities, such as Duxbury, in opting for a later start to the school day. Taunton High School students begin classes before 7:30 a.m. ... Board member Carol Doherty said she believed it was worth doing a feasibility study on a later start time. The report will be due in six months, all board members agreed on voice vote.
MASSACHUSETTS IS WAKING UP TO SLEEP-FRIENDLY SCHOOLS
http://www.huffingtonpost.com/terra-ziporyn-snider-phd/massachusetts-is-waking-u_b_9649650.html

“The momentum is gaining considerable speed in Massachusetts,” says Hamaker. “We have 14
town-based chapters where parents and school officials are cooperating to work through the
logistics to change school start time. Their local efforts are becoming statewide efforts as more and
more people contact Start School Later about how to drive the conversation in their towns.”

TOWNS IN MASSACHUSETTS LOOKING AT START TIME
Start School Later Massachusetts, April 2016

Below is a list of MA towns known to SSL-MA as of 4/2016 where either schools are looking at start
times or we have received communications from residents about how to initiate an effort to change
school start times.

• Acton/Boxborough
• Barnstable
• Belmont
• Boston Public Schools
• Chesterfield
• Concord-Carlisle
• Denis-Yarmoth
• Dover-Sherborn
• East Longmeadow
• Framingham
• Franklin
• Georgetown
• Kingston (Silverlake Regional HS)
• Lenox
• Lincoln/Sudbury
• Masconomet Regional (Boxford, Middleton & Topsfield)
• Mashpee
• Mendon/Upton Regional School District
• Natick
• Nashoba Regional HS
• Newburyport
• Newton
• North Andover
• Northborough-Southborough
  (Algonquin Regional HS)
• Northampton
• Reading
• Taunton
• Wayland
• Westborough
• Weston
• Winchester
• Worcester

The schools listed below announced in 2016 that they will move start times later

• Ashland (change start time to 8:15 for 2017-18)
• Canton (change start time +40 minutes for 2016-17)
• Easton (change start time to 7:55 a.m. for 2016-17)
• Hanover (change start time to 7:55 a.m. for 2016-17)
• Melrose (change start time to 8:15 for 2017-18)
• Monomoy Regional HS (change start time to 8:30 for 2017-18)
Articles about towns outside Massachusetts

There are case studies happening all over the country. The articles below are from other states nearby and from areas that have lead on this topic. A few more case studies can be found here:

- http://www.startschoollater.net/case-studies.html

KEY READING: SCHOOL START TIME CHANGE

An In-Depth Examination of School Districts in the United States
April 15, 2014

This report looks at case studies of start time change in multiple school districts: how they implemented the change and what the results were. The authors write: Finally, after reviewing all of the available information on the process of school start time change from a wide variety of sources as described above, we developed an integration and summary of the most common and salient points likely to best inform other school districts. While not necessarily exhaustive, as each school district has both unique challenges and solutions, the ten key messages, categorized according to major content themes, represent principles that have a basic foundation in successful implementation of start time change and are those that are most applicable to the majority of school districts, no matter their size or complexity of issues.

BIDDEFORD, ME

Seacoast Online, February 16 2017

"I said, 'no excuses,' to our administrative team, 'When we have a problem you need to come back to me with a way to work this out,'" said Ray. "There was a time where athletics was challenging. So we talked about unique ways to schedule games. Middle school soccer; the hardest one to plan around because the sun goes down, and I said, 'get on the Internet, look at what time the sun goes down in the fall and I want you to schedule your away trips early in the season, the farthest ones, when October comes we need to be playing Saco, Old Orchard, Kennebunk and we'd build our schedules that way."

Maine Schools Team Up for Teen Health — and Sleep
http://www.huffingtonpost.com/terra-ziporyn-snyder-phd/maine-schools-team-up-for_b_9705538.html

"I am pleased that Biddeford was able to cross the bridge and partner with area schools to make this critical change in service to our kids," stated Biddeford superintendent Jeremy Ray. "The science is unimpeachable, and the results will be measurable. I am pleased that we were able to accomplish what so many consider difficult: collaborating across town lines. Our leadership team in Biddeford has a history of shared services and collaboration, and this is yet another example of what good will and good science can do to help our community."

PRINCIPALS: LATER SCHOOL STARTS POSITIVE

Biddeford-Saco Courier, Garrick Hoffman
http://courier.mainelymediallc.com/news/2017-03-16/Front_Page/Principals_Later_school_starts_positive.html

The schools in Biddeford and Saco changed start time from 7:30am to 8:30am in the 2016-2017 school year. The school has seen great results: Collins said since delayed start time was implemented, Saco Middle School, Thornton Academy and Biddeford schools have seen an increase in student attendance, which is about a 1 percent attendance increase; a 30 to 45 percent reduction in tardiness; 36 percent fewer student suspensions; 50 percent less visits to the school nurse by this time in the previous two years; and more than two thirds of students reporting nine hours of
sleep per night that they had not gotten before. Students are reporting going to bed between 9:30 and 11 p.m. and waking up between 6 and 7 a.m.

Kyle Keenan, principal of Biddeford Middle School, said responses to the delayed start time have been positive. “The positive feedback I’ve received from students, parents and staff regarding our change to a later start time has been overwhelming,” Keenan said. “Parents have reported to me that their mornings at home have gone from a battle over getting their middle schooler out of bed, to peaceful mornings where they are actually able to eat breakfast with their child. Students have reported appreciating the extra sleep. Staff have reported morning classes have higher levels of student engagement in years past. Students appear more alert and focused.”

Sirois said many students have told him that they originally did not support the change but now are happy to see it in effect and are getting an extra hour of sleep, which has been beneficial for them. Parents have told him their children are going to bed at normal times and getting more sleep. Parents have also said they don’t need to pester their children to get out of bed.

KITTERY, ME
Seacoast Online, February 16 2017

"What we find with adolescents is there’s a shift two hours later so that the melatonin, the sleep cycle has them getting sleepy and wanting to go to bed at about midnight and the brain not signaling alert until 8 or 9 in the morning,” said Sharp. "It’s not just how many hours of sleep an adolescent is getting but what time in the morning they are expected to be at attention. Some of the changes in school start time might not help give us the nine hours of sleep we’d like to see but at least they’re engaging at a time when their brain is not physiologically asleep."

RHODE ISLAND
Boston.com, July 6 2010
http://archive.boston.com/news/nation/articles/2010/07/06/study_shows_teens_benefit_from_later_school_day/

Giving teens 30 extra minutes to start their school day leads to more alertness in class, better moods, less tardiness, and healthier breakfasts, a small study found. “The results were stunning. There’s no other word to use,” said Patricia Moss, academic dean at the Rhode Island boarding school where the study was done. “We didn’t think we’d get that much bang for the buck.”

Health Day News, July 6, 2010

High school students at a private school in Rhode Island who started school a half-hour later in the morning were in better moods, more alert, less depressed and more likely to actually attend class than before the time change, a new study shows. In fact, the experiment was so successful that the school has now permanently shifted its start time from 8 a.m. to 8:30 a.m. "At the end of the experimental period, there was not a single faculty member, student or administrator who wanted to go back to the old start time," said Dr. Judith Owens, lead author of a paper appearing in the July issue of the Archives of Pediatrics & Adolescent Medicine.

SEATTLE, WA: LET THE TEENS SLEEP
http://seattlemamadoc.seattlechildrens.org/let-the-teens-sleep/

"I touched base with Dr Maida Chen, a sleep expert about why this movement matters so much. “I have to start by saying that it is impossible to place a ‘price’ on the health, safety and achievement of a child,” she told me. She mentioned she’d spent significant time this week documenting the evolving data and cost-effectiveness of moving school start times. She’s written, "Rational start times, which align with students’ fundamental sleep needs, are a cost-effective and
Articles about towns outside Massachusetts
Important Media Coverage and Articles

I’ve tried to extract key media coverage on this issue, but there are so many articles coming out on a nearly daily basis that it’s difficult to curate such a list. If this isn’t enough for you, more can be found here:

http://www.startschoollater.net/major-studies--other-resources.html

SNOOZE OR loose
New York Magazine, Po Bronson, October 7 2007

Half of all adolescents get less than seven hours of sleep on weeknights. By the time they are seniors in high school, according to studies by the University of Kentucky, they average only slightly more than 6.5 hours of sleep a night. Only 5 percent of high-school seniors average eight hours. Sure, we remember being tired when we went to school. But not like today’s kids. It has been documented in a handful of major studies that children, from elementary school through high school, get about an hour less sleep each night than they did 30 years ago. There are many causes for this lost hour of sleep. Overscheduling of activities, burdensome homework, lax bedtimes, televisions and cell phones in the bedroom all contribute. So does guilt; home from work after dark, parents want time with their children and are reluctant to play the hard-ass who orders them to bed. All these reasons converge on one simple twist of convenient ignorance: Until now, we could overlook the lost hour because we never really knew its true cost to children. Using newly developed technological and statistical tools, sleep scientists have recently been able to isolate and measure the impact of this single lost hour. Because children’s brains are a work-in-progress until the age of 21, and because much of that work is done while a child is asleep, this lost hour appears to have an exponential impact on children that it simply doesn’t have on adults.

WHY SCHOOL SHOULD START LATER IN THE MORNING
The Atlantic, Emily Richard, August 17 2005

“Social norms are at the root of this problem—most people don’t take [adolescent sleep deprivation] seriously and don’t see it as a public-health issue,” Snider said. “That kind of thinking has to change.” One of the problems facing advocates of later school start times is that the people sympathetic to their cause seldom have the authority to reset the academic clock, Snider said. Parents typically only care about the issue when it affects their own families’ schedules, she said. That means roughly every four years the key players are replaced, and the grassroots efforts have to start from scratch. “You start talking about changing start times, and people immediately jump to [all kinds of conclusions]. Teens will miss out on sports. Little kids will go to school in the dark and get run over by a car. What will happen to my child care?” Snider said. “A lot of these fears and speculations turn out to be red herrings. The real obstacles are failure of imagination.”

WHEN SLEEP AND SCHOOL DON’T MIX
Time, Alexandra Sifferlin,
http://time.com/when-sleep-and-school-dont-mix/

If teens are biologically programmed to go to sleep at a certain hour, pushing back a start time means they have more time in the morning when their bodies want to sleep in. And if their circadian clock is keeping them up at night, it’s not as big of deal. “There’s zero evidence that the current hours are doing anyone any good and a lot of evidence that they are doing a lot of harm,”
says Snider. "We are not talking about letting kids sleep in until 1pm every day, we are taking about allowing them sleep until seven or eight in the morning. It's not a very radical proposition.”

THE CONSEQUENCES OF INSUFFICIENT SLEEP FOR ADOLESCENTS
Phi Delta Kappan, Ronald Dahl, January 1999

The author is an associate professor of psychiatry and pediatrics at the University of Pittsburgh Medical Center, Pittsburgh. He wrote this article in 1999 (a review of scientific literature at the time), and argues persuasively for the need to focus on adolescent sleep issues: **At the center of this discussion is a critical and pragmatic point: any evaluation of the sleep habits of adolescents must include a careful consideration of the waking consequences of sleep loss. The question becomes, in essence, “What are the daytime signs of diminished functioning that indicate insufficient sleep?” While there is a shortage of well-controlled research studies that seek to answer this question, this article focuses on the convergence of evidence suggesting that changes in mood and motivation are among the most important effects of sleep loss. Thus an important place to begin looking for evidence of insufficient sleep among adolescents is in the area of emotional or behavioral difficulties. […] To reiterate the main point with which I began, adequate sleep is defined as the amount necessary for optimal daytime functioning. It appears that the potentially fragile underpinnings of adolescent social competence (controlling thoughts and feelings at the same time) may be most sensitive to the effects of inadequate sleep. Any review of adolescent lifestyles in our society will reveal more than a dozen forces converging to push the sleep/arousal balance away from sleep and toward ever-higher arousal. What harm could there be in trying to push back a little toward valuing sleep? The potential benefits seem enormous.**

ASLEEP AT THE DESK: HOW SCHOOL BEGINS FOR MANY MICHIGAN TEENS
Ted Roelofs, May 31, 2016
http://bridgemi.com/2016/05/asleep-at-the-desk-how-school-begins-for-many-michigan-teens/

"District administrators at the time said they would continue to look for ways to push start times to 8 a.m. The move drew considerable online comment from parents, some faulting the board for taking such timid steps toward a later start time. But there were doubts about moving the start of school back as well, including this comment: "The schools don’t need to alter their schedules for our high school students. The students need to suck it up and manage themselves. After all, who will do this for them after they graduate from high school? 80% of life is just showing up.” Brown University sleep researcher Carskadon told Bridge that entrenched skepticism about the science of sleep continues to impede widespread adoption of later school start times. She said the debate is often shaped by what’s convenient for adults rather what’s best for learning. "**This kind of, 'Suck it up, Buttercup' approach is really not well informed. It’s not useful and it’s not a public health strategy. The job of adolescents isn’t just to show up. They have work to do. They need to learn. They need to grow their brains. This matters a lot. If they are wandering through school half awake, it isn’t going to be successful.”**

REFUTING CONCERNS ABOUT LATER SCHOOL START TIMES

"Ms. Herrmann argues that a later start time at GHS will not increase sleep for students. The science refutes this. The University of Minnesota’s 2014 study of more than 9,000 high school students across six districts showed that students get more sleep when start times are moved later — and the later the start time, the more sleep they gained. … Herrmann also raises a concern that if high school students were to benefit from a later schedule initiated now, they might not be able to handle the transition to college, which might not offer “the flexibility to sleep in.” First, few college
students face a schedule with 7:30 a.m. classes five days a week, if at all. Some colleges are actually doing away with even 8 a.m. classes. Second, college students usually have flexibility in choosing what time in the morning is reasonable to start class. Lastly, adolescents’ circadian rhythm begins to shift back toward a “normal” arc by their early twenties, making early mornings less of an issue down the road."

**WIPED OUT: EARLY SCHOOL START TIMES AND BOSTON’S EPIDEMIC OF EXHAUSTED STUDENTS**

http://cognoscenti.wbur.org/2016/04/20/sleep-and-school-start-times-deborah-j-bennett

"Here’s the problem with denying children the sleep they need: They don’t learn as well when they are tired. Grades are not the only thing to suffer — students experience anxiety, depression, poor concentration and behavioral problems. What’s more, the latest research on teenagers' sleep patterns suggests that, as puberty begins, their circadian rhythms shift to a “sleep phase delay,” which means they naturally fall asleep as late as 10:00 and 11:00 at night, even as their need for up to nine hours of sleep remains the same."

**HIGH SCHOOL IMPLEMENTS LATER START TIMES, SEES DRAMATIC IMPROVEMENTS**

http://www.goodnewsnetwork.org/school-starts-implementing-later-start-times-sees-dramatic-improvement/

"Some kids are exposed to the same degree of sleep loss for four or five years,” Judith Owens, director of the Center for Pediatric Sleep Disorders at Boston Children’s Hospital told the Boston Globe. "It’s not a good thing. . . . If you are asking teenagers to get up at 5:30 or 6, that is their lowest point of alertness in their 24-hour cycle. It’s at that point where their brain is most loudly saying ‘stay asleep.’“ The Globe investigated several high schools experimenting with pushing their morning start time back to 8:30 a.m., letting their students sleep an extra hour every night. The switch produced positive results almost immediately: test scores went up, the number of Ds and Fs dropped by half, rates of tardiness and absence went down, and teen related car crashes decreased dramatically. Students said they did not mind being kept in school until 3:00 p.m. because the later start time made them feel better rested and less likely to fall asleep while in class. New legislation for a delayed morning bell is currently being discussed by the school boards with possible implementation as early as 2017.

**EARLY SCHOOL STARTS CAN TURN TEENS INTO ‘ZOMBIES’**

https://student.societyforscience.org/article/early-school-starts-can-turn-teens-‘zombies’

Janet Croft studies teens and sleep at the Centers for Disease Control and Prevention (CDC) in Atlanta, Ga. U.S. high schools, she says, “start at such an early time that most teens are essentially brain dead when they go to these early classes.” As a result, she says, too many students start their day as “walking zombies.” Too little sleep has become so common among teens that the CDC calls it an epidemic, or a widespread public-health problem. Many teens get too little sleep because they attend middle and high schools that start earlier than 8:30 a.m., according to the AAP. Those early start times throw off a student’s internal body rhythm, called the circadian clock. Too little sleep disrupts that clock and causes problems.

**THE U.S.’S BEST HIGH SCHOOL STARTS AT 9:15 A.M.**

http://www.slate.com/articles/life/education/2016/04/can_the_best_high_school_in_the_country_thank_its_9_15_a_m_start_time_for.html

"There are doubtless many reasons why the School for the Talented and Gifted landed in the top spot—for the fifth straight year—in the U.S. News and World Report rankings. That its start time
allows students to get a good night's sleep is likely just a part of the equation—but it's one that we can easily implement elsewhere. Our students deserve it.”

**STANFORD MEDICINE: AMONG TEENS, SLEEP DEPRIVATION AN EPIDEMIC**

“I think high school is the real danger spot in terms of sleep deprivation,” said William Dement, MD, PhD, founder of the Stanford Sleep Disorders Clinic, the first of its kind in the world. “It's a huge problem. What it means is that nobody performs at the level they could perform,” whether it’s in school, on the roadways, on the sports field or in terms of physical and emotional health. Social and cultural factors, as well as the advent of technology, all have collided with the biology of the adolescent to prevent teens from getting enough rest. Since the early 1990s, it’s been established that teens have a biologic tendency to go to sleep later — as much as two hours later — than their younger counterparts. *Yet when they enter their high school years, they find themselves at schools that typically start the day at a relatively early hour. So their time for sleep is compressed, and many are jolted out of bed before they are physically or mentally ready.* In the process, they not only lose precious hours of rest, but their natural rhythm is disrupted, as they are being robbed of the dream-rich, rapid-eye-movement stage of sleep, some of the deepest, most productive sleep time, said pediatric sleep specialist Rafael Pelayo, MD, with the Stanford Sleep Disorders Clinic.

**TEENAGERS AND SLEEP - DR. IRENA KELLER ON HOW TEENAGERS ARE WIRED DIFFERENTLY**
http://onedublin.org/2016/03/11/teenagers-and-sleep-dr-irena-keller-on-how-teenagers-are-wired-differently/

“The start time for school needs to be developmentally appropriate. Most teenagers are sleep-deprived and it’s not just because of gadgets or stubbornness, but because of their biology and being required to wake up early for school. "It's no surprise that when teenagers go to school they are sleepy, they are tired, they can't learn as well, they can't remember what they learned the day before, and they are not as safe driving to school. As I noted earlier, sleep helps with emotional healing so sleep-deprived teenagers also have emotional challenges. Research has shown that the judgement of facial expressions can be impaired by sleep deprivation, misperceiving a person as being aggressive when they are not. A lack of sleep can cause more negative thoughts, anxiety, and even depression. "Some states and districts are shifting the start of school to be later, but change is difficult. Bus schedules are hard to change, parents need to get to work and schools get set into a schedule."

**SAVED BY THE BELL: LATER START TIMES HELPING HIGH SCHOOL STUDENTS**
http://www.today.com/parents/saved-bell-later-start-times-helping-high-school-students-t81086

"Showing respect for our kids' inner clocks helps them behave as respected individuals usually do: with more courtesy and care. Also, giving them the chance to get to school when they're actually awake should make them safer pedestrians, bikers and drivers," she said. "The research speaks for itself," he says. "The impact on school climate and student learning is significant. Very few of our student athletes will make their living within the sports world. Focusing on every way to improve the student learning on your campus must be always at the forefront."

Later Education Start Times in Adolescence: Time for Change

**STILL SLEEPLESS IN AMERICA: THE PARADOX OF LOCAL CONTROL IN EDUCATION**
http://sheu.org.uk/x/eh332ss.pdf

In America we pride ourselves on our child labour laws, yet look the other way when children rise in the 4 or 5 o’clock hour and walk to school or the bus stop in the dark. Given the approximately
90-minute later shift in sleep cycle experienced during puberty, and given that adolescents require approximately 90 minutes more sleep than adults – a compulsory wake time of 5am for teens is biochemically similar to a compulsory wake time of 2am for all adults – something few Americans would tolerate. ... Many people have stated that early school start times ‘prepare kids for the real world’ – however when it comes to sleep, American adults appear to have better protection than children. Children will also be better prepared for the ‘real world’ if they can make it through puberty intact.

**SCHOOLS IN THE US ARE BEGINNING TO PUSH BACK THEIR START TIMES AND IT’S WORKING**

Science Alert, Chris Weller, February 14 2017  

A new study involving 30,000 high-school students across 29 schools in seven states found that graduation rates and attendance rates both went up in the two years after schools pushed start times to at least 8:30am. Dobbs Ferry superintendent Lisa Brady tells Business Insider that the schools there have experienced tremendous benefits.

Following a survey issued at the end of the 2015-2016 school year (the first full year with later start times), Brady says, "It was clear from both the parents and the kids, overwhelmingly, that the mornings were just less stressful." Many of the kids reported having more time to eat breakfast and get ready for school, while parents said they didn't have to drag kids out of bed or yell at them to hurry up. Once students got to school, they felt more alert. At night, they tended to reported going to bed at the same time, even though the new schedule freed up an extra 45 minutes.

**TEENAGERS AND SLEEP – DR. IRENA KELLER ON HOW TEENAGERS ARE WIRED DIFFERENTLY**

One Dublin, March 2016  
[https://onedublin.org/2016/03/11/teenagers-and-sleep-dr-irena-keller-on-how-teenagers-are-wired-differently/](https://onedublin.org/2016/03/11/teenagers-and-sleep-dr-irena-keller-on-how-teenagers-are-wired-differently/)

"The start time for school needs to be developmentally appropriate. Most teenagers are sleep-deprived and it’s not just because of gadgets or stubbornness, but because of their biology and being required to wake up early for school. It’s no surprise that when teenagers go to school they are sleepy, they are tired, they can’t learn as well, they can’t remember what they learned the day before, and they are not as safe driving to school."

**LATER EDUCATION START TIMES IN ADOLESCENCE: TIME FOR CHANGE**

[http://www.ecs.org/clearinghouse/01/12/19/11219.pdf](http://www.ecs.org/clearinghouse/01/12/19/11219.pdf)

This is a terrific article, which provides a great closing quote for this document:  

There is *virtually unanimous agreement* in the research community that later start times in adolescent education would produce a positive change in adolescent learning, health and safety. Leading researchers in sleep medicine and sleep neuroscience have frequently called for this change in education start times to improve learning and reduce health risks. Few, if any, educational interventions are *so strongly supported by research evidence from so many different disciplines and experts in the field.*

**Appendix**