STATE OF MARYLAND
DHMH

Maryland Department of Health and Mental Hygiene
201 W. Preston Street • Baltimore, Maryland 21201
Martin O'Malley, Governor – Anthony G. Brown, Lt. Governor – Joshua M. Sharfstein, M.D., Secretary

December 22, 2014

The Honorable Martin O'Malley
Governor
100 State Circle
Annapolis, MD 21401-1925

The Honorable Thomas V. Mike Miller, Jr.
President of Senate
H-107 State House
Annapolis, MD 21401-1991

The Honorable Michael E. Busch
Speaker of the House of Delegates
H-101 State House
Annapolis, MD 21401-1991

Re: HB 883 (Chapter 620 of the Acts of 2014) 2014 Report on Safe and Healthy Schools Hours

Dear Governor O'Malley, President Miller and Speaker Busch:

Enclosed please find a report pursuant to HB 883, *Department of Health and Mental Hygiene – Study of Safe and Healthy School Hours for Maryland Public Schools*, which passed during the 2014 session of the General Assembly. The report addresses the science on the sleep needs of children and adolescents and makes recommendations regarding whether public schools should implement a starting time of no earlier than 8:00 a.m.

We hope you find this information helpful. If you have any questions regarding this report, please contact Ms. Allison Taylor, Director of Governmental Affairs, at (410) 767-6481.

Sincerely,

Joshua M. Sharfstein, M.D.
Secretary

Enclosure

cc: Laura Herrera, Deputy Secretary for Public Health
Allison Taylor, Office of Governmental Affairs
Michail Gill, Office of Government Relations
Melissa Schober, Office of School Health
Sarah Albert, MSAR #10233

Study of Safe and Healthy School Hours for Maryland Public Schools

Submitted by:

The Maryland Department of Health and Mental Hygiene

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Executive Summary

This report is submitted pursuant to Chapter 620 of the Acts of 2014 (House Bill 883), which requires the Office of Public Health Services in the Department of Health and Mental Hygiene (DHMH or Department) to:

> "…review the science on the sleep needs of children and adolescents, including the effects of sleep deprivation on academic performance and benefits of sufficient sleep; review and study how other school systems have implemented alternative school day starting times and how various activities in those school systems were impacted and scheduled around the changes; and make recommendations regarding whether public schools should implement a starting time of no earlier than 8:00 a.m."

In response to this request, Part I, written by DHMH, provides a summary of the scientific literature on sleep physiology and sleep needs of youth, the effects of insufficient sleep on school performance and other parameters impacting academic and overall health and well-being, and the positive outcomes associated with sufficient sleep. Part II, written by the Maryland State Department of Education (MSDE), studies how other school systems have implemented alternative school day starting times. Additionally, a summary table of school districts that have implemented later start times is included. Finally, recommendations on whether earlier start times should be implemented will incorporate all findings.

Children and Adolescents: Maturation Means Less Sleep

While there is not perfect agreement as to what constitutes adequate sleep, there is general consensus among the health care community, including sleep science experts, that school-age children need at least eight hours (adolescents) to 10 hours (young children) of sleep each night. The literature on sleep and academic performance consistently shows that sleep (duration, efficiency, sleepiness) is an important predictor of attention and cognitive ability in children and adolescents. This topic has been studied in racially and economically diverse populations and among school systems in urban, suburban, and rural environments with similar results.

As young people pass from childhood into and through puberty, they take longer to fall asleep. Melatonin, the hormone that signals preparation for sleep, is secreted later in the evening, and shuts off later at night, another physiologic change which contributes to the basis for the later-to-bed, difficult-to-wake pattern of puberty. As children age through adolescence, they spend less time in the phase of sleep which is believed to be critical to brain refreshment and restoration. These normal changes of puberty, factors intrinsic to the child and his or her developmental stage, provide a biological foundation for insufficient sleep and daytime sleepiness in adolescents particularly when an early wake time is imposed.

Extrinsic factors, attributes, or practices in the life or environment of the child that contribute to decreased sleep have also been documented. Early school start time has been identified as one of the strongest predictors of shorter weeknight sleep duration in adolescents. Other factors negatively impacting sleep include social and extracurricular activities; computer, video game, and TV time; and caffeine use. Parental-set bedtime has been found to positively impact sleep duration.

Consequences of Insufficient Sleep

Insufficient sleep, however defined, has been associated with poorer academic performance across multiple age groups, and across several school subjects, including math, science, writing and social studies. With less sleep, children score lower on achievement tests and tests of eye-hand coordination, dexterity and non-verbal concept formation. Conversely, more sleep is associated with improvement in executive function and in measures of attention and impulsivity.

Poor health outcomes, including depression, anxiety, suicidal ideation, and overweight/obesity have been associated with insufficient sleep, particularly in adolescents. Some studies have found a link between reduced sleep and risk-taking behavior such as alcohol and drug use, tobacco use, sexual activity, and school truancy. Literature that supports an association between insufficient sleep and overweight/obesity is especially robust (although not completely unanimous). Although the literature consistently reports benefits from sufficient sleep, which may be achieved by implementing a later school start time, the studies have been conducted using a range of methodological approaches. The Department has highlighted some of the strengths and limitations of the literature in the body of the report.

Short sleep duration (less than six hours) is associated with subjective sleepiness while driving and significantly increased motor vehicle accidents, even controlling for a number of other clearly impactful variables, including alcohol and drug use, previous crash history and risky driving behaviors such as speeding.

Effects of Later School Start Times

Increased awareness of the sleep problems facing children and adolescents has driven national and local advocacy efforts to allow longer sleep times by delaying school start time. To date, over 100 schools and school districts in 43 states and the District of Columbia have implemented policies to begin school later, or have maintained a start time of 8:00 a.m. or later; the majority fall into the former category. The first U.S. schools to implement a later start time were in Edina, Minnesota, where change began nearly two decades ago in 1997. Of course, this list represents a small fraction of total U.S. schools, as evidenced by the fact that the mean national high school start time reported by the National Center for Education Statistics Schools and Staffing Survey has moved only five minutes, from 7:54 a.m. in the 2001-2002 academic year, to 7:59 a.m. in school year 2011-2012.

Additionally, a handful of schools and school districts in Canada, the United Kingdom, and South Korea have implemented later start times. Following later start times, schools in the U.S. and abroad have reported financial savings, improved academic achievement, improved mental and overall health, decreased motor vehicle accidents, and higher attendance and graduation rates. Increases in enrollment and attendance (including fewer tardy arrivals) have been noted in some schools where later start time has been implemented.

Students' subjective assessment of their own well-being is favorably affected: they report less daytime sleepiness and fatigue, greater motivation, and report better ability to stay awake while studying, taking tests or attending class. Objective parameters such as performance in a variety of school subjects, and in state and national achievement tests also show improvement. Notably, students were found to have lower

grades and more absences in their first period class than in other classes. It is also noted that poor performance in a first period math class may negatively impact performance in future math classes. Schools where start time is delayed may see a decrease in motor vehicle accident risk in surrounding neighborhoods, and in comparison to schools with earlier start times. A recent review of the effects of later start times noted a 65-70% reduction in motor vehicle crashes when school start times were delayed.

Part I: Department of Health and Mental Hygiene

Literature Review

How Much Sleep Do Children Need? How Much Do They Get?

Sleep patterns change throughout the lifecycle, and changing stages of development are associated with different sleep needs (Carskadon, 1980; Roy-Bornstein, 2012; USHHS 2012). (Table 1):

Age	Recommended Amount of Sleep
Newborns	16–18 hours a day
Preschool-aged children	11–12 hours a day
School-aged children	At least 10 hours a day
Teens	9–10 hours a day
Adults (including the elderly)	7–8 hours a day

Table 1: Recommended amount of sleep, by age group (USHHS, 2012)

The national prevalence of insufficient sleep is high, but likely holding constant, at least since 2007, when high school students were first queried on weeknight sleep in a population-based survey. Self-reported data on sleep collected from the Centers for Disease Control and Prevention 2007 Youth Risk Behavior Survey was collapsed into categories of insufficient (<8 hours), borderline (8 hours), and optimal (>=9 hours) sleep. Analysis showed, 69% of respondents (N=12,154) reported insufficient sleep. Overall, insufficient sleep was more prevalent in females, Black students and students in 12th grade. An overwhelming 92.4% of respondents reported either insufficient or borderline sleep. Optimal sleep, reported by 7.6% of students overall, was more prevalent in males (8.8%), Hispanics (10.6%), and 9th grade students (12.5%) (Eaton, 2010).

Actual hours slept versus self-reported hours slept differed across several countries, and studies vary significantly in terms of covariates included in adjusted statistical models. A meta-analysis by Gradisar et al. (2011) included 41 studies with more than 300 participants aged 11–18 years, and published from 1999 to 2010. Data on total sleep time (TST) was included in 14 of the 41 studies: four from North America, six from Europe, three from Asia, and one from Australia. Mean school-night TST for Asian samples (7.64 hours) was significantly less than that of European samples (8.44 hours), but did not differ significantly from North American samples (7.46 hours), with more than half the samples showing sleep insufficiency of less than eight hours per night. These comparative data are summarized in Figure 1 below:

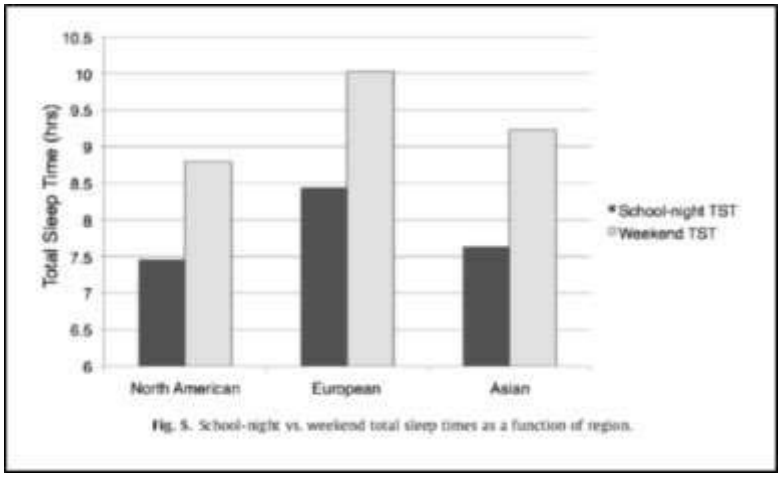

Figure 1: Total sleep time (TST), school-night vs. weekend, by three regions. (Gradisar, 2011).

Two more recent studies looked at other geographic locations. Short et al. (2013) found that, on average, controlling for age and gender in students aged approximately 13 - 19, U.S. adolescents got seven hours, 42 minutes (standard deviation, 57 minutes) of sleep, 47 minutes less per school night than their Australian peers. School start time, parent-set bedtimes, and extracurricular load together explained a small (nearly 10%) but statistically significant portion of the difference in sleep duration, with an hour earlier school start time associated with a loss of 29 minutes sleep per night.

In Borcher and Randler's study of younger students (ages 10 – 15) in Cote D'Ivoire, West Africa (2012), mean weekday sleep duration (with separate analyses adjusted for gender, "occupation," urban vs. rural, or religion) ranged from over eight hours 30 minutes to nine hours 20 minutes, a departure from sleep duration documented from other parts of the world.

In South Korea, in part because students take on additional evening coursework, with classes lasting until midnight or even later for more than half, students get significantly less sleep than in the US, with weekend bedtimes earlier than on school nights. (Chang-Kook, 2005). Thus, these later-to-bed, later-to-rise sleep patterns are not unique to the U.S., but are present in other countries as well (Carskadon, 2004).

Sleep Physiology: The Phases of Sleep

Sleep is traditionally divided into two main phases: rapid eye-movement (REM) sleep, and non-rapid eye-movement (NREM) sleep. NREM sleep is further subdivided into stages 1, 2 and 3 (Morris, 2012); individuals generally descend through these stages as they "fall" asleep, as illustrated in Figure 2 (below). Time spent in REM sleep usually increases as sleep progresses, with the longest REM periods occurring near the end of sleep.

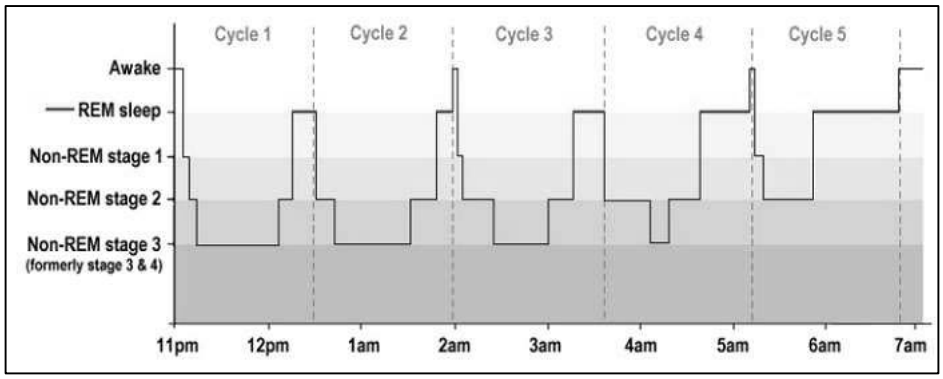

Figure 2: A typical hypnogram showing sleep stages and cycles in adult sleep
From http://www.howsleepworks.com/types_cycles.html. Image by Luke Mastin

Sleep Regulation

Current theories postulate two mechanisms that underlie sleep (Carskadon, 2004). The homeostatic mechanism, the process that attempts to maintain sleep, is termed "Process S." Process S, which can be thought of as the drive to sleep, increases during wakefulness and dissipates during sleep (Carskadon, 2004). Slow wave activity as seen on EEG, is characteristic of Stage 3 sleep (slow wave sleep or SWS), and can be used to study Process S (Carksadon, 2004). More time is spent in SWS early in sleep, when an individual has the greatest need for sleep. Time spent in SWS decreases exponentially as sleep progresses (Borbely, 1982; Carskadon, 2004). Sleep latency, the time it takes to fall asleep, decreases the longer a person is awake, and is explained by Process S (Carskadon, 1981).

The second mechanism underlying sleep is the circadian mechanism, termed "Process C." This process is independent of prior wake and sleep patterns, and relies on neurochemically based, cyclical drives that determine sleep patterns. One of these neurochemicals, melatonin, signals the body to prepare for sleep. The level of melatonin in saliva is one of the most widely utilized and reliable methods of assessing Process C (Carskadon, 2004).

Melatonin is secreted by the pineal gland, a small gland near the brain's center that contains light sensitive neural cells that trigger melatonin secretion in response to the fading light of dusk (dim light) – the "dim light melatonin onset," or DLMO. These cells also turn off melatonin secretion in response to even small amounts of light, as one would naturally be exposed to at sunrise. DLMO is considered to be the most reliable marker of the phase of sleep, and when it occurs, melatonin levels would be at peak. Of note, the photosensitive cells of the pineal gland are finely tuned to respond most actively to blue light wavelengths, which are especially prominent in contemporary indoor lighting, and light from television, video game, computer and cell phone screens.

Sleep in Adolescence

Adolescence is characterized by biological, cognitive and psychosocial change during which children transition to adulthood. During this developmental period, individuals undergo physiologic changes that trigger dramatic alteration in sleep needs and behaviors (Colrain, 2011). These changes can be seen in alterations in the sleep processes described above.

Intrinsic factors

Physiologically, adolescents experience large declines in slow wave sleep and a progressively slower build-up of Process S throughout the day, and thus an increase in sleep latency (Taylor, 2005, Colrain, 2011, Carskadon, 2004, Carskadon, 1998; Caraskadon, 1980; Karacan, 1975). This change is termed sleep phase delay. Other aspects of Process S do not change (Colrain, 2011; Carskadon, 1980) during puberty.

The Process C also changes during adolescence. Older, more mature adolescents have later melatonin secretion onset (Taylor, 2005; Carskadon, 1998) and offset (Carskadon, 2004, Carskadon, 1997) than younger, less mature adolescents. This is exemplified in a study by Taylor et al. (2005) where melatonin secretion began, on average, 56 minutes later in older adolescents than in their younger counterparts. These changes are termed phase delayed circadian rhythm (Colrain, 2011). Together with Process S changes, these normal physiologic changes underlie the preference for later bedtimes and wake times that occur during adolescence. The preference for later bedtimes and wake times is a normal developmental characteristic of puberty, and is known as a tendency towards "eveningness," or having an evening chronotype ("evening-type"), in contrast to "morningness" or "morning-type" (Roennenberg, 2004; Randler, 2011). A change from predominant morning chronotype to evening chronotype generally occurs between ages 12 and 14, with a more gradual transition back to morning type between ages 19 and 21 (Randler, 2011). As noted previously, females begin these transitions before males, in tandem with their earlier onset of pubertal development.

Sex-based differences in sleep

The literature is limited in terms of addressing differences in sleep physiology in adolescent girls and boys. Results are mixed depending upon the sleep parameter measured. For example, a hybrid (cross sectional and longitudinal phases) study of 33 adolescents ages 11 to 14, Baker et al. (2012) looked for sleep EEG differences by gender over six to eight months, and found none. Evidence for sex-based differences can be found in sleep literature which looks at sex differences across the life spectrum.

A review article by Bailey and Silver (2014) enumerates a myriad of sex-based differences in sleep physiology, but emphasizes two basic changes which correspond to puberty. Girls undergo the usual adolescent change in chronotype about one year earlier than boys: they begin to go to bed later and awaken later than when they were younger, displaying more of a tendency towards becoming an "evening type" before their male peers. On the other hand, the magnitude of this shift is more pronounced in boys than in girls, as illustrated in Figure 3 below.

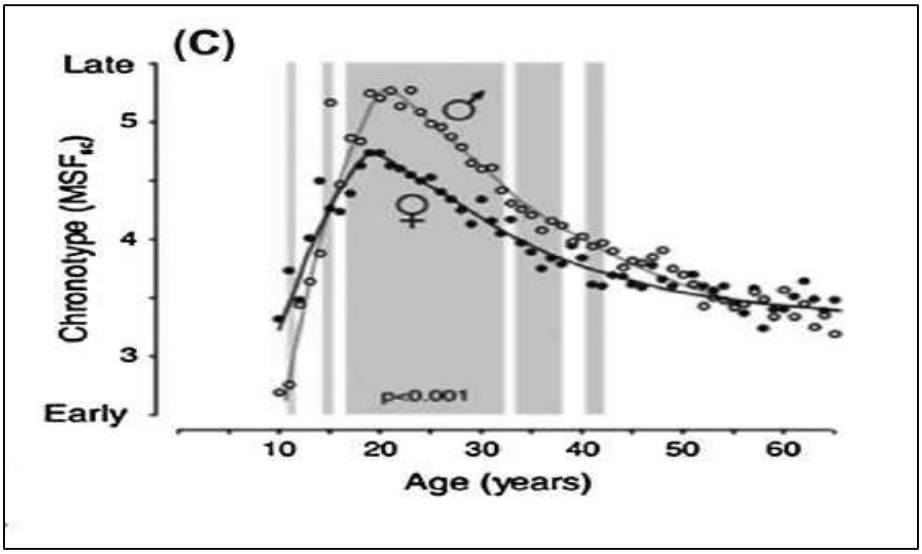

Figure 3: Sex differences in sleep onset with age. Assessment of chronotype (N =25,000 people). Sex difference in age-dependent changes in chronotype (filled circles and black line: females; open circles and gray line: males). Gray areas indicate significant male–female differences (t-test, $p < 0.001$). (Roenneberg et al. 2004).

Some postulate that adolescent sleep behaviors (perhaps distinct from physiology) may vary by sex as well. Lee et al. (1999) showed, in a survey-based study of 144 adolescents between 11 and 14 years old, that girls woke up earlier on school days and later on weekends than boys. The authors found no differences in terms of total sleep time, sleep latency or number of awakenings. Two small studies (N<20) did not show a gender difference in adolescent sleep behaviors (Carskadon, 2004; Karacan, 1975).

While there is good evidence that physiologic changes in adolescent sleep does vary by gender, the relationship between sleep, and race, and ethnicity is much less clear. While several studies examine race/ethnicity as covariates, very few studies look at race or ethnicity specifically as exposure variables.

In a population-based (N=12,154) study by Eaton et al. (2010), sleep insufficiency, defined here as less than or equal to seven hours of sleep per night, was highest in Black females. Although Mateo and colleagues (2012) made no racial or ethnic comparisons, their study of 2,649 Spanish adolescents between 12 and 16 years of age does provide some basis for comparison with U.S. students. Of note, among this group of students from six cities near Madrid, school start times were approximately equal to, or later than, a U.S. school start time of 8:30 a.m. Similar to U.S. adolescents, the tendency towards a morning chronotype decreased with age. Girls woke up earlier on weekdays and later on weekends than boys, consistent with Lee et al. (1999).

Extrinsic factors

Extrinsic factors also contribute to changes in sleep. School start time has been identified as the strongest predictor of wake time during adolescence (Knutson, 2009), but academic demand, computer use, social activities, employment, and caffeine also contribute (Knutson, 2009; Moore, 2008). High school students identified that too much homework, stress, TV, and hanging out with friends prevented them from

sleeping (Noland, 2009). Consequently, most teens are not getting the 8.5-10 hours of sleep per night recommended for their age group (Carskadon, 1980; Roy-Bornstein, 2012). In 2010, Eaton et al. found that in a study of 12,145 9th–12th graders, 68.9% got insufficient sleep (defined as less than or equal to seven hours), and this deficiency increased with grade level. Similarly, in a study of 384 high school students, 91.9% of students got less than nine hours of sleep per night (Noland, 2009) and in a sample of 529 adolescents, 90% reported sleeping less than eight hours per night (Seicean, 2007). Other studies have shown average nightly sleep time to be 6.7 hours (Eliasson, 2002), 7.7 hours (Pasch, 2010), 7.55 hours (Weiss, 2010), 7.68 hours (Gupta, 2002). Adolescents believe that eight to ten hours of sleep per night is recommended by physicians (Eliasson 2002; Noland 2009), thus sleep insufficiency does not result from a lack of knowledge regarding adequate needs. Older adolescents take longer to recover from sleep loss than younger adolescents (Jenni, 2005; Carskadon, 2001).

The extrinsic factors of evening television viewing, video game play, and internet use have been found to be variably associated with sleep-related measures, although studies that directly test hypotheses around these relationships are not abundant. Cain and Gradisar, in their review of 36 articles that examined use or ownership of electronic media and sleep (2010), concluded that "excessive" use of electronic media was associated most consistently with decreases in total sleep time and delayed bedtime. Of the 36 articles reviewed, only 3 used an experimental intervention; most were cross-sectional studies that were not designed to demonstrate causal relationships. Additionally, two of the articles examined media use as a sleep aid, thus acknowledging a potentially paradoxical element in the relationship between electronic media use and sleep. The authors postulated several possible mechanisms by which such media might affect sleep, including direct displacement of sleep time by electronics use, melatonin depression by bright light exposure from electronic screens, direct physiologic arousal in response to interaction with electronic media, and an adverse effect on sleep architecture by electromagnetic radiation from cell phones (Cain, 2010). Of note, in human adults, light in which blue wavelengths predominate is known to more efficiently suppress melatonin secretion, and to suppress EEG correlates of sleepiness. There is some evidence that adolescents are more sensitive to blue wavelengths than adults (Figueiro, 2011; Wood, 2013) though the sample sizes in these studies are quite small.

In summary, insufficient sleep in adolescence is extremely common, results from intrinsic and extrinsic pressure to delay bedtime and is associated with multiple negative outcomes. Adolescents themselves feel that it leads to lower grades, daytime sleepiness, problems with attention, and difficulty getting along with others (Noland, 2009) and studies have linked it to mood disorders, obesity, poor academic performance, motor vehicle accidents, and significant daytime sleepiness (Moore, 2008; De Souza, 2012; Carskadon, 1980). This problem has been highlighted on a national level. Healthy People 2020, developed by the U.S. Department of Health and Human Services, includes as an objective, to "increase the proportion of students in grades 9-12 who get sufficient sleep" by the year 2020. This was based on data that showed only 30.9% of 9th-12th graders getting eight or more hours of sleep per night. Sleep insufficiency tends to worsen as children progress into and through puberty, and negative effects on adolescent physical and mental health and wellbeing have been reliably documented in numerous studies described below.

Academic Performance

Sleep insufficiency is associated with decreased academic achievement among multiple age groups (Wolfson, 2003). In a study of 553 primary school children in China, students who reported more daytime sleepiness and who got less than nine hours of sleep per night had worse achievement scores than less sleepy children and those who got sufficient sleep (Li, 2013). Sleepier children also had less attention and motivation according to teachers (Gruber, 2012; Li, 2013). Similarly, poor sleep quality caused by night awakenings and nightmares has been associated with worse performance in science, spelling, handwriting and other academic subjects (Wiechers, 2011), and sleep inefficiency or insufficiency has been associated with worse divided attention (Vriend, 2012; Paavonen, 2009), and worse visuospatial performance (Paavonen, 2010). This would translate into poorer spatial visualization and analysis, visual-motor (e.g., eye – hand) coordination, dexterity, and nonverbal concept formation. In a meta-analysis involving 35,963 children ages five to 12, more sleep was associated with better performance on executive function tasks (Astill, 2012). Studies have not consistently shown that sleep is associated with memory or sustained attention (Vriend, 2012; Astill, 2012). In summary, insufficient sleep is associated with multiple measures of low academic achievement and cognitive ability in children.

It is possible that this association varies according to socioeconomic status (SES). Among elementary school students with earlier starting schools (school start time was analyzed as a continuous variable), achievement was decreased in writing, reading, math, science and social studies, but only in schools that were presumably higher SES, based upon enrollment of a smaller proportion of children eligible for free or reduced-cost lunch (Keller, 2014). The authors discuss this finding in the context of a cumulative risk model, where low SES students may be surrounded by multiple psychosocial and environmental risk factors for poor academic achievement (e.g., lack of resources, exposure to toxins or poor housing conditions), of which school start time is one. Removing one risk factor from the lives of low SES students may have a smaller effect when there are many other risk factors potentially affecting academic achievement. Of note, particularly in light of the paucity of literature that addresses SES, Keller and colleagues examined school start times, rather than any qualitative or quantitative measure of sleep.

Sufficient sleep duration and quality were associated with higher grades, controlling for previous academic results, class attendance, and night outings (Gomes, 2011), and this positive association has been demonstrated in multiple studies (Fredriksen, 2004; Pagel, 2007; Link, 1995). Subjective sleepiness has been shown to negatively affect executive functioning (Anderson, 2008), and this effect was especially strong among adolescents with less educated caregivers, though the reason for this relationship was not elucidated (Anderson, 2008). In addition to grades, measures of attention, impulsivity, and error making were also improved with longer sleep duration (Lufi, 2011). Mak et al. (2012) studied 22,678 participants enrolled in what would be the U.S. equivalent of grades 7 through 12 in Hong Kong, and found that a sleep debt (defined as the difference in the duration of weekend sleep and weekday sleep) of greater than two hours was associated with 17% more students reporting poor academic performance. Waking up one or more hours later on weekends than on weekdays seemed to be protective, decreasing the proportion of students reporting poor academic performance by 31 – 36%. Although Eliasson et al. (2002) found no significant association between sleep and academic performance in their teacher-administered, questionnaire-based study of 1500 9th through 12th grade students, the current body of literature overwhelmingly supports an association between sleep quality and quantity, and academic performance.

The physiologic mechanisms underlying sleep-wake cycles in adolescents likely contribute to this association. As adolescents progress through normal physiologic changes in sleep processes (see Process S and Process C, in Sleep in Adolescence), they gain increased wakefulness during the evenings and a preference for later and later evening activities. So-called "evening-type" individuals have been shown to have worse academic outcomes than "morning-type" or "neither-type" individuals (Escribano, 2012). Also, students have been shown to perform significantly better on computer cognitive tests in the afternoon than in the morning, while reporting feeling wearier, less alert, and expending more effort in the morning (Hansen, 2005). Together, these studies may illuminate some of the ways in which early school start times force adolescents to learn at times that are at odds with normal physiology, and therefore negatively impact academic performance.

Health Outcomes

Short sleep duration is associated with negative health outcomes. There exists a large body of research linking inadequate sleep and overweight/obesity (Cappuccio, 2008; Seicean, 2007; Gupta, 2002; Sekine, 2002; Noland, 2009), which has been attributed to hormonal dysregulation of hormones related to hunger and satiety (leptin and ghrelin, see Appendix A) (Taheri, 2004), altered eating habits, and/or reductions in physical activity (Guidolin, 2012). Seicean et al. (2007), in a cross-sectional study of 529 Ohio high school students, found a statistically significant association and trend between short sleep duration and overweight, controlling for age and sex. Compared to participants who slept less than eight hours, those who slept less than five hours per night had 8.5 times the odds of being overweight [(odds ratio 8.53 (95% CI 2.26- 32.14)], and those who slept seven to eight hours per night had 1.3 times the odds of overweight [1.29 (0.52, 3.26)], with intermediate odds ratios seen in those who slept five to six and six to seven hours per night.

A similar dose-response relationship was also found between late bedtime or short sleeping hours, and childhood obesity, in a cross-sectional study of 8,274 Japanese children ages six to seven (Sekine, 2002). Compared with children with 10 or more hours of sleep (by parental report), those with nine to ten hours sleep per night had 1.5 times the odds (1.49 [1.08-2.14]) of overweight/obesity; those with eight to nine hours sleep, nearly twice the odds (1.89 [1.34-2.73]), and for those with less than eight hours sleep, nearly three times the odds (2.87 [1.61-5.05]). Odds ratios in Sekine et al. were adjusted for a number of covariates, including age, sex, parental obesity, and such lifestyle variables as hours of television watched and frequency of eating breakfast.

A similar relationship between insufficient sleep and overweight/obesity has been found in studies with large sample sizes, including a meta-analysis of 30,002 children (Cappuccio, 2008) and multiple other studies with sample sizes over 1000 participants (Knutson, 2005; Gupta, 2002), as well as in studies that examined this relationship across age groups, races, and socioeconomic status. Typically, this relationship is identified using linear or logistic regression analyses, which control for demographic and other variables that could confound weight status, such as health status, caffeine intake, and irregular eating (Seicean, 2007).

Other studies fail to demonstrate this relationship. Knutson et al., (2005) showed that sleep duration predicted BMI z-score (i.e., BMI percentage for age and gender) in linear regression models, but when additional potentially confounding variables including age, race, parental education, activity, and

inactivity scores were added, this relationship was lost among females. A weak association remained among males. Peach et al. (2014) similarly demonstrated a relationship between sleep and obesity in boys, but not girls, and significance has been lost upon statistical modeling in other studies as well (Hassan, 2011). Overall, it appears that adequate, valid evidence linking insufficient sleep and overweight/obesity exists, and that the association may be weaker, or not significant, in girls; additionally, this relationship may be confounded by lifestyle variables. Further research, particularly longitudinal studies, will be useful in fully clarifying this relationship.

A variety of other health outcomes have been associated with sleep duration. Sleep insufficiency has been negatively associated with eating a healthy diet and getting adequate exercise, stress management, and overall health scores on an adolescent health promotion questionnaire (Chen, 2006). Additionally, adolescents have been shown to consume 2.2% more calories from fat and 3% less calories from carbohydrates when getting less than eight hours of sleep, which study authors interpret as an association between high energy diets and inadequate sleep (Weiss, 2010). Sleep insufficiency has been identified as a risk factor for self-reported hypercholesterolemia in females (with a trend towards this relationship in males) with each additional hour of sleep associated with decreased odds of being diagnosed with high cholesterol in young adulthood (Gangwisch, 2010). This was found while controlling for physical activity, emotional distress, and body weight. Sleep also appears to be indirectly linked to hypertension (Peach, 2014). Last, self-reported sleepiness has been associated with lower perception of overall health (Moore, 2009). Taken together, it appears that sleep plays a role in overall health status, though a better understanding of the physiologic basis of these relationships is still being studied.

Risk Behaviors

It is noted that insufficient sleep during adolescence increases the probability of risky behaviors. Insufficient sleep on school nights has been associated with alcohol and other drug use, drunkenness, sexual behaviors, school truancy, and weapon-carrying (O'Brien, 2005; Pasch, 2010; Roberts, 2009; Wahlstrom, 2014; Hildenbrand, 2013; McNight-Eily, 2011), but the literature is not unanimous across these risk behaviors (Roberts, 2009). In a large (N=14,782), nationally representative sample, adolescents who slept less than eight hours on school nights were 52% more likely to carry a weapon on school property and 27% more likely to have been threatened or injured with a weapon on school property, as compared to those who slept eight or more hours. Of note, fighting in school (the sole variable examined that was a direct measure of actual violent behavior on the part of study subjects) did *not* show a significant relationship with insufficient sleep (Hildenbrand, 2013). Although this was a cross-sectional, survey-based study, the authors suggested a number of factors that could potentially mediate the association demonstrated, such being the victim of violence possibly decreasing the ability to sleep.

Behavioral Health

Behavioral health and sleep are closely linked and an association between these variables has been consistently identified. Insufficient sleep has been associated with depressive symptoms and depression diagnoses in multiple studies (Alfano, 2009; Boergers, 2014; McKnight-Eily, 2011; Patten, 2000; Rhie, 2013; Roberts, 2009; Shanahan, 2014; Yip, 2014; Wahlstrom, 2014). This has been demonstrated longitudinally where less sleep in 6th grade was associated with higher depression and lower self-esteem later on (Fredriksen, 2004). The study authors deemed this relationship unidirectional based on cross-domain statistical modeling and post-hoc analysis. In addition to depression, sleep insufficiency has been longitudinally associated with anxiety and oppositional defiant disorder (Shanahan, 2014), as well as

stress (Rhie, 2013) and poor perception of own mental health (Roberts, 2009) in cross sectional designs. Subjective sleepiness has also been identified as a risk factor for anxiety and depression; though this study found no relationship between sleep duration and psychological variables (Moore, 2009). Last, sleep insufficiency (less than five or less than eight hours, depending on the study) has been shown to increase risk for suicidal ideation, suicide attempts, and hopelessness (Fitzgerald, 2011; McKnight-Eily, 2011; Rhie, 2013). Getting greater than 10 hours of sleep has also been linked with suicidality, demonstrating the complicated nature of the relationship between sleep and mental health. Taken together, insufficient sleep is a risk factor for psychiatric diagnoses and symptoms.

These relationships hold true among pre-adolescent children where decreased sleep duration has been associated with behavioral problems (Astill, 2012), sadness, anger, and fear (Vriend, 2012). Socioeconomic status may mediate this relationship. Among low SES children, decreased sleep efficiency was associated with aggression, impulsivity, disruptive behavior, delinquency, and noncompliance whereas among high SES, it was associated with depression, anxiety, fear, worry, and psychosomatic problems (El-Sheikh, 2010). The mechanism underlying these relationships is unclear, but this demonstrates the complicated interrelationships between social, psychological and sleep variables.

The link between mental health and sleep is shown in a study by Yip et al. (2014), which showed that adolescents experiencing high levels of discrimination who also experienced poor sleep had increased depressive symptoms and decreased self-esteem over time. When sleep habits alone and discrimination alone were compared to mental health outcomes, significance was lost. Moreover, among adolescents with high quality sleep, discrimination was not linked to depression. The fact that multiple factors contribute to mental health is further demonstrated by Chatburn et al. (2014) who showed that resiliency mediated the relationship between sleep problems and depression and anxiety, hypothesizing that reduced sleep quality yields less resilience, predisposing adolescents to behavioral and emotional problems. Taken together, the relationship between mental health and sleep is complicated; it appears that sleep clearly influences mental health outcomes, but that many additional factors also contribute to the strength and evolution of this relationship.

Increasing sleep duration may improve mental health. For example, Dewald-Kaufmann (2014) designed a randomized, controlled trial where adolescent participants were randomized to a control group or an intervention group where they were counseled about sleep hygiene and gradually advanced their bedtimes for two weeks. In pre-post comparison, the experimental group had earlier bedtimes and sleep onset as well as significantly decreased depressive symptoms. Because this single study was 85% female and had a small sample size, further examination of interventions aimed at increasing sleep, and the effects on depression is required.

Motor Vehicle Accident Risk

Motor vehicle crashes are the leading cause of death for teenagers in the U.S. (CDC, 2011), and it is of critical importance that we attempt to better understand this topic. Drowsy driving has been identified as a risk factor for car crashes in multiple studies (Hutchens, 2008; Pizza, 2010). Pizza et al. (2010) found that 15% percent of adolescents who were involved in car accidents reported sleepiness as the main cause of the crash. Teens commonly report drowsy driving, and it has been found that 15%-40% of teens and young adults frequently drive drowsy (Hutchens 2008; Pizza, 2010). In addition to subjective sleepiness,

short sleep duration (less than six hours) was associated with a 21% increased crash risk, as shown in Martiniuk et al., a prospective study of 19,327 17-24 year olds (2013). The association was noted even while controlling for a myriad of factors, including prior crash history, age, sex, average weekly driving hours, residency in urban versus rural environments, alcohol and drug usage, risky driving behaviors such as speeding, sensation seeking and psychological distress score. Of note, these crashes most commonly occurred between 8 p.m. and 6 a.m. Overall, it is clear that insufficient sleep and sleepiness are important risk factors for motor vehicle accidents in adolescents.

While the aforementioned data involves predominantly self-report, a study by Philip et al. (2003) examined the effects of sleep deprivation on reaction time, fatigue and sleepiness. Participants' reaction time was tested in three different conditions: in the laboratory after 8.5 hours of sleep, while driving after 8.5 hours of sleep, and while driving after two hours of sleep. Researchers found that in sleep-restricted conditions, some participant's reaction times increased by 650 milliseconds, equivalent to 23 meters when stopping a car on the highway. Also under sleep restricted conditions, a co-driver had to take control of participants' cars for 70% of participants, which never occurred when subjects got 8.5 hours of sleep. This laboratory condition represented an objective measure of dangerous driving that occurs after sleep deprivation. While it is not possible to judge whether participant drowsiness was similar to that experienced by adolescents due to early school start times, this objectively demonstrates that fatigue negatively affects reaction time and propensity for safe driving.

Strengths of the body of research on motor vehicle accident risk include large sample sizes representative of diverse racial and socioeconomic backgrounds, and of urban, suburban, and rural settings; taken together, these attributes increase the generalizability of the studies. Multivariable analyses control for many confounding factors, another strength. While many of the studies are cross-sectional, making assumptions of causality impossible, prospective studies in this area tend to reach the same conclusions (Martiniuk, 2013).

The Effects of Delayed School Start Time

The national push towards delaying school start time has slowly gained momentum across the U.S. There is a growing body of literature regarding the effects of this change on adolescents, most of which are positive.

Most commonly, earlier school start times are associated with less sleep for adolescents (Ming, 2011; Dexter, 2003), and when school start time is delayed, sleep duration increases (Owens, 2011; Li, 2013; Danner, 2008; Lufi, 2011; Dexter, 2003). For example, a start time of 7:30 a.m. was correlated with less than seven hours of sleep in New Jersey (Ming, 2011), while in Kentucky, a changing from a start time between 7:30 and 8 a.m. to a start time between 8:30 and 9 a.m. start time was associated with 12 – 30 more minutes of sleep (Danner, 2008). In New England, changing the school start time from 7:15 to 8:37 a.m. was associated with 37 additional minutes of sleep (Wolfson, 2007). Outside the U.S., results are similar: in a small study in Israel (N=47), a change from 7:30 to 8:30 a.m. was associated with 55 additional minutes of sleep per night (Lufi, 2011), and in a larger study in China (N>500), delayed start times of 30 and 60 minutes resulted in sleep duration increases of 15 to 23 minutes, respectively.

Delaying school start time also increases the proportion of youth who get more adequate sleep (or decreases the proportion that gets inadequate sleep). In Rhode Island, changing the start time from 8:00 to 8:30 a.m. was associated with a 79.4% decrease in the number of students getting less than seven hours of sleep per night. In this same study, 54.7% of children reported getting at least eight hours of sleep, up from 16.4% before the change (Owens, 2010). In Kentucky, the later start time resulted in 50.0% of children getting at least eight hours of sleep, up from 35.7%, a statistically significant finding (Danner, 2008), and in Colorado, Minnesota, and Wyoming, start times of 8:30 a.m. or later were associated with more than 60% of students obtaining at least 8 hours of sleep, up from 33% with earlier starts.

One early argument against delaying school start time was that students would go to bed later. However, the literature consistently demonstrates that students go to bed at a similar time despite being able to sleep later in the morning, and the end result is more sleep (Wahlstrom, 2002; Wolfson, 2007). Delayed start times have not been shown to affect hours spent on homework, sports, music, or hanging out with friends (Danner, 2008). Thus, overall, delaying school start time increases the amount of sleep obtained by adolescents.

In addition to more sleep, an association of delayed start times with a number of positive outcomes has been noted: students report less daytime sleepiness, fatigue, and lack of motivation (Owens, 2010; Wahlstrom, 2002; Danner, 2008; Wolfson, 2007), and better ability to stay awake while studying, taking tests, or during class (Wahlstrom, 2002). Later start times have also been associated with better attention and fewer mistakes (Lufi, 2011). Of note, Vedaa et al. (2012), in a study of 10th grade students in Norway, did not find less sleepiness among late starters, but did find significantly better performance on a computerized reaction time test. This study was unique in that the change in start time involved starting later only on Mondays, providing a cross-over comparison during the school week.

Academic performance also seems to improve when start time is delayed. Wahlstrom et al. (2014) studied ethnically and socio-economically diverse populations in eight public high schools over three states. In schools with 8:35 a.m. or later start times, academic performance in math, English, science and social studies, as well as in state and national achievement tests, were significantly improved. This finding has been repeated in multiple studies, where later start times are associated with better academic achievement (Carrell, 2010; Edwards, 2012), including by Carrell et al. (2010) where the authors claimed causality based on statistical modeling. Delaying school start time was also associated with increased attendance rates and decreased tardiness (Owens, 2010; Wahlstrom, 2002; Wolfson, 2007; Wahlstrom, 2014), both of which perhaps contribute to improved academic performance.

In a sample of 27,686 middle school students, Edwards et al. (2012) estimated that a one-hour increase in start time would lead to a three-percentile-point gain in math and reading test scores. In 82 Chicago public schools, it was shown that students had lower grades and more absences in their first period class than in other classes, and that having math during first period reduced achievement in all subjects, including future math courses (Cortes, 2010). Taken together, researchers have found that early classes are associated with negative academic outcomes, and delaying start time improves academic performance as measured by grades and standardized test scores. This has been shown in racially and socio-economically diverse samples, among urban and rural districts, in studies with thousands of participants, and utilizing statistical analyses that control for confounding variables. Delaying school start time

decreases motor vehicle accident risk, and this has been demonstrated in multiple U.S. counties (Vorona, 2011; Danner, 2008; Wahlstrom, 2014). When school start times were changed from 7:30 or 8:00 to 8:30 or 9:00 a.m. among a sample of 9,966 17-18 year olds, car crashes decreased by 16.5%, despite a concurrent 7.8% increase in accidents statewide (Danner, 2008). The author was careful to note that the findings were not necessarily causal, because the sleep habits and miles driven of drivers who did and did not have crashes were not directly assessed.

This was especially significant in a study by Wahlstrom et al. (2002), which examined 50,962 high school students in Minnesota after school start time was delayed from 7:14 to 8:40 a.m. Continuous enrollment (enrollment in the same school for two years) significantly improved with the later start times. The authors note the special significance of this finding. Historically, there had been a proportion of students in the Minnesota school system that enrolled and unenrolled in one school after the other. The authors speculate that this was due to a policy where students were given a failing grade after eight tardy arrivals, and would therefore un-enroll and enroll in a new school to avoid the failing grade. Students who frequently change schools have lower academic achievement than students who attend one school for multiple years. Notably, delaying school start time significantly increased the number of students who continuously attended the same school. Even among the population of students who continued to change schools frequently after the delayed start times, attendance rates significantly increased. Without additional information describing these students (e.g. demographic data), it is impossible to fully understand this finding, but home and family variables merit further attention in future studies on effects of changes in school start time.

Similarly, in a study of over 9,000 16-18 year olds, car crashes were reduced by 65-70% in two of the four counties studied when school start time changed from 7:35 to 8:55 a.m.; the high school with the latest start time, where 66% of students got more than eight hours of sleep per night, had the largest decline in crash rate. In the other two counties, crashes increased by 9% and decreased by 6% (Wahlstrom, 2014). The authors hypothesized that the increased accident risk was related to the geographic layout of the neighboring district. They speculated that teens from nearby towns drove through the studied county despite not attending school there, and that these teens with earlier school start times skewed the results to a higher accident rate. In Virginia, two demographically similar, neighboring communities had school start times of 7:20 a.m. and 8:40 a.m. There were 19.2 more car crashes per 1000 teen drivers in the earlier starting schools and the timing of crashes correlated with school commute times. There were no differences in traffic patterns between the two locations (Vorona, 2011). Of note, these studies did not measure sleep time and thus the analysis relies on aggregate measures of school start time and crash data. Yet overall, it appears that delaying start times decreases motor vehicle accident risk. As noted previously, Vedaa et al. (2012) found that later start times were associated with improved performance on a test of reaction time; additional research is necessary to determine whether this improved reaction time is reproducible, and if so, whether it plays a role in the decrease in accidents observed with delayed start times.

Delaying school start times positively affects mental and overall health. An 8:00 to 8:30 a.m. delay was associated with improved scores on depression scales (Owens, 2010; Wahlstrom, 2002) and decreased sick days and visits to health centers for fatigue related complaints (Owens, 2010; Wahlstrom, 2002). Overall, the impact of school start time on mental health has not been adequately studied.

One study surveyed 335 teachers regarding their opinions of start time. More than half believed an 8:00 to 8:30 a.m. start time to be optimal citing observations of increased student alertness and decreased sleeping in class after start time had been delayed as the key reasons (Wahlstrom, 2014).

Strengths and Limitations of the Literature Review

Across the body of literature on sleep physiology in children/adolescents, requirements, insufficiency and its effects, several limitations emerge as common themes. One overarching theme is the frequent use of the cross-sectional study design. In these cases, while associations may be demonstrated, causation cannot be assumed. Thus, one cannot state that sleep insufficiency *causes* poor academic outcomes, only that the two variables are associated.

In studies on health outcomes, the link between insufficient sleep and overweight/obesity has been found in studies with large sample sizes, including a meta-analysis of 30,002 children (Cappuccio, 2008) and multiple other studies with sample sizes over 1000 participants (Knutson, 2005; Gupta, 2002). Additionally, health outcomes have been examined across multiple age groups, races and ethnicities, and socioeconomic statuses. Typically, this relationship is analyzed using regression analyses that attempt to control for demographic and other variables that could influence weight status, such as overall health status, caffeine intake, and irregular eating habits (Seicean, 2007).

Another theme across much of the sleep literature is the study of non-overlapping age ranges of children. Some studies may examine sleep behavior in pre-adolescents, for example, while others may examine behavior in students in late adolescence. Nonetheless, while the literature overall, looks at youth across a wide range of ages, results, conclusions and recommendations more often emphasize adolescents because sleep insufficiency is exacerbated as children mature, and effects associated with sleep insufficiency tend to worsen as sleep insufficiency increases.

Finally, many studies are based upon self-reported data, or, as is often the case with children under 10, parental report. These kinds of data are subject to certain biases that may under- or overestimate the measure of effect, as discussed in more detail below.

Sleep physiology studies in particular are characterized by small (N = < 40) sample size, likely because of the necessary use of invasive monitoring in sleep labs. In these cases, differences in the controlled nature of the sleep "lab" and a child's usual sleep environment may detract from the validity of sleep physiology research. However, the quantitative nature of sleep physiology literature is a strength, in that variables examined are usually objective and widely recognized markers of certain sleep processes, e.g. slow wave sleep as seen on EEG, or melatonin secretion. Finally, research in sleep physiology has been conducted over several decades. The accumulated evidence for changes in adolescent sleep is robust widely accepted.

By contrast, studies reporting conclusions of insufficient sleep are often larger (hundreds or thousands of subjects) because they are based upon surveys of populations or subpopulations. While the size of these studies is a strength, findings based upon self-reported data are subject to a number of biases (e.g., volunteer or social desirability bias) that call into question their validity. For example, volunteer bias would tend to push results towards no association, as those who volunteer, or who cooperate in completing surveys are often healthier than the general population. Additionally, there is social

desirability bias, which would tend to cause subjects to provide responses that are more socially desirable, again tending to push results towards no association in these studies. The overall effect of these biases is to underestimate the measure of effect, suggesting that associations seen in the studies in this report may be stronger than observed. On the other hand, where parental reports of bedtime and wake time are utilized, reported bedtimes may be earlier (e.g. related to "lights-out") than true bedtimes, and parental reported wake time may vary in either direction. Calculation of sleep duration based upon these estimates may differ from what is real, but not in a systematic way (no overall tendency to over or underestimate the sleep duration). In this instance, any association demonstrated should be unchanged.

The other limitation of the studies of sleep sufficiency is that there is no common definition of insufficient sleep. In studies reviewed here, "insufficient sleep" is defined anywhere from less than six hours up to and including 7.5 or eight hours per night. Since required sleep for adolescents is estimated to be 8.5 – 10 hours, this variation among studies is less problematic than some of the other study limitations noted above.

Limitations of the academic performance research are well-summarized in a review article by Wolfson and Carskadon (2003). Diverse measures of academic achievement (semester grades, quarterly evaluations, absenteeism, standardized tests, and questionnaires regarding cognitive variables) and sleep (self-report, sleep quantity, night awakenings, later weekend rise times, and daytime sleepiness) are used, and results are therefore, not completely comparable across studies. Furthermore, they note that data from many of the studies is self-reported, and therefore subject to biases discussed above. Most of the associations noted have been found using statistical modeling that controls for confounding variables (which in itself is a strength), but it is always possible for background characteristics of participants that are not controlled to confound findings.

The many studies linking sleep and behavioral health have large sample sizes and racially, socioeconomically, and geographically diverse populations. Statistical analyses are often robust, with appropriate attention to possible confounders. Yet many limitations remain. As is the case in much sleep research, studies utilize a wide range of cut-offs to define "insufficient sleep" – usually between six and eight hours. Because insufficient sleep is not uniformly defined, it makes comparisons among studies that have contradictory findings challenging. Additionally, personal, psychosocial, and institutional variables influence mental health, perhaps more significantly than they influence other variables in this report, making it difficult to determine the direction of causality. These studies are predominantly cross-sectional, and while statistical models control for several confounding variables, it is impossible to control for all of the variables that could mediate or confound the relationship between behavioral health and sleep. Additional studies that address limitations noted are necessary to elaborate on these complex relationships.

Studies on sleep insufficiency and risk behaviors have been both prospective and cross-sectional, and have included diverse racial and socioeconomic samples. Despite some positive associations, there is insufficient evidence to conclude that insufficient sleep affects risk-taking behaviors such as alcohol use, drug use, and violence-related and sexual behaviors.

Data on the effects of delayed school start time came mostly from small (>200) to large (>1,000, with 50,962 in one study), urban, rural, and suburban sample populations. Participants attended predominantly

public schools, although Owens et al. (2010) conducted one study in a private school sample of 201 students. Several of these studies include racially and socioeconomically diverse populations (Wahlstrom, 2014; Wolfson, 2007), although some studies do not report demographic data. Limitations of studies on the effects of delayed school start time include self-reported data, and data aggregation in some of the studies.

Implementation of Delayed School Start Times

Although the Maryland State Board of Education has broad authority to determine elementary and secondary educational policies and to investigate the educational needs of the State and methods to improve educational conditions (Md. Code Ann, Ed. § 2-205), each county board of education is responsible for managing its operational logistics, including arranging for the transportation of students (Md. Code. Ann, Ed. § 4-120). Statewide legislation on school start times would reduce local autonomy, and was strongly opposed by many stakeholders at the Maryland State Department of Education's meeting on September 10, 2014 (see Appendices B & C).

Each of the 24 local jurisdictions has unique demographic characteristics and resources and no single solution will fit all districts. The uniqueness is reflected in each school district calendar. While each school must be in session 180 days and provide at least 1,080 hours of elementary and middle school education and 1,170 hours of high school education (Md. Code Ann, Ed. § 7-103 and COMAR 13a.03.02.12), local districts have the autonomy to decide start and end dates, vacation days and weeks, and community-specific closures such as the Autumn Glory Festival in Garrett County.

"Flipping" the schedules of primary and secondary school students might ensure each group is able to get the recommended hours of sleep per night, but it could also result in young students waiting for transportation or walking to school in the dark. A recent study suggests that swapping elementary and secondary school schedules shifts the problem of sleep insufficiency from adolescents to younger children (Keller, 2014).

The Department is concerned about the unintended consequences of later school start times, particularly on families of lower socioeconomic status. Such families "were more likely to report limited transportation alternatives and 'non-existent' child-care options that were affordable and reliable" (Wrobel, 1999). These families were more likely to depend on older children to care for younger siblings or to expect adolescents to work to supplement household earnings. A shift in school start times could result in unsupervised time for younger children, or in additional care transitions, leaving them fatigued and negating the benefits of a later start time. A later school start time reduces adolescents' availability for afterschool employment as federal (29 C.F.R. § 570.35) and State (Md. Code Ann, Labor & Employment § 3-203 et seq.) labor laws restrict the hours minors are permitted to work, particularly during the school year.

Two Maryland counties have produced cost estimates for changing school start times: Montgomery County issued a report in June 2014 with an operational and fiscal analysis indicating that the annual cost of shifting start times would be $21.6 million. Anne Arundel County reported that costs ranged from $600,000 (for shifting all schools 30 minutes later) to $8.9 million (moving high school start times to 8:30 a.m. or 9:15 a.m., with various adjustments to elementary and middle school start times). Jerry Wilson, Ph.D., legislative liaison for the Public School Superintendents of Maryland estimated that Carroll County would need to add a separate bus run or add an estimated 40 bus routes, at a cost of $1.2 million

annually. Dr. Wilson voiced concern that other additional costs may arise, when previously available buses are not available for transportation to extracurricular competitions, in shifting and/or extending custodial duties, and in shifting professional development opportunities for school staff.

Despite these fiscal analyses, it is difficult if not impossible to measure exactly how and to what degree students would benefit from later start times. For example, is moving high school schedules later by 30 minutes sufficient? Would changing the high school schedule by 30 minutes or one hour produce sufficient sleep gains for high school students or is a greater delay required? How much academic gain should be expected by moving start times later? Are the estimated academic gains worth the fiscal cost? Should concerns about the long-term effects of insufficient sleep be weighted more heavily in a cost-benefit analysis since such costs will affect the lifelong health trajectory? As Scott Pfeifer, Executive Director of the Maryland Association of Secondary School Principals noted, school start times must be viewed in the context of competing priorities, such as hiring more school psychologists to meet the emotional needs of students with the largest achievement gaps, investing in arts programs, expanding pre-kindergarten, and improving career education programs (see Appendix B).

Students, educators, and parents/guardians could benefit from sleep education that encourages good sleep hygiene, perhaps as part of the existing comprehensive health education curriculum outlined in COMAR 13A.04.18.01, which includes an instructional program to help "students adopt and maintain healthy behaviors and contribute directly to a student's ability to successfully practice behaviors that protect and promote health and avoid or reduce health risks." Promoting good sleep hygiene by minimizing exposure to light – most especially the blue light emitted by electronic devices which delays the release of melatonin – setting a regular bedtime, and increasing physical activity can reduce trouble falling asleep at night (Hagenauer, 2009).

Conclusions & Recommendations

The Department of Health and Mental Hygiene recognizes the connection between sufficient sleep and student health and wellness. To that end, the Department encourages the Maryland State Board of Education use its authority (specified in Md. Code Ann., Ed. § 2-205) to advise local school systems of the benefits of a later school start time policies, and to encourage them to conduct feasibility studies regarding the implementation of school starting times of 8 a.m. or later.

While this recommendation will not result in any immediate change, it is important to note that school districts that have successfully delayed school starts need adequate time to prepare, during which they engaged stakeholders and studied local transportation effects. The consequences of changing school start times are unavoidable, but they can be ameliorated with proper planning and preparation. Any consideration of a statewide mandate for a later school start time must consider the unique needs of each of the 24 local jurisdictions. However, in preserving the status quo where by school start times are a matter for each local jurisdiction, the state risks letting local resistance trump a strong body of scientific evidence that sleep is critical to health and academic achievement.

Part II: Maryland State Department of Education

Introduction

Pursuant to House Bill 883, the Department of Health and Mental Hygiene (DHMH) produced a report entitled, *Study of Safe and Healthy School Hours for Maryland Public Schools*. The legislation required DHMH to review the science of the sleep needs of children and adolescents, including the effects of sleep deprivation on academic performance and the benefits of sufficient sleep; review and study how other school systems have implemented alternative school day starting times and how various activities in those school systems were impacted and scheduled around the changes; and make recommendations regarding whether public schools should implement a starting time of no earlier than 8:00 a.m.

The recommendation of the *Study of Safe and Healthy School Hours for Maryland Public Schools* report was to encourage the Maryland State Board of Education to use its authority to advise local school systems of the benefits of later school start time policies and encourage them to conduct feasibility studies regarding the implementation of school starting times of 8:00 a.m. or later.

The DHMH report is a very robust report, rich with data, and backed with research. Of particular interest is the Literature Review, which clearly documents the need for more sleep by children and adolescents. The report also clearly states the impact of sleep insufficiency on academic performance, health, and safety. Additionally, the report carefully analyzes the effects of delayed school start time and the implementation thereof.

The purpose of this supplemental report is to more closely examine the impact of a later school starting time in Maryland schools on the following areas: safety; finance; scheduling; extra-curricular activities; and student achievement. In order to provide a deeper look into these areas, the Maryland State Department of Education (MSDE) tasked program managers and staff with reviewing the contents of the DHMH study and several other reports including, *High School Start Time - Phase I Preliminary Report* (Howard County, 2014), *The Report of the 2013 Bell Times Work Group: Sleep Needs of Students, Scheduling Practices, and Options for Consideration* (Montgomery County, 2013), and other related documents and reports. In addition to reviewing these reports, MSDE program managers and staff were asked to bring their professional expertise to bear. It is our hope that by providing a deeper view into these specific areas, this supplemental report enhances and adds perspective to the comprehensive report produced by DHMH.

Impact on School Safety

Some studies have found a link between reduced sleep, and risk-taking behavior such as alcohol and drug abuse, tobacco use, sexual activity, and school truancy (DHMH, 2014). The following

literature review concerns/issues should be considered as a part of any decision regarding later school start times.

- *School Safety* - Student safety is a priority. Consider daylight, traffic, travel distance, waiting at bus stops in the morning and walking to school in the morning and during inclement weather. School dismissal times have to consider the need for younger students to arrive home before it gets dark. (Howard County, 2014).

- *Student Safety Becomes Part of Debate on Later School Start Times* - Terra Ziporyn Snider, Ph.D., a spokeswoman for Start School Later, said the health and safety of high school students is at the forefront of the organization's mission to promote later school start times. Tied to teenagers' physical health are additional safety risks that arise when young people must head to bus stops and schools in the dark predawn hours.

Impact on Public Safety

The school safety literature review revealed that the primary concern among stakeholders was the issue of motor vehicle accidents by teens driving while sleep deprived. Another major concern was the danger associated with sleep-deprived teens waiting on street corners before dawn when few other people are around, walking/waiting on winding roads with no sidewalks or shoulders, and younger students arriving home before it gets dark.

- *Traffic Accidents* - Through a nationally representative survey of United States drivers ages 14-22, researchers found that aside from length of licensure, only driving alone while drowsy and being a smoker were associated with having been involved in a traffic collision. These results held true even after controlling for gender, average hours driven per week, urban versus suburban driving, sensation-seeking driving, and hours slept per night (Montgomery County, 2013).

- *Reduced Risk of Teen Crashes* - Teen drivers have several factors against them when it comes to their risk of motor vehicle accidents. Some teens drive while talking with friends or texting on their cell phones, taking their attention away from the road. Others are not mature enough to make good driving decisions, increasing the risk of accidents. What many people do not know is that sleepiness is a major factor in teen crashes. In fact, AAA says that drowsiness contributes to more than 100,000 crashes per year. When teens drive while they are drowsy, they have slowed reaction times and have a hard time paying attention to the road. Adolescents are especially at risk for driving drowsy because of early school start times. Moving school start times to at least 8:00 a.m. would give teens the opportunity to get more sleep each night (Morgan, 2012).

  "Not only is it dangerous for sleep-deprived teens to be waiting on street corners before dawn — when very few other people are out and about — or walking/waiting on winding roads, often with no sidewalks or shoulders, but we're putting some very young and

inexperienced drivers out on the roads all day long, many of them sleep-deprived," said Snider.

The only problem with this issue, she noted, is that it is very difficult to prove that any given accident was solely due to early school hours, as other factors might play a role. However, when schools move their start times later, car-crash rates go down, she said, and this is an issue that everyone should care about, not just parents of teenagers.

"We also know that early school start times and associated sleep deprivation are a factor in these accidents and that, unlike many other factors, they are one that we can fix," Snider continued (Fisher, 2013).

- *Later School Start Time Cuts Teens' Car Crash Risk* - Letting teens sleep a little more by starting the school day a bit later may lower their odds for car crash injury or death, a new study finds. The researchers found a 16.5 percent drop in auto accident rates for teen drivers when local high schools moved the start of classes from 7:30 a.m. to 8:30 a.m.

  The possible reason? More sleep, more alert driving, the researchers said. After puberty, adolescents are biologically programmed to stay up about an hour later each night, explained Fred Danner, the University of Kentucky psychologist who co-authored the study. This shift in their biological clocks then conflicts with having to get up earlier to go to high school than they did when they were in middle school, he added.

  "It's as if they are operating on West Coast time in an East Coast world," Danner said. People blame teenagers' sleep deprivation on computers and staying up late to e-mail friends, he added. "But there is evidence they get phase-shifted by at least an hour. So you've got biology pushing you later and then you've got the school systems starting an hour earlier. By the end of the week, [kids] are a wreck and our study shows they might actually be *in* one."

  In the study, the researchers surveyed around 10,000 Kentucky students from grades 6 through 12 on their sleep habits and daytime functioning, including auto mishaps. The surveys were completed twice -- first in 1998, when school started at 7:30 a.m., and then again in 1999, when the start time had been moved to 8:30 a.m.

  Besides the 16.5 percent drop in car crashes, the researchers also found that the number of students who got at least eight hours of sleep per night rose from 35.7 percent in 1998 to 50 percent after the later school time came into effect (Colwell, 2008).

Fiscal Impact on Maryland School Districts

If schools establish start times of 8:00 a.m. or later, it may have a fiscal effect on local school systems. Information on the fiscal effects would need to be provided by local school systems. Under the State's Bridge to Excellence funding for preK-12 public education, local systems receive aid through formula-driven grants. Local systems have significant flexibility in how they budget these State grant funds, and they report on the use of their funds through a Master Plan process. However, MSDE does not collect detailed data on local school district and school-level expenditures.

Anne Arundel, Howard, and Montgomery County Public Schools have conducted fiscal analyses of delayed school start time. In each analysis, which included multiple options, the cost of transportation was identified as having a significant impact.

Anne Arundel County studied three options (Anne Arundel County Public Schools' Transportation Division, 2013):

- Option 1: Universal Shift for All Schools. Concept: Delay the opening and closing time of all schools by an equal amount. For example, delay the start time of all schools by 15 minutes. Fiscal impact: Marginal.
- Option 2: Start high schools after middle schools and elementary schools. Concept: Start high schools at 9:45 a.m. and close at 4:33 p.m. Although the fiscal impact of this option was not reported, there were several barriers to the option, including loss of afternoon connectors to from magnet programs to community bus stops, impact on afterschool activities at high schools, and later dismissal for many students causing safety concerns such as putting buses in rush hour traffic and causing students to walk in the dark.
- Option 3A: Establish school hours window of 8:00 a.m. to approximately 4:00 p.m. Concept: High schools 8:00 a.m. to 2:48 p.m.; Middle schools would close no later than 4:00 p.m.; Elementary schools could be scheduled at the same time as many of the middle schools. Fiscal impact: estimated cost of $6.6 million to $8.4 million annually; impacts on Maintenance of Effort funding requirements.
- Option 3B: Establish school hours window of 8:00 a.m. to approximately 4:00 p.m. Concept: Middle schools 8:00 a.m. to 2:40 p.m.; High schools 9:15 a.m. to 4:03 p.m. Elementary schools staggered between the high and middle school hours. Fiscal Impact: Cost range $5.2 million to $6.6 million annually; impacts on Maintenance of Effort funding requirements.

Howard County studied the fiscal impact of shifting school start times for 241 high schools from 7:25 a.m. to 8:15 a.m. and close times from 2:10 a.m. to 3:00 p.m. The study estimated that altering the start time would require approximately 299 additional busses. The estimated total added cost of altering the start time is $19.152 million (Howard County Public Schools, 2014).

Montgomery County considered several options with regard to later school start times (Montgomery County Public Schools, 2013):

Note: Start times for elementary schools in Montgomery County are currently divided into two tiers: Elementary School Tier 1 (ES1) starts 8:50 a.m. and ends at 3:05 p.m.; Elementary School Tier 2 (ES2) starts at 9:15 a.m. and ends at 3:30 p.m.

Option 1

- Switch order of high schools and middle schools
- Start middle schools 10 minutes earlier and high schools 50 minutes later
- Lengthen elementary instructional day by 10 minutes and start 10 minutes later

Estimated Cost: $9,054,495 (transportation) + $260,000 (utilities) = $9,314,495

Option 1A

- Switch order of high schools and middle schools (as in Option 1)
- Start middle schools 10 minutes earlier and high schools 50 minutes later (as in Option 1)
- Lengthen elementary instructional day by 20 minutes; leave elementary start time unchanged

Estimated Cost: $11,500,301 (transportation) + $515,000 (utilities) = $12,015,301

Option 2

- All start times are moved 35 minutes later
- Order and length of day remain the same

Estimated Costs: $0 (no transportation/no utilities impact)

Option 2A

- All start times are moved 25 minutes later
- Order and length of day remain the same

Estimated Costs: $0 (no transportation/no utilities impact)

According to Montgomery County Public Schools, 2013, starting all schools 25-30 minutes incurs no additional costs and creates more desirable start times for high school (7:50 or 8:00 a.m.) and middle school (8:20 or 8:30 a.m.). However, Option 2 pushes the latest elementary start time to 9:40 or 9:50 a.m., possibly creating an increased need for before school child care

for some families or, as was reported in one study reviewed by the work group, setting some elementary students up for 2-3 hours of television before school. In addition, the dismissal time for some elementary schools could result in some students getting off the bus close to sunset during winter months (typically 4:45 p.m. in late December). (Montgomery County Public Schools, 2013).

Option 3

- Extend the elementary day by 30 minutes making the day six hours and forty-five minutes long for all levels (this provides for interchangeable order of start times and any range of first start and last end times)
- Switch the order of start times as follows: ES1, HS, MS, ES2
- High schools and middle schools start 55 minutes later
- ES1 starts 1 hour earlier, and ES2 starts 5 minutes later

Estimated Costs: TBD (more detail needed to compute transportation costs) + $775,000 (utilities)

Option 4

- Maintain current bell schedules, but consider existing practices and additional strategies to address concerns about first period classes, and also to support for students who need a later start time on an individual basis.

Estimated Costs: $0 (no transportation impact/no utilities impact)

It is important to note that while Options 2, 2A, and 4 are estimated to have no fiscal impact on the school system, there are other areas of impact. For example, Option 2 pushes the latest elementary start time to 9:40 a.m. or 9:50 a.m., possibly creating an increased need for before school child care for some families or, as was reported in one study reviewed by the work group, setting some elementary students up for 2–3 hours of television before school. In addition, the dismissal time for ES2 could result in some students getting off the bus close to sunset during winter months (typically 4:45 p.m. in late December). (Montgomery County Public Schools, 2013).

Based on the review of the reports from Anne Arundel, Howard, and Montgomery Counties, it is clear that cost could be a potential barrier to delaying school start times.

Impact on Operations and Logistics

After reviewing the reports by DHMH, three Maryland school systems, the forum conducted by the Maryland State Department of Education, and a review of the literature, the following observations emerged: The medical research strongly indicates that for adolescents to function

at full mental, physical, and emotional capacity they need more sleep than they are presently receiving given the start times of classes in Maryland high schools. The studies indicate that 9 hours of sleep would align with a high school student's need for sleep. Sleep research also indicates that the melatonin produced by adolescents which encourages sleepiness begins to be produced in the body at about 11:00 p.m. and continues to be produced until 8:00 a.m.

Present start times in high schools has many students standing at bus stops as early as 6:50 a.m. after having awakened, prepared for school, and walked to the bus stop. Actual waking time for high school students can actually be much earlier than 6:50 a.m. if they have to prepare themselves and younger siblings. It is obvious from the research that high school students are presently fighting the melatonin that their body is producing in order to awaken and to stay awake during the hours before 8:00 a.m. So the immediate solution would be to move the high school start time to a time that would better coincide with their sleep pattern. As easy as this sounds the impact on the present patterns of school openings and a host of other challenges were the focus of work groups and task forces in Montgomery, Anne Arundel, and Howard Counties.

Since these counties, like most of Maryland school districts, rely on a three, four, or five tiered transportation system, which allows buses to be utilized on multiple routes to pick up each level of student all three counties considered simply flipping either the elementary school or the middle school start time with the high school start time so they could continue to use the same tiered transportation system. Flipping the middle school with the high school was discounted when the same research and experts quickly pointed out that prepubescent students need the same amount of sleep and fall under the same sleep pattern as adolescents. This flip would simply be solving the problem for one age group by passing it to another. Flipping the high school schedule with the much later elementary school schedule would maintain the bus tiers but parents at all three school systems were alarmed because it would now be their 6 year olds standing at the bus stops in the dark at 6:50 a.m.

With both of the flipping options discounted the work groups began exploring the option of delaying the start time of all three school levels an equal amount each day. This would maintain the same tiered transportation system in order to not be forced to incur the expense of buying more buses and hiring additional bus drivers.

Some interesting points of consideration emerged that informed the dialogue at the local school work groups are found below.

Elementary School

- Howard County stated that research is lacking on the effect of school start times on younger students, making it difficult for them to discern if they would be helping or hurting their elementary school students if their schedule started earlier.

- Montgomery County stated that moving the elementary school to an earlier time is favorable for elementary school learning patterns.
- Anne Arundel County worried that if elementary school starting time is pushed later even by 30 minutes, prime learning time would be missed. (Aug 12, 2014)

Middle School

- Since middle school start times are more in alignment with their students' sleep needs and patterns, there was little discussion regarding changing their starting times except to say that after school outdoor activity would be shortened which would affect Recreation and Parks agendas.

High School

A high school bell schedule would not necessarily have to change because of a later start time. Most examples showing before and after scenarios of delaying school start times illustrated that the same number of minutes would be spent in each period whether the school was functioning on a seven or a four period day.

- Anne Arundel County investigated an option of allowing a hybrid schedule that would allow the students the option to take one or two online courses during periods one and two. Since these online courses require an 80/20 split regarding the amount of online instruction vs. teacher led instruction, students would be required to enter school during the second half of period two for this instruction or coaching. This was especially investigated in schools with 4 period days. Many online options allow students to engage the instruction at any time of the day or evening thus allowing students to sleep late; possibly 90 + 45 minutes later. This option would, by necessity, be limited to those students who had access to their own transportation to school each morning.

One overriding issue that was repeatedly voiced at the forum convened at MSDE by the legislative liaison in September of 2014 was that of local school system autonomy versus State control. Having the State legislature or the State Board of Education mandate the start times for school systems would be a departure from the present order as it would reduce local autonomy and discount the unique characteristics of each school district. The Executive Director of the Maryland Association of Secondary School Principals, the Director of Governmental Relations with the Maryland Association of Boards of Education, the representative for the Public School Superintendents Association of Maryland, all spoke against restricting the autonomy of the local boards of education in favor of increased State control of education.

Impact on Extra-Curricular Activities

According to a survey conducted in 2002 by NCES, approximately 50 percent of students participate in at least one interscholastic sport and 50 percent of students participate in other extracurricular activities. By moving the school day back, there is an impact on after school programs for elementary and middle school students, athletic practice and athletic competition schedules for high school students, clubs other than athletic activities, after-school work schedules, homework time and family time. (Howard County Report, Appendix F). Anne Arundel County looked into the impact a later end time would have on Parks and Recreation and other community facilities that share usage (Minutes April 30, 2014; May 28, 2014; June 12, 2014).

Impact on Student Achievement

The impact on of later start times on student achievement is well documented. Several studies, including Carrell et al. (2010) and Wahlstrom et al. (2014), both cited in the DHMH report show that in schools with 8:35 a.m. or later start times, academic performance in mathematics, English, science, and social studies, as well as in state and national achievement tests, were significantly improved. (Wahlstrom et al. 2014). As mentioned in the DHMH report, this finding has been repeated in multiple studies, where later start times were associated with better academic achievement. (Carrell et al. 2010).

Fairfax County, Virginia Implementation

According to a press release (2014) from Fairfax County Public Schools (FCPS), the County School Board, citing the clear health benefits for adolescents, approved a recommendation for starting high schools later, between 8 and 8:10 a.m. and ending between 2:45 and 2:55 p.m. This change, which will begin in the 2015-16 school year, will benefit more than 57,000 high school students representing more than 30 percent of FCPS' student population.

According to the press release, the School Board's decision reflects a start time change for all four years of high school, a crucial period for students' college-preparatory or work-readiness years as well as their athletic engagements and other activities. As a part of the decision, the School Board approved later start times for all middle and high school students who attend the three FCPS secondary schools. (Fairfax County Public Schools, 2014). Additionally, middle school students will attend school from 7:30 a.m. to 2:15 p.m. and the elementary school window remains unchanged with elementary school students beginning their day between 8 and 9:20 a.m. All elementary schools will start at the same time or within 5 to 10 minutes of their current start time (Fairfax County Public Schools, 2014).

According to information on FCPS' website, the cost of this change is estimated at $4.9 million, including 27 additional buses.

Summary and Conclusion

Based on the review of national and local data, the Maryland State Department of Education also recognizes the connection between sufficient sleep and student health and wellness pointed out in the DHMH report. Therefore, the Department concurs with the recommendation of the Department of Health and Mental Hygiene's recommendation to encourage the Maryland State Board of Education to use its authority (specified in Md. Code. Ann., Ed. § 2-205) to advise local school systems of the benefits of later start time policies and encourage them to conduct feasibility studies regarding the implementation of school starting times of 8 a.m. or later.

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Appendices

Appendix A: Glossary of Terms

Chronotype – at it most simplistic, an individual's preference for time of sleep and waking activities. Physiologically, chronotype reflects the time of day when certain biological functions, i.e. hormone level, body temperature, cognitive functioning, eating and sleeping) are most active, or reach certain levels, Individual preferences often predominate, dividing people into morning chronotypes commonly referred to as "larks") and evening chronotypes (commonly referred to as "owls"), but many people fall into an intermediate category, expressing a preference for neither type. There are a variety of questionnaires that can help to determine chonotype, but a few are widely used and well-validated in many populations. The Composite Scale of Morningness (CSM), the Morningness Eveningness Questionnaire (MEQ) and the Morningness Eveningness Scale for Children (MESC) are often used to assess chronotype.

Ghrelin – a hormone secreted by the gastrointestinal system that functions as a neurochemical (i.e. exerting its effect at the level of the nervous system, specifically the hypothalamus) "hunger hormone." It is released when the stomach is empty, increasing appetite and increasing the amount of energy that goes into stored fat, thus playing a role in energy balance and increasing fat mass. Short sleep duration is associated with elevated ghrelin. The strange spelling of ghrelin comes from the acronym for **g**rowth **h**ormone **rel**ease **in**ducing, which is one of the functions of ghrelin.

Leptin – a hormone that serves as a counterpoint to ghrelin in that it depresses hunger when fat stores reach a certain threshold. Secreted by fat cells, and acting on cells in the hypothalamus (like ghrelin) and in many areas of the body, leptin causes energy stores to be used while suppressing appetite. Short sleep duration is associated with decreased leptin levels.

Melatonin – the hormone that signals preparation for sleep and is secreted by the pineal gland in response to dim light, that is, what humans would normally be exposed to at dusk. Melatonin is suppressed by bright light, and thus cycles of melatonin onset and offset (when secretion is shut off) are both intrinisic to the individual (and will be reflected in chronotype) and synchronized to the 24-hour light-dark cycle. Light exposure is the strongest environmental clue to an individual's intrinsic biological clock that it is either time to get sleepy or time to begin waking up. The light sensitive cells that receive light (dim or bright) and signal the pineal to secrete or stop secreting melatonin, are most sensitive to light in the blue wavelength range.

Process C –the circadian (meaning "about a day") process, which is an endogenous process, that is, intrinsic to the individual. Melatonin is the best biological marker of process C we currently have, and is what we attempt to measure to study Process C. The circadian cycle is approximately 24 hours, but can vary in humans to fall within the range of 23.8 hours to 27.1 hours. The light-dark cycle of our environment ties ("entrains") our personal circadian cycle more tightly to the length of the Earth's day.

Process S –reflects the propensity to sleep, and is a function of the amount of sleep or wakefulness accumulated at any given time. This propensity, or sleep pressure, increases the longer one has been awake, and decreases the longer one has been asleep. Stage 3 slow wave sleep (SWS), reflected by slower waves on EEG, can be used to study Process S.

Rapid-eye movement (REM) sleep – the phase of sleep that corresponds to dreaming, when the eyes can be seen to be moving rapidly beneath the eyelids. Time spent in REM sleep increases as sleep progresses, with the longest period of REM usually occurring shortly before awakening. Short sleep duration can deprive an individual of the full complement of REM sleep, which is thought to help in consolidating certain types of memories and increasing the depth and breadth of the network of neurons in the developing brain. Humans will attempt to make up for any accumulated deficit in REM sleep by increasing the amount of REM sleep on subsequent nights; this is known as the REM rebound.

Slow wave sleep (SWS) – corresponds to Stage 3 and 4 sleep, In contrast to REM sleep, SWS occupies a longer proportion of sleep time earlier in the sleep period, and progressively decreases as a proportion of sleep time, as sleep progresses. Similar to REM sleep, an individual experiences an increase in the amount of SWS if he or she is previously deprived of SWS, the so-called SWS rebound. SWS is thought to support consolidation of certain types of memory as well, in addition to physical growth and development.

Appendix B: MSDE Forum for Stakeholders Notes

Study of Safe and Healthy School Hours for Maryland Public Schools
Forum for Education Stakeholders September 10, 2014

Attendees:

- Renee Spence, Maryland State Department of Education (MSDE)
- Dr. Michial A. Gill, Maryland State Department of Education (MSDE)
- William Cappe, Specialist, Maryland State Department of Education (MSDE)
- Terry Ball, former President, Maryland Association of Elementary School Principals (MAESP)
- John Woolums, Maryland Association of Boards of Education (MABE)
- Ray Leone, Parent Teacher Association (PTA)
- Scott Pfeifer, Maryland Association of Secondary School Principals (MASSP)
- Betty Weller, Maryland State Education Association (MSEA)
- Dr. Jerry Wilson, Public School Superintendents Association of Maryland (PSSAM)
- Deborah Nelson, MSDE, School Psychologist
- Leon Langley, Maryland State Department of Education (MSDE)
- Jim Knighton, Maryland Department of Transportation (MDOT)
- Jeremy Price, Maryland Association of Student Councils (MASC)
- Dr. William Flook, Maryland School Psychologists Association (MSPA)

Today, September 10, 2014 a group of stakeholders met regarding the "Study of Safe and Healthy School Hours" for Maryland Public Schools at the Maryland State Department of Education (MSDE).

Mrs. Renee Spence introduced herself and asked participants to introduce themselves. She provided an overview of H.B. 883, legislation adopted by the 2014 Maryland General Assembly to study safe and healthy school hours for Maryland public schools. She explained that this group is meeting once as a consultation forum and further explained that although this issue comes under the purview of local education agencies (LEAs), the Department of Health and Mental Hygiene (DHMH) has been directed to make recommendations to the Governor regarding whether public schools in the state should establish a policy regarding a school starting time of 8 a.m. or later. She explained this is not a task force but rather a study. The bill as introduced was conceived as a task force staffed by MSDE; however the bill was amended.

There is scientific medical research that shows that adolescents require more sleep than younger children and noted that there is a lot of support for changing the starting time for middle and high school students. More recently the Academy of Pediatrics came out in support of the research and start times. Dr. Joshua M. Sharfstein, Secretary of the Department of Health and Mental Hygiene (DHMH) had discussions with Dr. Lillian M. Lowery, State Superintendent of Schools, requesting MSDE's assistance in convening the education stakeholders. It was decided that MSDE would host a forum and invite all stakeholders outlined in the legislation to participate. The Office of Public Health Services shall report its findings and make recommendations to the Governor and General Assembly on or before December 31, 2014.

Ms. Spence explained that the State Board of Education is the over-arching policy-maker for education in Maryland. The Board typically opposes legislation that mandates education curriculum and policy. Over the years educational governance has experienced many changes, including the procedure for choosing local school boards from appointed to elected. Therefore, in some instances local officials are impacting education policy. Previous legislation infringing on local autonomy has included bills on financial literacy as a graduation requirement and mandated physical education. Maryland has a history of local autonomy

by the 24 jurisdictions. Although in concept, many of these issues are supported by the education community it is strongly felt these kinds of policy decisions should continue to be made at the local level. Mrs. Spence informed the group that a letter from Dr. Lowery was included in the packet of information that addressed the issue of local autonomy for local jurisdictions.

At this John Woolums, Director of Governmental Relations with the Maryland Association of Boards of Education (MABE) was introduced to discuss state and local board authority.

Mr. Woolums shared a legalistic fact based presentation on the structure of educational governance in the State of Maryland. He explained that governance in Maryland is very unique and that Maryland places a high priority on public education. He explained that Maryland leadership determined that funding for public education should be based on need with lower income producing counties receiving more funding for education than those with higher tax bases. He noted that Maryland provides local autonomy for LEAs and the State Board of Education is seen as a partner in providing public education. He noted that the issue of school start times is usually addressed at the local level.

Renee Spence explained that there is nothing in current law that prohibits a local school system from changing their start times.

Bill Cappe, MSDE's Ombudsman, said school calendar is the precedent that school be in session 180 days and 1080 hours for elementary and middle schools and 1,170 for high schools. This falls under Section 7-103 of the Education Article. He shared a chart with the group showing each school systems' first day, Thanksgiving holiday, winter break, spring break as well as other closings and holidays. School superintendents determine start dates and end dates. These calendars take into account weather related delays/closings in addition to state and federal holidays and other determinations. With respect to other holidays there are communities that include such events as fair days or hunting days in certain communities.

Dr. Jerry Wilson (PSSAM) said it is good to put this issue into context regarding the post Labor Day start discussions also going on at this time as both are issues best handled by local boards. Worcester County would be the beneficiary if there were to be a change. However his board made the decision as a deciding body to start after Labor Day. This is important and needs to remain a local board decision. PSSAM is interested in the health and welfare of our students and the studies provide important issues to consider. When looking at the range of start times, only one county, Washington, has the late start time. In preparation for this meeting Dr. Wilson asked other superintendents to provide him with information on busing as it relates to later start times. Indications are that the later start time would cost more and given the revenue concerns any additional costs would be of concern to the superintendents. Essentially, the way we use buses at the start of school day to transport students, high schools start earlier than elementary schools. Buses pick up high school students and then go to the elementary schools. Carroll County said they would require additional bus routes at $40 million. Dorchester uses 39 buses total for 38 elementary runs. He provided other examples of schools system costs. Also to be considered would be those systems that use their own buses verses contract buses. Essentially more buses will be needed. Another concern is the employing of bus drivers. They are not full time employees and many have other jobs. One county superintendent said they are trying to get people to become drivers (Caroline) to be trained. Another concern is for high school students who provide childcare/after school care. . With later dismissal times, various concerns were voiced regarding professional development and athletics. In regard to student achievement, he suggested there could be slight increase in other states, but seems to waiver and is not consistent. Anne Arundel County is currently looking at this issue and it appears students may do better with earlier day. The practical issue is we could switch the elementary and high schools start times but this does not seem to work as we could have elementary students at bus stop as early as 5-6 am.

Scott Pfeifer, MASSP said his organization is uniform in that this should be a local issue due to the complexity of the issue. He was reading Dr. Starr's report in Montgomery County and on page 3 he captured the fact that bell times is an important issue to student success and well-being, but it has to be viewed in the context of other priorities the school system must consider, such as hiring more counselors and school psychologists to meet the emotion needs of students with the largest achievement gaps; investing in arts programs that will engage students and improving career-oriented education programs

Betty Weller (MSEA) said, "There is nothing simple about education. We believe in local autonomy."

Dr. Flook, of the Maryland School Psychologists Association, said that school systems need more school psychologists and that his Association hasn't taken a position on this but that it is a very valid concern. He said his personal experience is the earlier the start the harder it is for some kids. He is very much looking forward to seeing some of the findings from the health department.

Jim Knighton, (MDOT) said, "It is more a matter of implementation on the back end." He explained that the Baltimore City Board of School Commissioners will add or subtract the number of buses based on bell times of city schools. He said "changing start time is not something we would have an issue with." It should be noted that the MDOT partners with the Baltimore City Board of School Commissioners to provide transportation for Baltimore City students.

Leon Langley, Director of Transportation at MSDE, said many counties have 2, 4 or 5 tiers where the school bus can be used three times in a day. Student transportation is a shared responsibility and when bus routes change, this becomes an issue for parents as well as school officials. We want to be as efficient as possible. If this change should occur, transportation departments need time to implement this effectively and efficiently. The routes are planned early in the calendar process. Mr. Langley feels that Anne Arundel and Montgomery County reports on early start time did a good job outlining this issue.

Jeremy Price, a student representing the Maryland Association of School Councils, supports a later start time and feels this would bring a host of advantages, however the issue would also be county resources and how do you deal with the transportation logistics. He feels this would be a "beginning step for other things as more sleep is good for better health." He feels county boards would see improvement in student achievement. Although he feels it is up to the local boards to determine policy, he feels this should happen and resources should be shifted.

John Woolums said with his advocacy hat in picking up what Jeremy said, it is a matter of costs and benefits such as what was seen with advocates wanting more physical education. However, when looking at logistics and staff requirements you then waive the $15 million to $40 million when increasing PE. There are many other issues facing school systems such as pre-k, would the resources needed for early start time be better utilized in other areas. This can be in the $100 million price tag. Keep in mind that many systems have had declining revenue. So the cost analysis should also be a concern when looking at the fact that school systems are fiscally dependent. The local systems are very much bound by predictable, but not always adequate funding.

Audience members were asked if they would like to make any comments.

Renee' Spence said there are two local school systems that are in the process of conducting studies on later start times, Anne Arundel County and Montgomery County. Patrick Crain, Anne Arundel County thanked those who stated that this is a local issue. They have had a task force for 8 months and have had a good working group. Ultimately the Anne Arundel County Board of Education will make the decision based on recommendations in the report. They are looking at many areas objectively. For others considering such a study, there are many areas/issues to be factored in such as increasing significantly

transportation costs. He said they are not in a position yet to make a decision, they are still reviewing the research, planning community forums for input and hope to move forward , Representatives from the Department of Health and Mental Hygiene (DHMH) said they appreciate being included in the meeting for education stakeholders. There is very little question that this would be good for students; staff will consider everything that has been said at this meeting when making recommendations.

An advocate for the Schools Start Later Association said it is important to note there are other areas in the country passing this issue. They are looking to do something by next year in Maryland. We are mindful of the issues and very sensitive regarding local control, but also believe there is good that can come with students starting later.

A representative of Delegate Aruna Miller (Montgomery County), sponsor of H.B. 883, said, "Everyone is talking about local control. Let's adjust the resource allocation to help students learn and achieve." Ms. Spence said that Ned Sparks, an MSDE staffer who represents the school sports organization, was unable to attend this meeting but that he will provide his comments and they will be shared with this group (Mr. Sparks written comments are attached). Michial Gill, MSDE, recapped the issued discussed. Ultimately we are concerned with student achievement and how this would/could affect students. In making a determination about later start time consideration should be given to student transportation, teacher professional development opportunities, and timeliness of such a change, costs and benefits as well as the priorities of local school systems. It is worth noting that the education stakeholders overwhelmingly advocate for local autonomy and with this kind of a decision be left with the local boards of education.

Written comments from Ned Sparks, Executive Director of Athletic Programs at MSDE, and Dr. Jerry Wilson, PSSAM, are attached.

The meeting adjourned at 11:15 a.m.

Appendix C: Statement from Jerry Wilson, Ph.D., Public School Superintendents Association of Maryland (PSSAM)

Jerry Wilson, Ph.D., Superintendent
Worcester County Public Schools
September 10, 2014

Later High School and Middle School Start Times

As Maryland considers to examine and possibly recommend later high school and middle school start times based on research that indicates adolescents benefit from 8-9 hours of sleep and that their circadian rhythm patterns cause them to stay up later at night, PSSAM views this as a decision best made by local Boards of Education. Sorting out the multiple variables for successful implementation and to permit communities to weigh the implications of these decisions is the province of local control.

PSSAM in this brief outline will address some of the most salient factors that administrators face when confronted by the interest to have high schools primarily and middle schools secondarily to begin later. For the purposes of this review, the most recent recommendation that the start time for schools to begin after 8:30 a.m. will be the starting point for comparison.

1. Having later start times for high schools costs more. The current efficiencies in transportation in most school systems rely on shared buses referred to as double bussing. In the fleet, bus loops are generally used to pick up both secondary and elementary students separately. By staggering start times of schools and closely coordinating these times, school systems are able to generate efficiencies that can save substantial school resources. If these adjustments are made at the state level, it is likely to create substantial additional initial costs to purchase buses and pay for additional routes. For example, Cecil County utilizes 142 buses to deliver middle and high school students; all but five buses have double runs and the five that do not support transportation to the Technical High School. Carroll County similarly would need to add a separate bus run or 40 additional bus routes at a cost of about $1.2M. Cecil County also noted that athletics would require additional and separate buses for in county games as buses would be already in use for elementary routes. Talbot County uses 38 buses for double bussing. Dorchester County uses 39 buses and 38 are also used for

elementary runs. Wicomico County uses 103 buses of which 86 double bus. From these three counties several, outcomes immediately emerge: county school systems have achieved efficiencies with the starting times of schools. Without local consideration, costs would increase dramatically due to having separate runs to secondary and elementary programs. Additional costs may emerge when otherwise available buses are not available such as in the transportation to technical high schools and for in county school extracurricular competition.

2. Most school systems on the Eastern Shore that responded to our request for information rely on double bussing. With a school start for High Schools and Middle Schools that would be after 8:30 a.m. these systems would see the need to purchase or contract for a number of buses that would nearly double their existing fleet. Again this situation dependent since not all counties solely rely on double bussing. In addition to the material costs of purchasing buses, hiring additional bus drivers is likely to be problematic in counties that operate their own transportation departments. One county superintendent indicated that, "We hardly have any substitute drivers and are struggling to find employees willing to go through the training, obtain the correct driver endorsement that don't either have a criminal record or driving record. I would almost guarantee that we could not comply."

3. Superintendents noted the following issues:
    a. Families are dependent on older children to provide childcare for younger children after school.
    b. Families seem more willing to allow a younger child to leave home unsupervised in the morning than to have them return to an empty home after school.
    c. Secondary sports and other activities (practices and events) are set up on the framework of mid-afternoon dismissal/practice/part-time jobs/homework. Any change involves multiple stakeholders.
    d. Moving the start time back will reduce the bus service window (i.e. 6:00 a.m. to 5:00 p.m. for to-and-from school), reducing

evening. This should be a local decision rather than one that is impacted by state dictated start or end time for schools.

Superintendents are fundamentally committed to the health and wellness of our students. At the same time, this issue of changing school start times, if legislated, will have numerous unintended consequences and will result in substantial increased transportation costs. This comes at the same time as local school systems are making curricular changes in response to Maryland College and Career Readiness Standards and Next Generation Science Standards, are preparing to implement new state assessments PARCC on line, are responding to State Board student disciplinary regulations, while operating the largest organizations in many communities in their counties. For these reasons, superintendents believe these decisions are best made by local school boards.

Appendix D: Statement from Ned Sparks, Executive Director, Athletic Programs, MSDE

Ned Sparks
Executive Director, Athletic Programs
Maryland State Department of Education

Modification of School Day Impact on Interscholastic Athletics

Interscholastic athletics is an integral component of Maryland schools. Last year over 113,000 students participated in athletics in Maryland public high schools. The current school day provides for a mid-afternoon dismissal thus allowing for practice, competition and return home at a reasonable evening hour, mostly before night fall.

A modification to school starting time will result in some school teams that share facilities needing to schedule practice prior to the start of school thus negating benefits of a later start time.

In addition, a later ending of the school day will push back game times and thus a later arrival back to school following an away game. This will require students who drive to school to be on the road at a later hour then most parents would consider being a reasonable time.

This issue is better left to decisions make on the local level.

Appendix E: Fairfax County Public Schools' Sampling of Select School Districts with Later Start Times

From *School Start Time Change: An In-Depth Examination of School Districts in the United States*
The Children's National Medical Center's Blueprint for Change Team

School District	Year	Original Bell Times	Current Bell Times	#Students #Schools	Change Strategy	Additional Strategy	Comments
Pulaski County Special SD, Arkansas	2012	HS: 7:30-2:40 MS: 7:30-2:40 ES: 7:20-2:20	HS: 8:35-3:45 MS: 8:20-8:40 ES: 7:20-2:20 7:50-2:35	17,501 38	Flip ES with HS & MS 1 tier to 2 HS late	Announced change in January to allow parents to make changes.	State's 2nd largest district. Change done to improve sleep health & savings on buses.
Bentonville, Arkansas	2007	HS: 7:45-2:45 MS: 8:00-3:00 ES: 8:00-3:00	HS: 8:45-3:45 MS: 7:40-2:40 ES: 7:30-2:30	11,100 14	Flip HS with MS and ES	HS uses A/B block schedule.	Change due to address sleep health & growing traffic issues. Cost savings.
Albany Unified SD, California	2014	HS: 7:40-3:10 MS: 8:00-3:05 ES: 8:30-3:05	HS: 8:00-3:30 MS: 8:00-3:05 ES: 8:30-3:05	3,807 6	20 min shift as pilot HS/MS	Evaluate and consider future changes. Elimination of MS 7:00 zero hour proposed.	HS principal very influential in promoting sleep science.
Long Beach Unified SD, California	2014	HS: 7:50-2:40 MS: 8:00-2:40 ES: n/a	HS: 8:50-3:40 MS: 9:00-3:40 ES: 8:00-2:10 ES: 9:00-3:10	81,000 84	Pilot in 1 HS and changed ½ of all MS	ES have 40 min. preparation period on 1 day during the week.	3rd largest district in state. Primary impetus for change was cost savings. ½ of MS already start at 9:00.
Denver PS, Colorado	2005	HS: 7:30-2:30 MS: 7:25-2:55 ES: 8:15-3:10 9:00-3:55	HS: 7:30-4:30 MS: 7:25-2:55 ES: 8:15-3:10 9:00-3:55	84,424 176	Added 2 hours to HS day for flexibility. Students pick their own start and end times.	District provides public transportation passes to eligible students & allows for flexible schedules.	Superintendent used change to allow students to choose their schedule. Saved $750,000 & 60 buses.
Colorado Springs District 11, Colorado	2000	HS: n/a MS: n/a ES: n/a	HS: 7:40-3:00 MS: 8:45-3:45 ES: 8:00-2:30	30,296 60	HS shift.	Superintendent formed task force to improve sleep, attendance & academics.	HSST still before 8:00.
Academy District 20, Colorado	2013	HS: 7:05-2:10 MS: 7:25-2:25 ES: n/a	HS: 7:45-2:45 MS: 7:45-2:45 8:30-3:30 ES: 8:45-3:45	22,460 35	HS/MS shift.	ES to start no later than 8:45. Reduced tiers from 4 to 3. Rolling MS Window.	Decision based on sleep health & transportation efficiencies.
Wilton PS, Connecticut	2003	HS: 7:35-2:10 MS: 7:35-2:10 ES: 8:15-2:45	HS: 8:15-2:50 MS: 8:15-2:50 ES: 7:40-2:10	4,300 5	HS (6-12) and ES Flip	Inspired by a senator, a community group formed a task force to study the issue & conduct outreach. Conducted survey of students after change.	Students reported to be more alert and better behaved. More participation in HS athletics & ES after school activities. HS students reported high satisfaction & 35 mins. more sleep.

School District	Year	Original Bell Times	Current Bell Times	#Students #Schools	Change Strategy	Additional Strategy	Comments
West Hartford SD, Connecticut	2007	HS: 7:30-2:15 MS: n/a ES: n/a	HS: 7:30-2:15 8:15-2:15 MS: 8:00-2:50 ES: 8:35-3:20	10,222 16	Flex time for HS.	Made first hour a study hall & allowed students to use "flex" time to start 2nd period.	District reported positive impacts on emotional health, stress & academic performance.
Milford County SD, Delaware	2012	HS: n/a MS: n/a ES: n/a	HS: 8:16-3:20 MS: 8:00-3:00 ES: 7:45-2:15	4,195 6	HS and ES flip.	Superintendent led. HS start at 9:35 on Wed. Block scheduling.	Decision based on sleep health, improvements in learning & bus cost savings.
Brevard PS, Florida	2000	HS: 7:30 -2:15 MS: 8:50-3:35 ES: 9:50-4:20	HS 8:30-3:15 MS: 9:15-4:00 ES: 8:00-2:30	96,000 137	HS/MS shift. ES moves earlier.	MS activities changed to before school with own transportation required.	District reported large reduction in tardiness & absences.
Santa Rosa County SD, Florida	2006	HS: 8:00-2:45 MS: 8:20-2:55 ES: 7:30-1:30	HS: 9:15-3:15 MS: 8:30-2:30 ES: 7:30-1:30	26,144 36 200 buses	HS shift.	Used 3-tier bus system, MS & ED rolling windows.	Increased graduation rates, decreased delinquency & lowered bus costs.
Marion County PS, Florida	2002	HS: n/a MS: n/a ES: n/a	HS: 8:35- 3:05 9:20-4:15 MS: 7:50-1:45 9:25-3:25 ES: 7:45-2:20	43,123 51	HS shift.	Added a MS rolling window.	
Bonneville Joint SD, Idaho	2000	HS: 7:45-2:39 MS: n/a ES: n/a	HS: 8:45-3:39 MS: 7:15-1-30 8:45-3:34 ES: 8:05-2:31 8:25-2:51	11,200 21	HS shift.	Superintendent led based on sleep science.	Study showed absences dropped 15% & tardiness 22%. Students got 44 min. more sleep on average.
Harlem School District 122, Illinois	2007	HS: n/a MS: n/a ES: n/a	HS: 8:55-3:46 MS: 8:55-3:46 ES: 8:10-2:45	6,721 11	HS/ES flip.	Superintendent & school board led the effort due to concern about sleep health of students.	Teachers' union defeated 1st effort, but a new contract allowed a start time change of up to 90 min. without union approval. District reported $750,000 in savings.
Fayette County PS, Kentucky	1996	HS: 7:30-2:20 MS: 8:00-2:50 ES: Abt. 8:30	HS: 8:25-3:15 MS: 9:05-3:55 ES: 7:45-2:35	40,000 66	HS/ES flip.	Parents went school board after *earlier* HS times were 1st proposed. Superintendent was looking for way to boost attendance. Pre & post studies conducted. Plan was announced 10 months ahead of change.	Pre & post study 1 year after showed improved sleep & reduced auto crashes, increased sleep across all grades. District reported better attendance & a decrease in tardiness in 1999.
Jessamine County, Kentucky	Prior to 2005	HS: 7:30-2:15 MS: 7:40-2:25 ES: 8:30-3:15	HS: 8:40-3:25 MS: 8:50-3:35 ES: 8:00-2:45	7,000 11	MS/HS shift. ES 30 min. earlier.	Superintendent led. Community & student engagement was key.	Change based on sleep health. District reported lower tardiness & increased attendance.

School District	Year	Original Bell Times	Current Bell Times	#Students #Schools	Change Strategy	Additional Strategy	Comments
Needham, Mass.	2004	HS: 7:40-2:20 MS: 7:40-1:55 ES: 8:20-2:30 9:00-3:00	HS: 8:00-2:35 MS: 7:50-2:10 ES: 8:35-2:35	5,523 8	HS shift.	Superintendent formed advisory committee to study all issues.	Change based on concerns about sleep health.
North Andover PS, Mass.	2011	HS: 7:15-1:57 MS: 7:20-2:05 ES: 8:15-2:50	HS: 7:40-2:15 MS: 7:55-2:20 ES: 8:35-3:00	4,502 7	All shifted	Superintendent formed advisory committee to collect research, speak to sleep experts & conduct stakeholder meetings.	Did not shift as much as recommended. Reported outcomes included improved grades & attendance & decreased tardiness & disciplinary action.
Holyoke PS, Mass.	2005	HS: 7:15-1:52 MS: 7:15-1:52 ES: 9:05-3:05	HS: 8:15-2:52 MS: 8:15-2:52 ES: 9:05-3:05	5,573 14	Shift HS & MS	School board led based on sleep science.	School Board voted with hopes to improve sleep & tardiness.
Topsham PS, Maine	2005	HS: 7:30-2:00 MS: 7:20-2:00 ES: n/a	HS: 7:50-2:21 MS: 7:40-2:10 ES: 8:55-3:15	2,739 7	MS & HS shift	HS & MS shared buses.	Transportation cost savings.
Brunswick County PS, Maine	2001	HS: 7:25-1:50 MS: 7:40-2:10 ES: 8:40-2:55	HS: 7:45-2:10 MS: 8:08-2:30 ES: 9:00-3:30	2,645 5	MS/HS 30 min. shift. ES 15 min. shift	Superintendent & school board influenced by neighboring Topsham district & sleep science. Conducted district-wide student survey.	Decision based on sleep health & community & student body support.
Edina PS, Minnesota	1996	HS: 7:25-2:10 MS: n/a ES: n/a	HS: 8:25-3:10 MS: 7:40-2:38 ES: 8:30-3:05 9:15-3:50	8,300 9	HS shift.	Superintendent led based on sleep science & MN Medical Association recommend-ations.	One of the first districts to change; outcomes extensively documented. One year after, 92% of parents preferred the change. Decline in tardiness & absenteeism reported.
Mahtomedi PS, Minn.	2002	HS: 7:30-2:10 MS: n/a ES: n/a	HS: 8:00-2:30 MS: 8:00-2:30 ES: 9:10-3:30	3,305 4	HS/ES flip.	Encouraged use of personal transportation. 4-period day before & after change. Students agreed to shorten "passing" time between classes.	District saw improved attendance, test scores & grades. Decreased costs & tardiness rates. 65% decrease in auto crashes.
Minneapolis PS, Minn.	1997	HS: 7:15-1:45 MS: 7:05-1:35 ES: 9:40-4:10	HS: 8:10-3:00 8:35-3:00 MS: 9:40-4:10 ES: 7:30-2:00 8:05 -2:35	36,370 75	HS/MS flip.	School board led to reduce transportation costs. Sleep health of students was secondary motivation.	Most extensively documented outcomes of all school districts delaying start times. Students reported more sleep & fewer depressive symptoms. Lower tardiness rates also reported.

School District	Year	Original Bell Times	Current Bell Times	#Students #Schools	Change Strategy	Additional Strategy	Comments
South Washington County, Minnesota	2009	HS: 7:35-2:05 MS: 7:30-2:00 ES: n/a	HS: 8:35-3:05 MS: 7:55-2:25 ES: 8:10-2:40 9:20-3:50	17,418 26	HS/MS shifted later.	Superintendent formed task force to study to optimize learning & sleep. Initiated a 4x4 block schedule.	Part of 2014 study. Grades in 1st and 3rd period classes rose by as much as a full point. Scores on standardized tests improved. 58% of HS students slept 8 hrs. or more. Auto crashes fell by 6%.
Hattiesburg PSD, Mississippi	2013	HS: 7:20-2:45 MS: 8:30-3:50 ES: n/a	HS: 8:30-3:50 MS: 7:30-2:45 ES: 8:00-3:00	4,528 10	MS/HS flip.	Superintendent implemented in the last few days of the previous school year as an experiment.	Changed based on sleep science.
Ithaca City SD, New York	2006	HS: 8:00-2:37 MS: 8:00-2:21 ES: 7:55-1:55 9:00-3:00	HS: 8:55-3:32 MS: 9:10-3:25 ES: 8:00-2:00	5,273 11	HS/MS shift.	Superintendent led because buses were not arriving on time & students were late. Sleep expert's advocacy over a few years helped bring the change. Discussions held with employers, athletic clubs & public at board meetings.	Change primarily made to reduce bus costs. District realized about $400-600K.
Moore County, North Carolina	2012	HS: 8:00-3:00 MS: n/a ES: 8:00	HS: 9:00-4:00 MS: 8:00-3:00 ES: 7:45/7:30	12,491 23	HS shift	Implemented 2-tiered bus system.	Saved $700,000 in transportation costs.
Hudson City, Ohio	2010	HS: 7:30-2:30 MS: 7:20-2:10 ES: 8:30-9:15	HS: 8:00-3:00 MS: 7:56-2:50 ES: 8:55-3:40	4,941 6	All shifted later.	Superintendent & school board formed advisory committee to review health, transportation, outreach, & other school districts. Subcommittees held separate public meetings & conducted surveys. Phased-in over three years.	The whole process took about two years. Superintendent & school board worked together to study the issues & gain public support.
North Clackamas SD, Oregon	1999	HS: 7:30-2:20 MS: n/a ES: n/a	HS: 8:45-3:20 MS: 9:30-4:05 ES: 8:20-2:45	17,439 31	HS shift.	HS principals pushed change for a decade. Full year study proceeded change.	Improved attendance & GPA in 1st period. Large community acceptance.
Beaufort County SD, South Carolina	2014	HS: 7:45-2:30 MS: n/a ES: n/a	HS: 8:35-3:25 MS: 7:15-2:30 ES: 8:30-3:30	20,000 36	Pilot 1 HS first.	HS principal led pilot based on sleep science provided by the superintendent. Students gave feedback.	Evaluation is expected following the 1-year pilot period.

School District	Year	Original Bell Times	Current Bell Times	#Students #Schools	Change Strategy	Additional Strategy	Comments
Dallas ISD, Texas	1990s & 2014	HS: n/a MS: n/a ES: n/a	HS: 9:15-4:15 MS: 8:35-3:35 ES: 7:55-2:55	158,932	HS shift.	Changed in the 90s, but little info exists.	Delayed HSs an additional 15 mins in 2014.
Austin ISD, Texas	1990s	HS: n/a MS: n/a ES: n/a	HS: 9:00-4:10 MS: 8:20-3:30 ES: 7:45-2:25	87,000 158	HS shift.	No public records could be found regarding change.	Large district where community works around the district's bell times.
Arlington, Virginia PS	2001	HS: 7:30-2:15 MS: 8:10-2:45 ES: 8:30-3:10	HS: 8:19-3:01 MS: 7:50-2:24 ES: 8:00-2:40 9:00-3:40	19,000 38	HS/MS flip.	School board & superintendent formed a large task force with working groups. Formed district team for implementation. 4-tier bus system.	Teachers & parents reported students were more alert & focused. Teachers raised concerns, but none left the district.
Bedford County PS, Virginia	2013	HS: 8:30-3:00 MS: 8:30-3:00 ES: 8:30-3:00	HS: 8:55-3:35 MS: 8:55-3:35 ES: 7:55-2:35	10,000 21	HS/MS flip with ES.	Added tier to bus system & students shared buses. Added online early classes & early dismissal for athletes.	Changes led to cost savings.
Loudoun County PS, Virginia	1954	HS: 9:00-3:48 MS: 8:30-3:18 ES: 7:50-2:35	HS: 9:00-3:48 MS: 8:30-3:18 ES: 7:50-2:35	70,000 82 854 buses	Never changed.	Same bell schedule since 1954.	Community built programs around existing schedules
River Falls SD, Wisconsin	2011	HS: 7:25-2:35 MS: 7:30-2:35 ES: 8:35-3:40	HS: 7:45-2:50 MS: 7:45-2:50 ES: 8:45-3:50	3,109 8	15 minute shift for all.	Superintendent formed committee. Surveyed parents, staff & others. Added change goal to strategic plan.	Change based on sleep science. Bell times did not change as much as leadership recommended.

PS = Public Schools
ISD = Independent School District
SD = School District

Appendix F: 2013 Maryland Youth Risk Behavior Survey Middle School Student Survey sample

Question 72 of the 2013 Youth Risk Behavior Survey (YRBS) asked middle school students about whether they got eight or more hours of sleep on an average school night (the question was not asked of high school students in 2013). Summary data is shown in Figure 1.

QN72: Percentage of students who get eight or more hours of sleep on average school night

	Total			Male			Female		
	Percentage	95% confidence interval	N	Percentage	95% confidence interval	N	Percentage	95% confidence interval	N
Total	53.5	(52.0 - 55.0)	25,522	55.2	(53.5 - 56.9)	12,650	51.9	(50.1 - 53.7)	12,771
Age									
11 or younger	65.3	(62.7 - 67.8)	3,577	67.2	(64.0 - 70.3)	1,696	64.0	(60.4 - 67.4)	1,871
12	59.9	(58.0 - 61.7)	8,607	61.4	(59.1 - 63.7)	4,206	58.5	(56.0 - 61.0)	4,378
13	49.1	(47.3 - 50.9)	8,170	52.1	(49.4 - 54.7)	4,477	46.3	(44.2 - 48.5)	4,670
14 or older	41.0	(39.0 - 43.1)	4,107	42.3	(39.6 - 45.0)	2,254	39.3	(35.8 - 42.9)	1,838
Grade									
6th	63.8	(61.7 - 65.8)	7,864	64.4	(62.2 - 66.5)	3,891	63.3	(60.7 - 65.9)	3,954
7th	53.4	(51.4 - 55.4)	8,976	55.4	(53.0 - 57.8)	4,417	51.5	(49.0 - 54.1)	4,543
8th	44.6	(42.8 - 46.4)	8,384	46.9	(44.5 - 49.6)	4,209	42.3	(40.0 - 44.6)	4,158
Race/Ethnicity									
Black*	46.6	(44.8 - 48.5)	5,570	47.3	(44.5 - 50.2)	2,752	45.9	(43.8 - 48.0)	2,804
Hispanic/Latino	49.2	(46.1 - 52.2)	2,844	52.2	(47.9 - 56.4)	1,405	46.5	(42.1 - 50.9)	1,417
White*	59.4	(57.8 - 60.9)	12,310	61.7	(59.7 - 63.7)	6,052	57.1	(55.1 - 59.0)	6,242
All other races	56.2	(52.5 - 59.7)	1,842	57.9	(53.5 - 62.2)	997	54.2	(48.6 - 59.7)	843
Multiple races	48.8	(44.4 - 53.2)	1,478	53.0	(47.0 - 58.8)	666	45.6	(40.9 - 50.5)	808

Table 1: Summary table, 2013 Maryland YRBS Middle School Student Survey, showing percentage of students surveyed who reported getting 8+ hours of sleep on an average school night. Weighted data; 1445 students were excluded from this analysis
*Non-Hispanic; N = number of students in this subgroup

Analysis of data gathered from 25522 students (55.2% male and 51.9% female) showed that age (range 11 to 14 year olds) was strongly associated with the percentage of students in each age group who reported sleeping 8+ hours per night. This was a strong inverse, linear association, i.e. the percentage reporting adequate sleep varies inversely with the age of the student. A graphical depiction is shown in Figure 2.

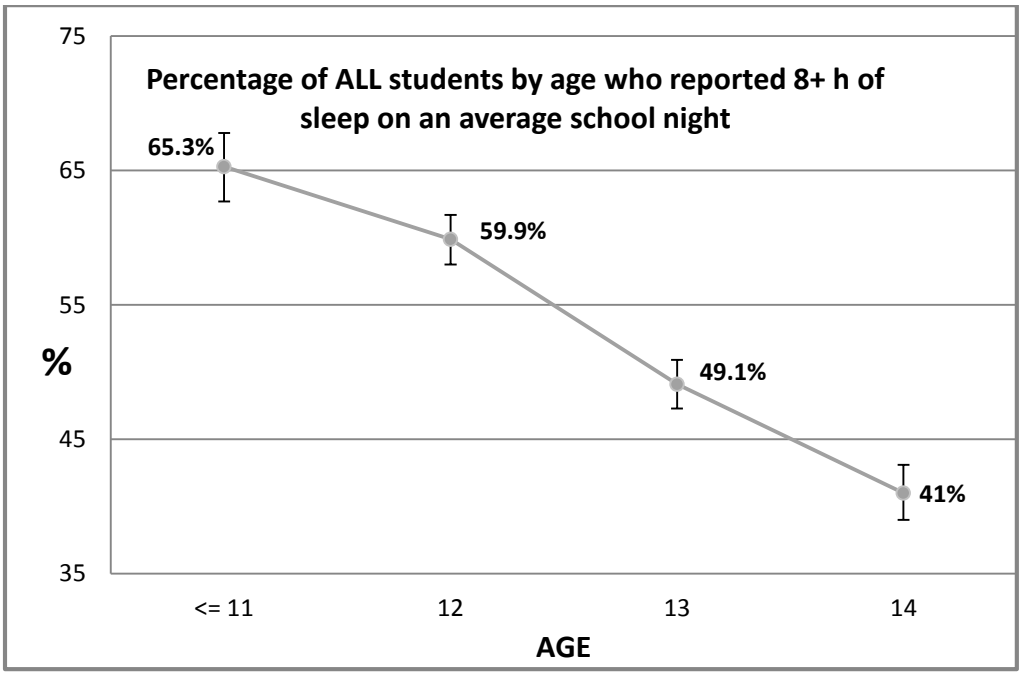

Figure 2: Summary statistics, 2013 Maryland YRBS Middle School Student Survey, showing percentage of all students surveyed who reported getting 8+ hours of sleep per night (vertical axis), by age

Non-overlapping 95% confidence intervals, represented by error bars in Figure 2, suggest that the percentage of students reporting 8+ hours of sleep differs significantly for each age pair, i.e. 11 year olds report significantly more sleep than 12, 13 and 14 year olds; 12 year olds report significantly more sleep than 11, 13 and 14 year olds, and so on. A strong trend is also observed here, with the proportion of students reporting 8 or more hours of sleep varying inversely with student age.

When stratified by sex, the proportion of males and females reporting 8 or more hours of sleep also follows a strong trend (Figure 3), with a comparable inverse association in both sexes. Again, there were significant differences observed when comparing age groups, for both sexes, but only among 13 year-olds was there a significant difference in reported sleep between male and female students.

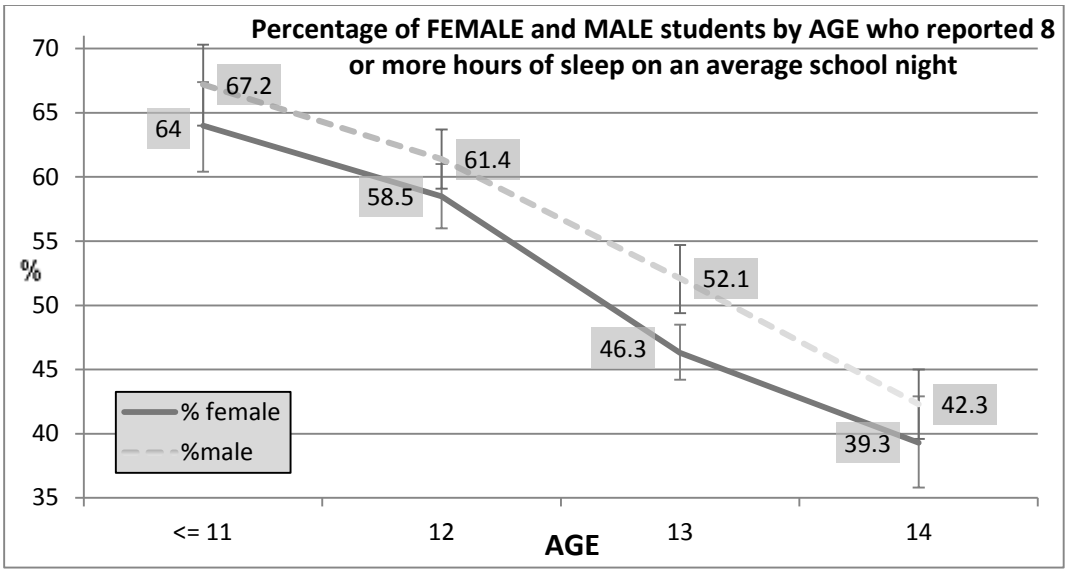

Figure 3: Summary statistics, 2013 Maryland YRBS Middle School Student Survey, showing percentage of all students surveyed who reported getting 8 or more hours of sleep per night (vertical axis), by age and sex

Analysis of data by grade level showed that grade (among 6th, 7th, and 8th graders) was strongly associated with the percentage of students in each grade who slept 8 or more hours of sleep per night. This was a very strong inverse, linear association, where the proportion of students in each grade reporting 8 or more hours of sleep varied inversely with grade level. Lastly, there were significant differences (among all three grades) in the proportion of students in each grade reporting 8 or more hours of sleep, as shown below by widely separated 95% confidence interval error bars (Figure 4).

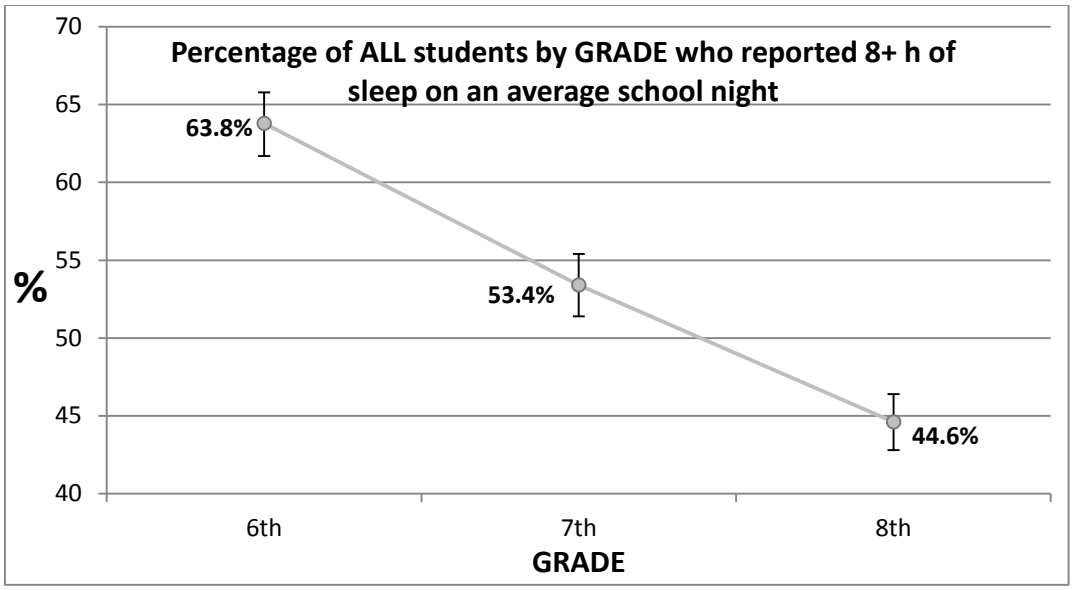

Figure 4: Summary statistics, 2013 Maryland YRBS Middle School Student Survey, showing percentage of all students surveyed who reported getting 8+ hours of sleep per night (vertical axis), by grade

When stratified by sex, the proportion of males and females in each grade reporting 8 or more hours of sleep also follows a strong trend (Figure 5), with a comparable inverse, linear association in males across grade level and in females across grade levels. Significant differences are noted between all grades in pairwise comparisons for males, and for females. Within each grade, the proportion of males reporting 8 or more hours of sleep does not differ significantly from the proportion of females reporting 8 or more hours of sleep.

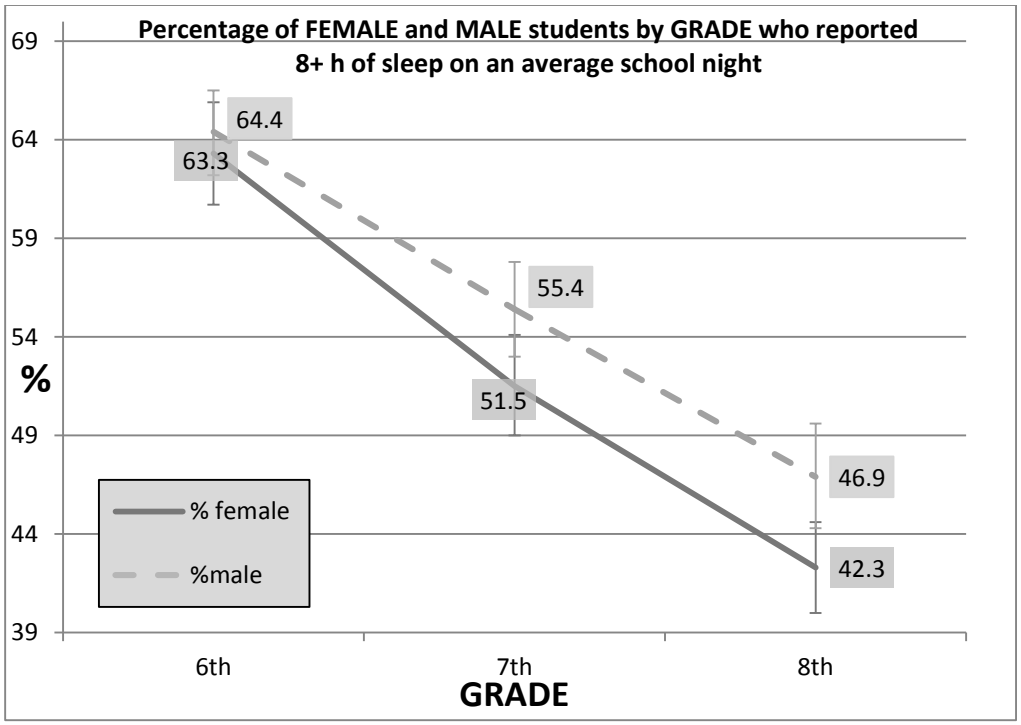

Figure 5: Summary statistics, 2013 Maryland YRBS Middle School Student Survey, showing percentage of all students surveyed who reported getting 8+ hours of sleep per night (vertical axis), by grade and sex

Student self-described race and ethnicity was captured by category as follows: Black (non-Hispanic), White (non-Hispanic); Hispanic/ Latino; multiple races, and all other races. Analysis of data by race/ ethnicity showed that nearly 60% of students who self-described as White reported getting >=8 hours of sleep per night, as compared to less than 50% of students who identified as Hispanic/ Latino, as "multiple races", or as Black. Nearly 60% of those who self-described as "all other races" also reported getting at least 8 hours of sleep per night. The percentage of students identifying as White reporting at least 8 hours of sleep nightly differed significantly from the percentage of students reporting 8+ hours of sleep in nearly every other group (except those identifying as “all other races”), suggesting that, in this population, significantly more White students get 8+ hours of sleep on weeknights than students in most other racial/ ethnic groups. Students self-describing as “all other races” also reported getting 8+ hours of sleep in significantly higher proportion than students identifying as Hispanic/Latino, as “multiple races”, and as Black. Students identifying as Black reported 8+ hours of sleep in the lowest proportion (46.6%) among all groups (Figure 6).

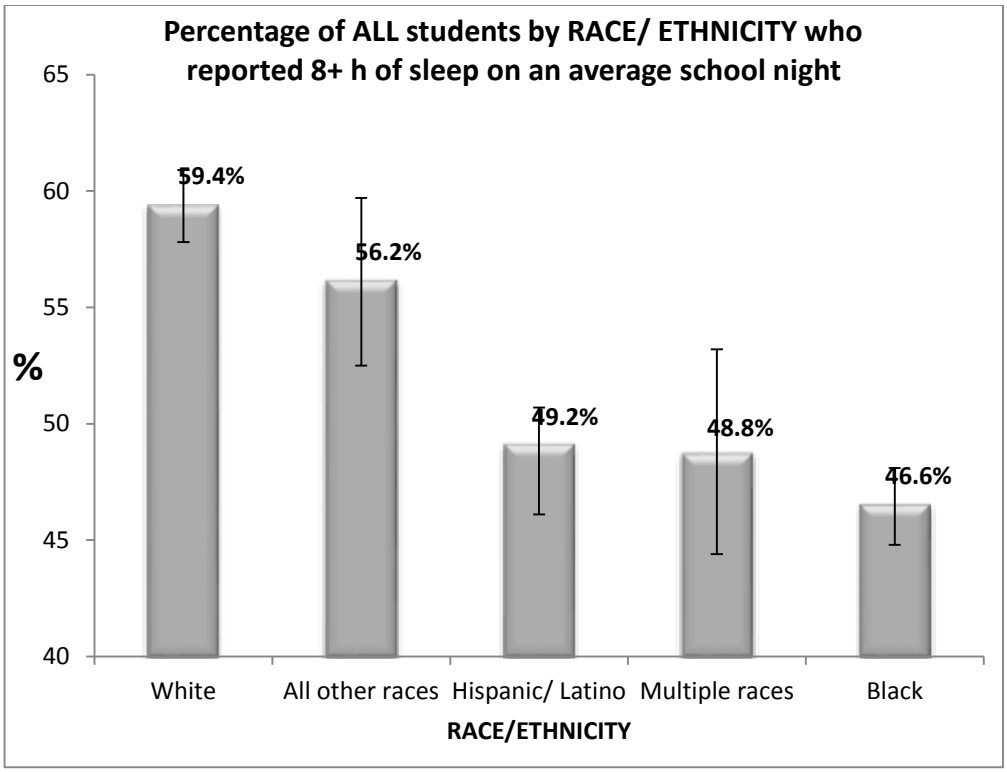

Figure 6: Summary statistics, 2013 Maryland YRBS Middle School Student Survey, showing percentage of all students surveyed who reported getting 8+ hours of sleep per night (vertical axis), by race/ ethnicity

When stratified by sex, analysis of data by race/ ethnicity showed that females reported 8+ hours of sleep in lower proportions than males in every racial/ ethnic group, although this difference appeared to be significant only among students who identified as White. More than 60% of male students who self-described as White reported getting 8+ hours of sleep per night, as compared to less than 50% of male students who identified as Black. Other male students ("all other" and "multiple" races, and Hispanic/ Latino) reported 8+ hours of sleep in proportions between 50 and 60%.

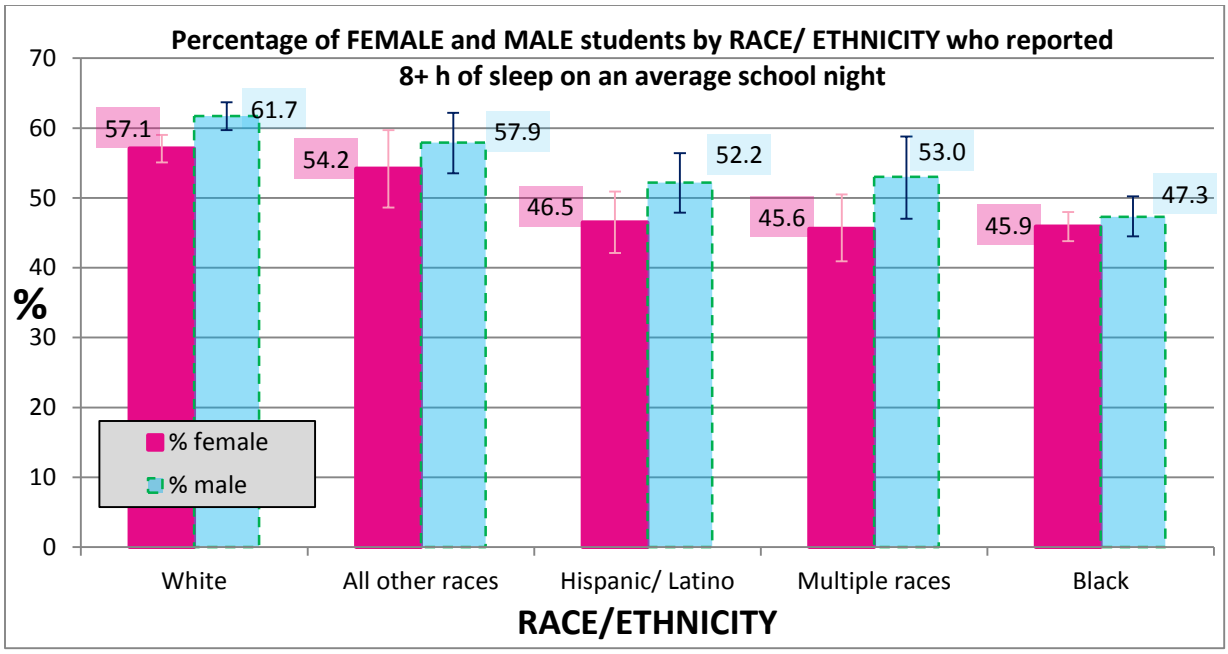

Figure 7: Summary statistics, 2013 Maryland YRBS Middle School Student Survey, showing percentage of male and female students surveyed who reported getting 8+ hours of sleep per night (vertical axis), by race/ ethnicity

In pairwise comparisons across all groups, among female students (Figure 7), significant differences in sleep reported are seen between self-identified White female students and all groups except "all other races". Similar differences are also seen between "all other races" females and Black females. No significant differences were seen among students identifying as Black, Hispanic/ Latino and "multiple races".

Among male students (Figure 7), significant differences were noted between White and other groups, with the exception of "all other races", similar to what was seen among female students. Significant differences were noted between those identifying as "all other races" and Black students as well.

Taken together, the analysis of the summarized 2013 YRBS data support the findings seen in the literature: that young people get less sleep as they get older; that, in general, boys tend to get more sleep than girls, and that there are racial and ethnic disparities in terms of sleep reported for school nights.

Strengths/ Limitations of this data analysis: The analyses above are of weighted, summary data (Figure 1). As such, these cannot be analyzed with more precision without raw data. Additionally, differences between those who responded to question 72 and those who did not are not addressed. These differences, if any exist, could affect the measures of association noted, but are not practical to address in a survey of this type. The responses to Question 72 are based upon self-report, and self-reported data is subject to social desirability bias as noted previously in this report, and to bias from misjudging or misremembering the true amount of sleep. While subjects would not be expected to remember, or even to judge the amount of sleep differently across age, grade or racial/ ethnic groups, social desirability bias could certainly be differential across ages, grades or races and/ or ethnicities, but not in any predictable way. Thus, the effect on the associations noted above is uncertain.

Healthy School Start Times Study: *Summary of Expert Interviews*

November 2014

Submitted to:
The Office of School Health, Health Systems and Infrastructure Administration, Maryland Department of Health and Mental Hygiene
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About the Center on Young Adult Health and Development

The Center on Young Adult Health and Development (CYAHD) was established at the University of Maryland School of Public Health in 2009. This research center is one of the first such centers in the United States specifically dedicated to understanding the health and development of young adults. More information about CYAHD can be found at www.cyahd.umd.edu.

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Summary of Findings

HB883 was passed by the Maryland State Legislature in 2014 and required the Maryland Department of Health and Mental Hygiene (DHMH) to describe the current state of scientific evidence regarding school start times for adolescents. The DHMH was tasked with gathering information on school start times from a multi-disciplinary group of experts. At the request of the DHMH, researchers at the University of Maryland School of Public Health designed an interview and conducted telephone interviews with nine experts (see *Expert Biographies*). The following narrative synthesizes the findings of the experts that were interviewed for this purpose. Importantly, the material contained in this report directly reflects the opinions of the experts that were interviewed.

Experts were very consistent in their responses to the interview questions about sleep needs, factors influencing the quality and quantity of sleep, the negative consequences of sleep deprivation, and the implications of changing school start times on child and adolescent health. There was an overwhelmingly positive response to the idea of delaying school start times for middle and high school children to improve their health, safety, and well-being. In short, sleep deprivation is common among children and adolescents and it has adverse consequences for physical health, cognitive and emotional development, nutritional status, and risk-taking behavior, all of which can negatively impact academic performance and risk for accidental injury. While the complexity of these issues was unanimously recognized by all experts, they all expressed the belief that the current school start times in Maryland are not concordant with adolescent biology, and therefore is one factor, through environmental policy change, that should be changed. Such a change, according to these experts, would have an overall positive impact on health.

Normal Developmental Sleep Needs of Children

Although significant variation exists both within and between children, elementary school children are thought to need between 10 and 12 hours of sleep per night, with middle school children needing a bit less—between 9 and 10 hours, and high school children needing between 8.5 and 9.5 hours. Interestingly, some experts noted that while the total amount of sleep that high school children need tends to decrease slightly relative to middle school children, sleep needs actually increase during their growth spurts.

The point was made that duration of sleep is often used as a proxy for adequate sleep, but quantity does not always equate with quality sleep. Sleep needs are task-dependent—that is, you need more or less depending upon what you need to do the next day. A recent review showed that the recommendations for the amount of sleep that children need has decreased by about seven minutes per year since the early 1900s.

Biologically, sleep is regulated by two processes. First is Process S (i.e., sleep-wake homeostasis or sleep drive). Process S is pressure for sleep—the longer you go without sleep, the more pressure builds up. In adolescence, sleep drive begins to accumulate more slowly, and thus, they do not need as much sleep as younger children.

The second process is Process C, or the circadian rhythm, which is tied in with environmental cues. As children reach puberty, the time at which they get sleepy naturally shifts two to three hours later, due specifically to a delay in the secretion of melatonin. The time that they feel sleepy gets later (11pm) and they wake up around 8am. There is also a shift from a preference for morning activity to evening activity. Sleep time for younger children is generally by 9pm and wake time is around 6 or 7am. Younger children tend to naturally fall asleep earlier and wake up earlier than older children. However, it is more difficult for older children to fall asleep early and more difficult for them to wake up early.

Younger and older children also differ with respect to the regulation of routines by parents, with younger children's routines being much more regulated by their parents. It is harder for parents to structure sleep time for teens than younger children. Moreover, younger children are much more reactive to their parents' routines and schedules. For instance, a younger child might wake up in the middle of the night when their parents arrive home from a late-night work shift, but an older teen might not be so sensitive to this.

Factors Influencing the Quality and Quantity of Children's Sleep

Parents

Parents have a major influence on the quality and quantity of children's sleep in several ways. Parents can play a large role in regulating the sleep of younger children because they can create a healthy sleep environment, check on them to make sure they are asleep, and can help them fall asleep. This is more difficult with older children because older children tend to go to bed later and parents might be going to sleep before them.

Parents of younger children can and should establish bedtime and wake-time rules. These rules are easier to set when children are younger than when they are older, but parents should still try to set rules as children get older. Parents can also set rules around avoiding electronics around bedtime, abstaining from caffeine, and in general, they need to set regular routines to encourage stability in the environment and promote healthy behavior. The practice of good sleep hygiene is carried into college and adulthood, and setting routines early in life helps to reinforce its importance.

Parents also provide structure to the household. Regardless of age, limits should be set on what activities take place prior to going to sleep. Experts stressed the importance of setting these rules while the children are young, so that when a child is older, they are used to routines (and they are used to the idea that their parents set rules). School days and weekends can perhaps be different with regard to the rigidity of the rules, with weekends being a bit more relaxed.

Establishing healthy sleep routines is an important parental responsibility. Parents should encourage a process or transition of going to bed, as well as do things to promote sleepiness and reduce distractions. As children grow into adolescence, there should be a graduated level of independence. For families with economic concerns, crowding in the household (e.g., sharing of bedrooms) can cause disruptions when the sleep times for household members is different.

Parental awareness of the importance of sleep as well as their children's sleeping patterns is also very important. Parents of younger children are often more in tune with their child's routines compared with when the child gets older. Parents can ask about their sleep routine (e.g., what helps them relax, what concerns they have about sleep), and give them choices for the sleep routine. Parents are still needed throughout development, especially for basic guidelines and rules at home. They tend to relinquish control as children get older, and that might not be entirely prudent because they overestimate the extent to which their adolescent children are getting enough sleep. Parents are less likely to supervise bedtime and wake times for older children. For example, parents that go to bed before their adolescent children might be unaware about technology use late at night or bedtime routines. This is unfortunate because older children need regularity in their sleep schedule too.

Parents can model good sleep hygiene for their children. Even when parents have to work multiple jobs and might not be getting a lot of sleep, they need to try and explain the difference between adult

responsibilities and the needs of children. They have to be role models for healthy behaviors, which might also include moderation of their own caffeine intake.

Parental education about the importance of sleep and regularity of sleep schedules is important. Parents should explain to their children why sleep is important. They can motivate compliance by having rewards for good behavior. They can also influence the choices their children make about the activities they are involved in—and "kids do not need to be involved with five million activities".

> *"Parents can influence children's sleep habits in a very positive way. First, by enforcing a consistent schedule that children have for going to bed and waking up. Second, they can encourage children to get enough sleep. Third, they have a lot of input into how children live their life in general, and the important need for sleep as part of a healthy life should be emphasized by parents. They should also try to encourage their children to have a sleep-wake up cycle that is biologically appropriate for their age."*[1]

Schools

Most importantly, schools need to set a culture that promotes healthy sleep patterns as well as a structure that encourages it. Schools should have start times that are not counter to adolescent biology. It is clear from sleep science that high school students naturally have more difficulty going to sleep early and waking up early, so policies should be concordant with that biology.

Changing school start times to coincide better with natural sleep cycles of adolescents is a "necessary but not sufficient" approach to address the chronic sleep deprivation that many adolescents are experiencing.

> *"With respect to school schedules, we should change school start times. When kids get up too early, they'll be too tired when they finally arrive at school. And often they will fall asleep in class—that's a real problem."*
>
> *"Changing school start times to be more compatible with natural sleep cycles of adolescents is a social constraint that will help reduce chronic sleep deprivation. Policies and changing the environment are key methods to improve public health—this has been proven to be the case over and over again. For instance, removing vending machines to promote less snacking, or making places to smoke less available to reduce smoking."*

In addition to start times, schools need to be mindful of the scheduling of before and after school activities. If school activities are scheduled in the evening or at night, children will likely have trouble completing homework, participating in the activity, and still going to sleep at a healthy time. Likewise, scheduling activities too early in the morning can also disrupt a healthy sleep schedule. Late and early activities can be seen as conflicting with messages about healthy sleep thus diminishing the influence of those messages.

[1] Due to the expert interviews not being recorded, all items marked as quotes in this report are based on the interviewer's paraphrasing of the expert's comments.

Second, schools can incorporate a lot more information about sleep into educational programming in the health curriculum. Schools can provide messages about how sleep is just as important as diet and exercise. Schools should make sleep education one of their priorities in health education, just like abstaining from smoking, drinking, and using drugs, and wearing seatbelts. The best methods for getting a good night's sleep can be part of the curriculum. Schools can also function as a source of education for parents by providing informational brochures or education programs at PTA meetings.

Third, there should be a greater emphasis on quality of homework rather than quantity of homework. The level of homework being given to kids is excessive. A "treadmill lifestyle" should not be encouraged. Rather there should be more of a focus on the quality of work done during the day rather than requiring a lot of work to be done at home. For many achievement-oriented kids, handling that amount of homework in addition to taking on a lot of extracurricular activities is a cause of a lot of stress. One expert noted that "the battle over sleep" is a common source of family conflict. Kids feel that they have to stay awake to get so much done, and parents get frustrated. Parents are often advised to bring these issues to the attention of their family practitioner.

Schools should recognize the importance of sleep deprivation as a risk factor for poor health as well as academic performance problems. They should set expectations around getting a good night's sleep to perform well.

> *"A lot of messaging takes a negative approach—it's all about sleep deprivation. It's great to think about sleep and mood and behavior in the same way we think about physical fitness (about optimizing performance). Make it more goal-oriented instead of punitive, talk about healthy habits and routines that promote healthy sleep. You can talk about things teens care about, like risk for obesity, performance in school, and risk for mood disorders."*

Physicians

One expert noted the importance of physicians in promoting sleep hygiene among children and adolescents. Unlike other preventative health care issues like car seats for infants or avoiding alcohol use for teenagers, sleep hygiene is not often talked about during visits to the doctor. However, physicians can play an important role by educating patients and parents.

Caffeine

Drinking caffeine makes students believe they can get by on less sleep, which is not the case. Because caffeine "hangs around a while in the body", drinking caffeinated beverages in the afternoon or evening makes it more difficult for a child/adolescent to fall asleep at night and can affect their ability to stay asleep. Dependence upon caffeine is also possible. Overall, sleep is compromised by caffeine.

> *"Caffeine use promotes a vicious cycle—it is used to feel more alert in the morning when you really should have gotten more sleep and then it is used again later to stay awake in the afternoon so that you can get work done, which then prevents you from going to sleep at a normal time. Caffeine used to cram for exams is a bad idea too…"*
>
> *"Energy drinks that have high levels of caffeine are especially concerning and problematic because they are so widely available to young people and there is no regulation to limit the amount of caffeine in energy drinks. Some other countries have stricter regulations, with some not allowing the sale to younger children."*
>
> *"Certainly energy drinks are disastrous for kids. They use these drinks to stay awake in class in the morning because they are so tired. Sometimes kids and parents don't even know that these energy drinks contain caffeine or how much they contain. Parents have to really monitor what their kids are drinking."*
>
> *"Caffeine is a really big problem. Late consumption, in the evening and especially at bedtime, will cause problems with kids going to sleep. Restricting caffeine, especially from dinnertime on, is critical."*

Using cell phones, computers, and other devices

There are two main issues with these devices. First, the bright lights from the screens suppress melatonin synthesis, thereby interfering with circadian rhythms, which is a direct biological mechanism linking the use of these devices to not being able to fall asleep. Second, the cognitive stimulation from using these devices and the social stimulation, because they are a method of interacting with peers, can also keep young people from falling asleep.

> *"It is not so much about the use of the devices, but about for how long the devices are used, and the time of day that they are used. Parents struggle regularly with limiting the use of these things, and online activities including Facebook®, especially at night. Adolescents can get addicted to these things. They aren't inherently bad if used in moderation, as all things in life…but not at night."*
>
> *"Reading books at bedtime is a better alternative than electronics, but it is hard for adolescents to avoid the temptation. Sometimes interaction with peers might be distressing, but if their parents are already asleep, the teens won't have help processing it."*

Playing video games

Both the light and the stimulation associated with playing video games can be detrimental to falling asleep, especially before bedtime. Playing video games should be avoided near bedtime.

Watching television

Similar to cell phones, computers, and video games, the bright light associated with television can make it more difficult to fall asleep. Several experts noted that they recommend that children stop using electronics about two hours before bedtime, akin to an "electronic curfew."

> *"Watching TV is inherently a more passive activity and thus might not carry as much risk for not falling asleep. But we don't really have a good answer for the relative risk of TV watching vs. other forms of screen time among adolescents. Even though it is a passive activity, there is still the issue of light, so it is probably good to avoid watching television close to bedtime if you want to go to sleep at a reasonable hour. Some children and adolescents overdo TV watching to the point where it interferes with sleep."*

Physical activity

The conventional wisdom is that physical activity is good for enhancing sleep quality, and being active during the day can improve sleep quality at night. However, there is thought that engaging in physical activity close to bedtime should be avoided. It raises core body temperature, which might negatively impact the ability to fall asleep. Physical activity promotes sleep, but not a few hours before bedtime. More relaxing activities before bed, such as reading, would be preferred. Sports practices at night could lead to more sleep deprivation, especially if they are really demanding.

Having a part-time job

Having a part-time job is a competing priority to homework and therefore needs to be carefully considered. There appears to be a "dose-response" relationship between the number of hours worked and sleep loss. Several experts noted, however, that this depends on when and how often the adolescent works. A job that fits into the child's routine and is balanced with schoolwork and sleep might be fine for some children. However, a job that causes stress or takes time away from homework will negatively impact sleep.

> *"Adolescents are sometimes juggling more than they can handle. Having kids come home at 9 to 10pm on weekdays because they have a part-time job leaves little time for family activities. I think having a part-time job really adds to the mix of stress—during the summer, I'd say it was OK, when you don't have so much schoolwork."*
>
> *"Having a lot of homework and a part-time job during the week could certainly lead to more sleep deprivation. There are some adolescents who can handle it better than others. It is up to the parents to realize what might be good or not so good for their own child. Also, they can help determine how the hours of a part-time job might be structured so that they are not so close to bedtime and make sure that the job does not interfere with getting homework done."*

Having a rigorous academic course load

There have been few scientific studies conducted to examine the association between a rigorous academic course load and sleep quality. Most likely there is a high degree of individual variability in the degree to which adolescents can effectively manage a heavy workload that is cognitively demanding. Several experts noted anecdotally that some children who take on a rigorous course load might experience greater stress and anxiety, which disrupts sleep. Some experts pointed out the controversy over this topic. On one hand, there is a fear that sleeping more will leave less time to manage a heavy workload. On the other hand, it is likely that if kids were less sleep-deprived, they would be more efficient at doing their work and be able to think more critically.

> *"The expectations we set for kids are way too high. We need to allow kids to be kids. A high level of expectations, and not being able to accomplish everything that is expected (two or three AP classes, sports practices, theater, etc.) leads to a lot of stress and anxiety. And sleep deprivation is a mediator of that. In other words, if kids have a hard time getting their stuff done to meet those high expectations, they try to stay awake and fight sleep. By doing this, they get more sleep-deprived, which makes their mental health even worse. It's a vicious cycle."*
>
> *"Adolescents vary a lot in their access to people to help them with homework (e.g., parents, school programs). As homework gets more complex, parents need to help break it down into smaller goals. I think that's where high school students have the most trouble and then they stay up all night."*

Being involved in extracurricular activities

It is difficult to disentangle the specific effects of various extracurricular activities (e.g., team sports, theater, clubs, etc.) on sleep quality. Many experts emphasized that extracurricular activities are very important for a child's social development and physical activity is healthy, particularly if children have been sitting in class all day. However, these activities have to be done in a way that will fit with their needs and their schedule. It should be a positive, prosocial activity that does not cause undue stress on getting homework done or the family routine. Trying to put a lot of activities into the day can lead to sleep deprivation if the child stays awake longer to get everything done. Children vary a lot with respect to how much time they need for homework, and thus, some children might be able to handle more extracurricular activities than other children.

The cultural norms of living in a fast-paced world

How sleep fits into our busy lives and people's perceptions about sleep is a very complex issue that really resonated with the experts. Sleep is often equated with being unproductive and that assumption plays a role in our culture's attitudes about our own sleep patterns and the sleep needs of children. The importance of sleep is under-recognized and ironically, getting enough sleep helps us to be more productive, not less. There is a prevailing attitude that being awake and getting things done is much

more important than getting enough sleep. It has almost turned into a moral issue—people are judged negatively if they want to get enough sleep.

> *"Society has trivialized the problem of sleep deprivation. These are real issues—the science is there—but people's attitudes and opinions tend to overrule the science, which is not a good thing."*
>
> *"The culture promotes needing to get everything "done"—parents, peers, and society in general place very high expectations on kids—and this contributes to sleep problems and promotes caffeine consumption which in turn, makes things worse."*
>
> *"As a society, our desire to always be on the go deserves a re-visit. There's not enough time for our kids just to relax and be kids. There is nothing wrong with having kids give it their all and try to be their best—that's not what I'm talking about. I mean the excessive and high level of expectations—we need to be very careful about not overcommitting our kids with activities and schoolwork so that they end up feeling overwhelmed and less confident about their own abilities."*
>
> *"This idea is reflected in the study that looks at the decreasing sleep guidelines over time. The reality is that the types of distractions that prevent sleep have changed over time, with technology playing a larger role today than earlier in history. What is important is striking the right balance for every individual child. When parents work multiple jobs, or there's crowding, or there are mental health issues in the family, it's harder. It's not just technology and fast pace, it's about the stress that families are under that also influences that child's sleep environment."*

Expert opinions about the most important issues that influence adolescent sleep

When the experts were asked what they considered to be the most important factors that contribute to sleep deprivation, three themes emerged. First, the early school start times are incongruent with the circadian rhythms of adolescents.

> *"Having schools start at times that are inconsistent with circadian rhythms contributes to chronic sleep deprivation. Changing school start times is a necessary but not sufficient condition for addressing the problem of sleep deprivation."*
>
> *"Changing school start times is supported by empirical evidence, and could be a major environmental factor to address sleep deprivation, more so than things like avoiding computers at night, etc."*

The second theme was the use of technology, particularly the use of social media.

> *"Electronic media is a huge contributor. Kids use video games and talk to their friends and text and those things eat up a lot of time. They can do it quietly so parents aren't always aware of what's going on. I suspect that kids continue to network with each other late into the night."*

Finally, several experts mentioned the cultural norms that devalue sleep, emphasize activities, and place high expectations on adolescents.

> *"Inappropriate scheduling. For each kid, it's a little different why they're staying up at night, either course load or extracurricular activities or jobs, but we're overall encouraging late activities and discouraging sleep."*
>
> *"The biggest issue concerns the high expectations we put on ourselves, our families, and our kids to get a lot accomplished. Many times you have more than one parent working, and family group activities take a back seat to everyone trying to get their own "stuff" done."*

The Consequences of Sleep Deprivation

Experts were asked questions about the impact of sleep deprivation on child and adolescent health, well-being, and safety. Below is a summary of their opinions. It is important to note that the experts fully recognized that their responses during the interviews could only partially capture the complexity of these issues.

Physical health

Overall health and immune function is compromised by sleep deprivation. Research evidence points to an association between sleep loss and cardiovascular disease, including strokes in adults. Also, sleep deprivation can have negative impacts on physical development, because growing takes place during sleep. The metabolic consequences of sleep deprivation are particularly powerful and are quite pronounced in younger individuals. Sleep deprivation is associated with factors that influence obesity risk like an increase in cortisol level and insulin sensitivity. Sleep deprivation is an independent risk factor for Type II Diabetes. Sleep deprivation is more serious for some kids, such as kids with seizure disorders.

Mental health

Chronic sleep deprivation commonly contributes to mental health problems in general, and more specifically, anxiety and depression. In some cases, suicidal ideation, self-harm, and behavioral dysregulation are associated with sleep problems.

One expert suggested that sleep deprivation might exacerbate some symptoms of ADHD (e.g., being breathless and fidgety). Adolescent judgment and information processing ability can be compromised as a result of sleep deprivation. In late adolescence, sleep deprivation might lead to an increased risk for mania, and having one manic episode increases the likelihood of experiencing another. Also, the ability to develop healthy social relationships is somewhat dependent on mood and ability to regulate behavior, so the mental health effects of sleep deprivation can compromise social development as well.

Behavior problems such as acting out and being irritable are often seen in children and adolescents who are sleep deprived, acutely and chronically. Although there is a lot of individual variation in this association, sleep loss can lead to behavior problems. For children with mental illness, the impact of sleep deprivation might be even greater.

Substance use

Adolescence is a highly vulnerable developmental period for substance use. Sleep loss has a selective negative effect on prefrontal cortex functioning, which is needed for higher level organizational skills and planning. This region is implicated in the vulnerability for substance use problems. Sleep deprivation is associated with risk-taking behavior in general, including early sexual activity and risky driving. The use of caffeine is certainly more likely among sleep-deprived kids.

One expert noted that marijuana is often used as a sleep aid among sleep-deprived adolescents seen in clinical practices—because kids are so "on the go" during the day. The latest research shows that marijuana is certainly not benign drug; there are cognitive impacts and changes in brain development associated with marijuana use.

> *"This is an emerging area, but there's some thought that sleep deprivation is associated with risk-taking, possibly including substance use. There's a general concern that kids who are up late and especially leave home late at night might be exposed to risky things."*

Academic issues

The complexity of the relationship between sleep and academic performance is well recognized. It is generally believed that children and adolescents will be more efficient with their time if they are not sleep deprived. The potential cognitive and attention problems associated with sleep deprivation can impact a student's ability to keep up with their academic work. It makes sense that being sleep deprived will affect a child's ability to keep up with schoolwork. If a child has trouble learning during the day, it will be harder to do homework. There is very strong evidence that acute and chronic sleep deprivation negatively impacts children's executive functioning, and as a result, children's ability to pay attention in school can be compromised. There is research to suggest that sleep deprivation is associated with poorer grades.

Tardiness is a big issue that is related to early school start times and can impact school attendance. It's clear from the literature that high schools with later start times have better attendance and tardiness outcomes.

> *"If you are cranky and irritable because you are tired, you're less likely to be motivated to learn anything. Students are constantly playing catch up with their work. Sleep influences alertness during the day, which affects learning, especially for mundane or routine tasks.*

Driving, traffic, and pedestrian safety

Fatigue can negatively impact reaction time, judgment, and driving ability, increasing the risk for accidents. All the "problem behaviors" tend to cluster together—if sleep deprivation plays a role in exacerbating behavioral problems, risky driving is just a part of the constellation of problem behaviors.

When young drivers are sleep deprived, the consequences could be even direr because they are inexperienced. Adolescents often feel invincible and therefore they will drive even though they are really tired and should not be on the road.

> *"They think nothing will happen to them, and they have an inflated sense of their ability to drive, even when they are drowsy. As a result, other drivers and pedestrians can be at risk."*

Breakfast consumption and general nutrition

Sleep and nutrition are related in two main ways. First, from a biological standpoint, the metabolic effects of sleep deprivation are very real. Circadian rhythms affect every cell in your body. Sleep deprivation is associated with the tendency to crave carbohydrates because of changes in hormone secretion (i.e., leptin, ghrelin). There is some evidence that food is not used as efficiently for energy under periods of sleep deprivation and stress.

Second, from a logistical standpoint, many times students do not have time to eat breakfast because they are rushing out the door to get to school on time when school starts early. Skipping breakfast compounds many other problems related to morning fatigue. Sleep deprivation affects food choices, with increased cravings for carbohydrates. Healthy eating habits will be worse when you're sleep deprived.

> *"If adolescents have to get up by 7:20 to make it to school, they are usually not very hungry because they are really dead to the world… sort of still in a deep sleep—there is no time for breakfast on many occasions, and therefore they end up snacking on non-nutritious foods. If you're barely getting out of bed in time for school, you're probably not eating breakfast."*

Mitigating the Effects of Sleep Deprivation

Experts were asked about whether alternative sleep patterns can ease the effects of sleep deprivation. The responses were consistent in their belief that "the only substitution for sleep is sleep." "Binge sleeping" on the weekends to compensate for sleep deprivation during the week is not advised by physicians and puts students in a permanent state of jet lag. Sleep times have to be consistent—one cannot make up for sleep lost during the week with weekend sleep. Sleeping longer on the weekend can

cause a shift in the time you feel sleepy, so it will increase the phase delay and will not help prevent sleep-related problems during the week when children are sleep deprived again.

When asked about napping, the experts said that short-term napping close to the time of sleep deprivation can be restorative and helpful, for example, if you take a nap the day after a night of little sleep it might be helpful, but taking a nap several days later will not be. Many agreed that napping does not compensate for chronic sleep deprivation. The benefits of napping are confined to young children, mostly less than four years of age. Brief naps lasting ten to twenty minutes can be helpful for adolescents and adults, but longer than that can interfere with falling sleep later.

> *"What is most important is setting a regular schedule for your sleep. I don't think changing the pattern is productive."*
>
> *"Napping, if it's closer to the time of sleep deprivation, like the night before, can sometimes help. But it's hard to take a short nap if you're sleep deprived. If you sleep for three to four hours after school, it'll affect your bedtime that evening."*

Implications of Changing School Start Times

Experts unanimously agreed that delaying school start times would most likely reduce the negative impacts of sleep deprivation that were discussed above, and therefore, would benefit the health of children and adolescents. Below we present several general illustrative responses from experts regarding their opinions on the implications of changing school start times, followed by more specific comments about the implications of delaying school start times on various facets of health and psychosocial functioning.

General comments about delaying school start times

> *"Many studies have shown the benefits of delaying school start times so that they better follow the diurnal cycles (circadian rhythms) of children. I think you would see the reversal of a lot of the negative things that are related to being chronically sleep-deprived. I think even having an extra hour in the morning would be helpful. It obviously isn't going to solve the problem but it would be very beneficial. This is not a simple problem, there are many complex issues here, but if we could figure out how to do it, it would be a good idea."*
>
> *"For older children, quite a number of studies have shown that there are improvements that are due to the fact that starting school later is more compatible with their circadian rhythms. Changing school start times would have a positive impact because middle and high school children will be allowed to sleep in a pattern that is more compatible with their normal sleep cycle. Changing the school start times so that high school students start later would make sense because it would help them fall into their natural circadian rhythm more easily."*

> *"People have to find a sleep strategy that will be most effective for adolescents that will be at minimal impact for younger children and families."*
>
> *"I think overall, having a later school start time of even half an hour will have a positive effect. I would strongly recommend having later start times for high school as well as middle school."*

Cognitive development

Sufficient sleep is necessary for cognitive function. Sleep deprivation means sacrificing efficiency, so it takes longer to do the same thing. In one study where school start times were changed, students reported being more efficient at getting their academic work done, and as a result, they were able to sleep even more than usual. Insufficient sleep also diminishes the ability to process information. If students were not as tired, they would be more able to focus in school.

Emotional/mental development

Benefits would include improvements in mood, self-esteem, and perhaps decreases in depressive symptoms. Students might also have a greater tolerance for things that were frustrating. For example, students sometimes find their schoolwork difficult to understand and, if they are sleep-deprived, this can be very frustrating.

Physical activity

Few experts could comment on impact of delaying school start times on physical activity. One expert thought that starting school later would mean that at the end of their academic day, students could roll right into later sports activities without having a break period, which might not be needed anyway. Another expert cited evidence that suggested that delaying start times does not have an effect on the time that adolescents go to bed. Instead, they sleep longer in the morning. Therefore, the time allotted for physical activity after school probably would not be affected.

Participation in athletics and other extracurricular activities

This topic has not been as well studied as other topics. There is evidence to suggest that sleep deprivation is associated with increased risk for sports-related injuries. Overall, adolescents could benefit from being less sleep deprived when participating in activities. They might be better coordinated and do better at their activities. However, the experts acknowledged the challenge of figuring out how to schedule after-school activities and still have enough time for homework and families. It was also acknowledged that better coordination and moderation of activities is necessary, regardless of school start times. However, as one expert concluded, these changes could be manageable with minimal negative impact.

Homework/academic performance

There is evidence to suggest that academic performance could be improved. However, the impact specifically on homework is not clear. Experts suggested that increased alertness and attentiveness would improve ability to complete homework, and one expert speculated that it might make a difference in academic performance only for those who were struggling, and not for those who were achieving already.

> *"Schools could try to accomplish more during the day so that there wouldn't need to be as much homework at night. Schools should try to decrease the quantity of homework required. I think academic improvements would be seen because kids might be able to learn better during the day if they weren't so tired. Overall, if kids are more alert and attentive during school, that'll help with both of those areas."*

Socializing

No research studies could be identified by the experts that examined this topic. It is possible that less sleep deprived children would lead to better social development, and the experts seemed to agree that it would not have a negative impact. It could even help with issues that some families might be having connecting with their kids.

Responsibilities at home

Several experts acknowledged that there is concern that if students get home later, they might not be able to care/provide for their younger siblings or pitch in with responsibilities at home. Little research has addressed this topic.

> *"I think it's good for kids to have some simple responsibilities at home, but I think during the school week, these responsibilities should be minimized. I would suggest putting those responsibilities to the weekend."*
>
> *"Older kids have responsibilities to be home after school, perhaps to be home with younger siblings. If start times are delayed, it depends what happens with the younger kids. If their start time is similar, maybe it'll help; older kids could drop off younger kids. But child care is a problem."*

The broader community

Experts were asked about possible effects on the broader community. Several pointed to a decrease in car crashes because of evidence that suggests a decrease in drowsy driving. There would be a positive impact at the community level from promoting healthier balances and choices. For family routines, the change could have a more variable impact. There are some issues related to cost, such as needing more buses and drivers if schools all started at the same time.

> *"There could be negative effects on traffic patterns and there could be impacts on the use of school facilities by community groups later in the day. But I know of no research on those specific effects—it's more theoretical at this point. Although many of the*

> *concerns are very legitimate, in the places where the policy has changed, these concerns have not materialized to the extent that people think they will. It's a complex issue. I'll leave it up to other people to worry about traffic flow and bus schedules, but I think delaying school start times would be beneficial for the health of children and families."*
>
> *"There could be positive impacts on traffic as well. Also, teachers might be happier because students might be more able to concentrate and pay attention, and might have less behavioral issues."*
>
> *"It might be less of a problem for kids coming home later at the end of the day, but more of a problem for ensuring that kids get to school at the beginning of the day. There may need to options for the school to open earlier so that kids can be dropped off, even thought that sort of negates what we're trying to do. For some families, that might be how it has to work."*
>
> *"Any amount would be good, given that there is a two hour shift in the sleep-wake cycle in older children. What would be good would be probably an hour or an hour and a half later for middle/high school kids."*

Experts were asked about whether starting high schools later would result in students simply staying up later to compensate for the later start time, thereby negating any positive impact upon wellness. This was not a major concern. Studies that evaluated changes in school start times have consistently shown that students do not go to bed later. As one expert noted, if adolescents are already going to sleep at 1am or 2am, it would be harder to go to sleep even later. In one study, students went to bed earlier, perhaps because they started to realize the benefits of getting more sleep.

> *"I don't think phase shifts would occur—I think it would be beneficial to have school start times correspond to natural biological rhythms."*
>
> *"Some teenagers might see it that way because they are teenagers, but I think what is key is parental responsibility to point out the reason for the extra hour or so. They have to remind their children how much better they will function if they aren't so tired at school. This sort of communication has to start when kids are young, so that by the time they get older, it's pretty much built into the routine. As children get older, naturally they will be given more freedom and more responsibility, but it is good to set expectations early. My understanding of the research is that it doesn't affect bedtime, it affects how much time they sleep in the morning. That's where you get your benefit."*

When asked how sleep science can inform school decisions on academic work load and school start times, experts were consistently in favor of delayed school start times.

> *"Schools should be running at times that are compatible with circadian rhythms. We know that naturally it is difficult for adolescents to fall asleep before 11pm. So, if the sleep requirement is 8.5-9.5 hours, then it follows that they will wake up at around 7:30 at the earliest. Time is needed to get ready for school, have breakfast, and get to school. As far as academic workload is concerned, there are a lot of competing priorities with*

> *sleep, so there might be a need to do more work while in school, rather than saving a lot of the work to do at home."*
>
> *"Students might become more efficient at doing their work in general though if they are not sleep deprived, so anything to reduce sleep deprivation is a good thing. I think there is a need to make the day at school more efficient so that it would be possible to start school later."*
>
> *"I highly support the change in school start times. Most schools start before 8am, which doesn't align well with what science tells us about the normal and predictable sleep phase delay among middle and high school children."*

Experts were also asked about "start time swap scenarios," where the benefits of later school start times for adolescents could be balanced or negated by effects of alterations in school start times of middle and elementary school-aged children. There was a general consensus that there should be a consistent start time, rather than staggered start times. One expert reflected on the fact that all schools in Maryland used to start at 9am. Another commented that what is important is setting a limit on how early schools can open. No school should start at a time that is not safe or healthy. For both middle and high school students, starting school earlier would not be a good thing. For young children, however, starting school earlier might not have a negative impact.

> *"There is the issue of "civil twilight" to consider, where young children should not be waiting in the dark for the bus. I don't think it would be a good idea to start younger children any earlier than 8:00am."*
>
> *"I would not touch the school start time for younger kids—I think that would be too difficult for families and it would be good to get kids used to a standard start time for all ages.*
>
> *"I don't know what that means for the younger kids, but that's a question that could be studied. There's a lot of variation in the country and the state in how school start times are done. You'd have to look at that data."*

NOTE: One expert was curious about the state's plans for an outcome evaluation, if the state or a school district changes the school start time.

Expert Biographies

Maria Cecilia Melendres, MD is a clinical associate and assistant professor in pediatrics at Johns Hopkins University. Her clinical specialty is pediatric pulmonary and pediatric sleep medicine, with an interest in obstructive sleep apnea. She is board certified in pediatrics, pediatric pulmonology, and sleep medicine. She is a member of the Maryland Sleep Society and the American Academy of Pediatrics.

Judith Owens, MD, MPH is an internationally recognized authority on children and sleep. She is the Director of Sleep Medicine at Children's National Health System. Her research interests include the neurobehavioral and health consequences of sleep problems in children, pharmacologic treatment of pediatric sleep disorders, and cultural and psychosocial issues that impact sleep. Dr. Owens chairs the pediatric section of the American Academy of Sleep Medicine. In 2005 and 2006, she was a spokesperson for the National Sleep Foundation "Sleep in America" poll. She is a founding member of the Board of Directors of the Society of Behavioral Sleep Medicine. Dr. Owens is co-author of *Take Charge of Your Child's Sleep: The All-in-One Resource for Solving Sleep Problems in Kids and Teens* for parents and *A Clinical Guide to Pediatric Sleep* for healthcare professionals. She is the recipient of many awards, including a five-year NIH grant on sleep education, and the AASM 2006 Excellence in Education Award. She is board certified in developmental/behavioral pediatrics and sleep medicine, and is the author of more than 75 original research and review articles in peer-review journals, chapters, and books on the topic.

Gloria Reeves, **MD** is an associate professor of psychiatry at University of Maryland School of Medicine. Her clinical specialties include family therapy interventions, attachment issues, complex psychiatric comorbidity, and trauma related disorders.

Maria Rodowski-Stanco, MD is a Jefferson and Yale trained, Board Certified Child and Adolescent Psychiatrist with extensive experience across all levels of care, holding particular interest in early childhood, developmental issues, and community psychiatry. She advocates always keeping the best interest of the child as primary focus in treatment decisions. In the past, she has served on the faculty of Johns Hopkins, Kennedy Krieger and Sheppard Pratt. For the last five years has worked with Value Options Maryland and the Department of Health and Mental Hygiene's Behavioral Health Administration (previously MHA) overseeing the use and distribution of public mental health services, particularly for youth and families in Maryland.

Laura M. Sterni, MD is the Director of the Johns Hopkins Pediatric Sleep Center and has more than 18 years of experience treating children with sleep disorders. Her practice focuses on patients with sleep disordered breathing including obstructive sleep apnea syndrome (OSAS). She is board certified in both pediatric pulmonary and sleep medicine, and is a member of the American Academy of Sleep Medicine, The American Thoracic Society and the Maryland Sleep Society. She received her MD from Johns Hopkins University School of Medicine in 1989.

Ken Tellerman, MD has been in practice 25 years as a general/behavioral pediatrician. Additionally, he has chaired the Emotional Health committee for the Maryland chapter of the American Academy of Pediatrics for 15 years. He is a clinical assistant professor of pediatrics at the University of Maryland School of Medicine. He received the 2011 Maryland AAP Leadership Award for his work in children's mental health issues.

Maria Trent, MD, MPH is an associate professor of pediatrics at Johns Hopkins University. She provides primary and subspecialty clinical care to children, adolescents, and young adults as a part of the Harriet Lane Program in the Johns Hopkins Children's Center. Dr. Trent's research focuses on the design of behavioral interventions to assist with fertility preservation in adolescent girls. She currently receives extramural funding through the Robert Wood Johnson Foundation Generalist Faculty Scholars Program and the Centers for Disease Control and Prevention to support her work. She is currently the principal investigator of several studies including the PID Quality Improvement Project, the Young Women's Health Study, and a study designed to develop a strategic approach to PID management using decision/economic analytic approaches. She is also co-investigator on a population based study examining the relationship between community factors that lead to the development of impaired fertility beliefs on the associated outcomes among adolescents in high STD prevalent communities and a study evaluating fertility desires of HIV infected youth.

Al Zachik, MD is a child and adolescent psychiatrist and a member of the American Academy of Child and Adolescent Psychiatry's Workgroup on Community Systems of Care. He is a member of the clinical faculty in psychiatry at the Johns Hopkins University School of Medicine, Georgetown University School of Medicine, and the University of Maryland Department of Psychiatry. Dr. Zachik has a special interest in developing a full system of care in Maryland for children and adolescents with mental health needs, which integrates mental health services into all existing programs for youth including schools, early childhood, juvenile services, and social services programs.

Terra Ziporyn Snider, PhD is the Executive Director and Co-Founder of Healthy Hours/Start School Later, a nonprofit dedicated to safe, healthy school hours, as well as an award-winning author of numerous popular health and medical books including *The New Harvard Guide to Women's Health*, *The Women's Concise Guide to Emotional Well-Being, Alternative Medicine for Dummies,* and *Nameless Diseases*. A Yale graduate (Phi Beta Kappa, summa cum laude), Dr. Ziporyn earned a doctorate at the University of Chicago as a Searle Fellow in the history of science and medicine while conducting research in biopsychology. She is a former associate editor at *The Journal of the American Medical Association* (*JAMA*) and has written extensively on a wide range of health and medical issues for publications including *The Harvard Health Letter*, *JAMA*, *Consumer Reports*, *CNN*, *Education Week, Weight Watchers Magazine*, *Business Week*, and *Longevity*. Dr. Ziporyn has been awarded science-writing fellowships by the American Association for the Advancement of Science, the American Chemical Society, and the Marine Biological Laboratory at Woods Hole.