The Report of the 2013 Bell Times Work Group:

Sleep Needs of Students, Scheduling Practices, and Options for Consideration

September 2013

MCPS

Table of Contents

Executive Summary

In December 2012, Montgomery County Public Schools (MCPS) Superintendent Dr. Joshua P. Starr directed staff to convene a work group—including community stakeholders—to develop options to address students' needs for more sleep, and in particular, to consider adjustments to school start times, often referred to as "bell times." The development of options was to take into consideration current research, the efforts of other school districts, as well as the previous efforts by interested stakeholders, which carefully considered and documented the issues, concerns, options, and implications of changing bell times, in reports published by MCPS in 1998 and 1999. The work group was asked to consider what has changed since 1998, what options previously offered might be more compelling in the current context, and what options not previously considered might be meaningful countermeasures to the problems associated with adolescent sleepiness.

The 2013 High School Bell Times Work Group (Bell Times Work Group) met from January to July 2013. The group heard presentations from local experts, reviewed current research from sleep experts and school start times experts nationwide, benchmarked comparable districts, conducted informal focus groups, and commissioned a survey of high school students and parents of high school students. The survey found that 70 percent of MCPS parents of high school students and 63 percent of high school students consider the 7:25 a.m. high school start time "too early." Sixty-nine percent of parents and 54 percent of high school students want the high school start time pushed back by 30 minutes or one hour, and 28 percent of parents and 38 percent of high school students want the high school start time to remain the same.

The Bell Times Work Group was tasked with researching and developing options but not with making a recommendation. The group did not reach consensus on all of the options discussed nor are the options presented in order of preference. Four options are proposed by the Bell Times Work Group for further consideration by the superintendent of schools and the Montgomery County Board of Education (Board) and are discussed in this report.

The work group concurred with medical experts who have identified sleep deprivation in adolescents and adults as a public health issue. Work group members felt that MCPS students, staff members, and parents could benefit from a sleep education campaign addressing the wide discrepancy between the hours of sleep needed versus the hours of sleep typically achieved by students, the relationship between sleep and learning, the impact of electronic devices on sleep habits, and other important findings in the sleep research literature regarding the academic, psychological, physical, and public safety problems associated with sleep deprivation.

Introduction

When the bell rings at the end of the high school day, teens scatter in directions as varied as their interests—to sports practices, jobs, and/or internships; to be with friends; to care for younger siblings; and, of course, home to study (or so their parents and teachers hope, at least for some portion of the night). Before they go to bed, they will have logged hours of activity and motion, some of those hours spent being driven—or driving themselves—from music or theater rehearsals to competitions, meetings, or friends' houses, and hopefully, home at a decent time before checking for that one last Tweet, reading one last text or e-mail message, or sending a Snapchat photo. And then they finally get to bed, where research shows they will sleep 7.6 hours on an average school night, or 6.9 hours on average if they are high school seniors—much less than the 9 hours of sleep per night that research says they should get.

They will sleep less than they need and probably wake before the sun comes up, walking to the school bus stop or driving or walking to school for the start of the school day. In MCPS, the high school day starts at 7:25 a.m.

When asked, 38 percent of MCPS high school students want school start times to stay the same. One may ask why student support for a later start time is not almost unanimous. Certainly students like the idea of sleeping later in the morning but not necessarily the idea of staying in school later in the afternoon. Proponents of the 7:25 a.m. start time rarely argue for the benefits for high school students of starting school that early. With the possible exception of high school staff members who appreciate a traffic-free early morning commute, most proponents of the 7:25 a.m. start time argue for the 2:10 p.m. end time and what happens after the bell rings at the end of the day. Students, teachers, students' employers, coaches, and club advisors argue for time to work, practice, meet, or compete in the afternoon before it gets too dark to practice on unlit fields or in time to travel across the county and return from a competition in time for homework before bedtime. Also, some parents count on high school students being the first ones home in the early afternoon to care for younger siblings or to contribute to the family finances by working after school. Similarly, a host of community businesses provide tutoring, private lessons, and other activities to students after school.

Logistically, in a traffic-congested metropolitan area like Montgomery County, it takes four separate "tiers" of school bus routes and start times to transport students at all levels—elementary, middle, and high school—to school and back again. Simply put, to make sure the latest school opening occurs by 9:15 a.m., someone has to take an early tier, and that tier in Montgomery County traditionally has been assigned to high school students.

According to a 2013 MCPS survey conducted by the Office of Shared Accountability (OSA), 70 percent of MCPS parents of high school students consider the 7:25 a.m. high school start time "too early," and 69 percent want it pushed back by 30 minutes or one hour. A petition received by MCPS in November 2012 requested a school start time schedule more aligned with sleep research. Sleep research shows that insufficient sleep contributes to a range of physical, psychological, and public safety problems. Important brain functions that are part of the learning process—the ability to complete abstract and complex tasks, develop working memory, and consolidate memories of information gathered during the day—are affected negatively by sleep deprivation. Additionally, the United States has the highest numbers of sleep-deprived students

of all countries participating in the Trends in International Mathematics and Science Study (TIMSS). TIMSS researchers hypothesize that the lack of sleep in affluent countries like the United States and Saudi Arabia results, in part, from affluent students having cell phones and tablets and the impact of artificial light from the screens on their ability to fall asleep.

While the sleep research emphasizes the importance of more sleep for students, school start time research does not conclusively demonstrate that later high school start times produces academic gains. While the findings on academic gains may be inconsistent, research consistently does show a relationship between starting high school later and lowering the traffic accident rate among school-aged drivers.

If research findings, school bus schedules, and the multiple after-school demands on high school students' lives were puzzle pieces, they seemingly come from different puzzles. Add in the pieces that impact elementary and middle school students and their families, and it soon becomes clear these pieces do not fit together into an image that pleases everyone. Moreover, depending on how these pieces are assembled, the costs can increase substantially.

In December 2012, MCPS Superintendent Dr. Joshua P. Starr directed staff to convene a work group—including community stakeholders—to develop options to address students' needs for more sleep, and in particular, to consider adjustments to school start times, often referred to as "bell times" (Appendix A). The development of options was to take into consideration the previous efforts by interested stakeholders, which carefully considered and documented the issues, concerns, options, and implications of changing bell times, as documented in reports published by MCPS in 1998 and 1999, as well as the efforts of other school districts. The purpose of the 2013 Bell Times Work Group was to consider what has changed since 1998, what options previously offered might be more compelling in the current context, and what options not previously considered might be meaningful countermeasures to the problems associated with adolescent sleepiness.

The Bell Times Work Group was tasked with researching and developing options but not with making a recommendation. The group did not reach consensus on all of the options presented nor are the options presented in order of preference. The following four options were put forward by the Bell Times Work Group for further consideration by the superintendent of schools and the Board (see page 23 for the current school bell times schedule):

- Option 1 and 1A reverse the order of school opening for the first two tiers, starting middle schools before high schools. Option 1 opens elementary schools 10 minutes later and extends the day by 10 minutes. Option 1A leaves the opening time for elementary schools unchanged and extends the day by 20 minutes.
- Option 2 retains the current order of school openings but moves all start times 25 to 35 minutes later.
- Option 3 extends the elementary day by 30 minutes, making the length of the school day at all levels the same (and therefore somewhat more interchangeable from a transportation perspective), and changes the order of school openings so that half of the elementary schools start first at 7:50 a.m.

- Option 4 maintains the current order of school openings and start times and suggests using existing within-day scheduling practices and additional instructional techniques to support students who need a later start time on an individual basis.

Each option presented has features that are responsive to research or public demand, but the fit of these various puzzle pieces is imperfect:

- Starting middle schools before high schools (Option 1 and Option 1A), before 8:00 a.m., allows high school students to sleep 50 minutes later and leaves elementary school families' lives minimally impacted but conflicts with the research that shows that pubescent middle school students sleep needs are similar to those of their high school counterparts.
- Starting all schools 25–35 minutes (Option 2 and Option 2A) later incurs no additional costs and creates desirable start times for high school (7:50 a.m. or 8:00 a.m.) and middle school (8:20 a.m. or 8:30 a.m.). However, Option 2 pushes the latest elementary start time to 9:40 a.m. or 9:50 a.m., creating a need for before-school child care for more families or, as was reported in one study reviewed by the work group, possibly setting some elementary students up for 2–3 hours of television before school.
- Starting elementary schools before middle and high schools (Option 3) is consistent with elementary students' sleep patterns and their tendencies to be alert and active in the early part of the day. An earlier start time for elementary schools appears to be a favorable option for many elementary school parents, teachers, and principals. Further, Option 3, as presented, proposes adding 30 minutes to the elementary school day and extending needed instructional time to assist elementary students in developing foundational skills. This brings the length of the MCPS elementary school day more in line with other Maryland school districts.[1] Option 3, as presented, starts high schools on the second tier and middle schools on the third tier to minimize the impact of a later start time on after-school activities. An undesirable feature of this arrangement is that the second elementary start time is on the fourth tier, and two elementary school start times are one and a half hours apart may make it more difficult to coordinate planning, training, and meeting times for staff members at elementary schools on different schedules. However, if high schools or middle schools move to the third or fourth tiers, the school day would end at 3:35 p.m. or 4:05 p.m., cutting into coveted after-school hours and leaving some families with the challenge of supervising elementary students after their school day ends.
- Leaving the schedule the same (Option 4) and depending on existing scheduling and instructional practices to minimize students being sleepy in first period classes causes minimal disruption to existing patterns and, in some cases, permits some high school students to arrive after first period. However, arriving after first period assumes that students will provide their own transportation to school for second period, making it difficult for students without transportation to utilize this flexibility. Further, taking full advantage of this option requires that students and their parents possess a degree of scheduling savvy to pursue and attain a nontraditional schedule.

[1] Data from the Maryland State Department of Education (Appendix I) shows that MCPS had the shortest elementary school day of all Maryland counties. Sixteen of 24 Maryland counties had elementary school days of six hours and thirty minutes or longer.

The ability to function on minimal sleep is often glamorized in American culture and has long been a part of military,[2] medical, and other academic training. Advertisements for caffeinated power drink products and other stimulants target students and young adults and further glamorize sleep deprivation while promising consumers the ability to function at a high level on little sleep. However, science increasingly cautions against sleep deprivation and demonstrates the impact of sleep loss on American health, safety, productivity, and learning.

Many work group members benefited personally from the education they received reviewing the sleep research. These studies showed that Americans, in general, are sleep deprived, and their lack of regard for sleep carries over into their opinions about what is acceptable and normal for students. A 2010 resolution of the American Medical Association identified insufficient sleep and sleepiness in adolescents as a public health issue and supported education about sleep health as a standard component of care for AMA members' adolescent patients. Similarly, the work group concurred that MCPS students, staff members, and parents could benefit from a sleep education campaign addressing the wide discrepancy between the hours of sleep needed versus the hours of sleep typically achieved by students. In addition, work group members believed it was important for students, parents, and staff to understand findings in sleep research literature regarding the academic, psychological, physical, and public health problems associated with sleep deprivation, as well as the impact of electronic devices on sleep habits.

As medical researchers investigate the sleep needs and sleep patterns of children and adolescents, educational policymakers wrestle with how to best educate students and operate school systems in ways that balance sleep research findings, the often incompatible demands of various stakeholder groups, the instructional needs of students, and resource constraints. Whether and to what extent school systems can provide countermeasures to a culture that places little value on the importance of sleep have been debated for almost twenty years in Montgomery County (see Appendix B) and throughout the United States.

History of Bell Times in MCPS

MCPS high schools currently start at 7:25 a.m.; middle schools start at 7:55 a.m.; and elementary schools start at 8:50 a.m. or 9:15 a.m. The current schedule was implemented during the 1993–1994 school year. Prior to 1993, school bell times were not uniform, and high school start times ranged from 7:20 a.m. to 8:20 a.m. Standardizing the start times resulted in most high schools changing by only a few minutes; only three schools shifted start times earlier by 25 to 50 minutes. MCPS's analysis of academic measures in these three schools after the schedule change showed average class marks in academic subjects shifted in inconsistent directions after the change in starting times.[3]

Two factors contributed to the consideration of school bell times in MCPS in the late 1990s. The first was increased awareness of sleep research and actions taken in several Minnesota school districts to change school start times. Research generated by the University of Minnesota studying these changes in Minnesota school districts was cited throughout national conversations

[2] Two articles reviewed for this report (Carrell, Maghakian, & West, 2011; Miller, Shattuck, Matsangas, & Dyche, 2008), showed that the U.S. Air Force Academy and the U.S. Navy Recruit Training Center have instituted recent policy changes to allow more sleep for their students.

[3] Changing Bell Times, January 1998, p. 4.

in the scientific, academic, and popular press about the need to start school later, particularly for adolescents.

The second contributing factor to the consideration of school start times in MCPS was the release of findings in 1995 from the National Education Commission on Time and Learning. Under consideration was the length of the school day and the recently standardized MCPS bell times. Then, as now, the elementary school day was six hours and fifteen minutes long,[4] and the middle and high school days were six hours and forty-five minutes long. Data from the Maryland State Department of Education in 1996 showed that MCPS had the shortest elementary school day of all Maryland counties. Sixteen of 24 Maryland counties had elementary school days of six hours and thirty minutes or longer.

In 1996, an MCPS survey of parents and staff was produced to receive input about the length of the school day and bell times, among other topics. The results specific to bell times showed that 55 percent of parents of high school students, 75 percent of parents of middle school parents, and 74 percent of parents of elementary school students said that the school days began at the right time.

From 1997 to 1999, the Board considered start times on several occasions, directing the superintendent of schools to analyze bell schedules and explore options that would permit high school students to start school at a later time. The first resulting report, *Changing Bell Times: Report of the Bell Times Work Group*, was distributed to the Board and to the community in January 1998. The report included 15 options for changed bell times and analyses of associated impacts on sleep needs, safety, child care, before- and after-school activities for students and staff, athletics, transportation, and budget implications. Also included were surveys of bell times from other jurisdictions, trip reports of site visits to Edina, Minnesota, and a review of current literature on sleep cycles and student achievement. Appendix B summarizes the history of actions by the Board and the superintendent of schools with respect to high school bell times from the 1990s to the present.

In April 1998, the Board commissioned a citizen task force to study all of the multifaceted aspects of changes to bell times. In October 1998, the task force presented its report to the superintendent of schools that included the recommendation to split high school schedule and offer two starting times. In November 1998, Dr. Paul Vance, superintendent of schools, recommended a proposal to seek one high school to pilot test a split schedule by September 1999, a recommendation that the Board adopted. The Board requested that the superintendent of schools seek volunteer schools and provide guidance in implementing a split starting time schedule.

The proposal for a split start time was thought to address both the needs of students who chose to start school at a later time to get more sleep and the needs of students who might prefer the 7:25 a.m. start time—mostly likely those who participate in extracurricular activities. Under a split schedule model, a student could select a normal start first-period class at 7:25 a.m. or opt to select a second-period arrival. A later arriving student still could attend seven periods with an

[4] There was a 5- or 10-minute secondary adjustment made to lengthen the elementary day to 6 hours and 15 minutes after the first year (1993) when times were standardized. Prior to 1993, the length of the elementary school day and bell times were varied from school to school and ranged from 5 hours and 55 minutes in some schools to 6 hours and 20 minutes.

added period at the end of the day. Skeleton bus service would have been provided during the pilot period both for the second period arrival and for the late departure, similar to activity bus routes provided at most schools. Additional resources for schools piloting were promised including added administrative and needed support staff. Another added benefit was that students who desired additional course offerings could use an eighth period under a split schedule model.

In February 1999, the Board requested that the superintendent of schools investigate the feasibility of using private bus contractors to provide high school bus service so that high schools could start later. In March 1999, staff reported back the Board that no vendors expressed an interest in providing contractual service for high school transportation and that such a contract, if awarded, would add significant costs to the MCPS transportation budget. The Board then requested staff to reexamine the available options and further investigate the option to eliminate school bus transportation for high school students and/or to rely on public transit as an alternative to school buses for high schools.

In September 1999, the superintendent of schools reported back the Board that after consulting with schools and Parent Teacher Association/Parent Student Teacher Associations at the 23 MCPS high schools, none were interested in pilot-testing a split schedule.

In November 1999, Dr. Jerry D. Weast, then superintendent of schools, presented *Bell Times: Analysis of Additional Options*, to the Board. This second report, developed in consultation with staff and representatives of the Washington Metropolitan Area Transit Authority (WMATA) and Ride-On, presented eight options, including the options requested earlier by the Board to assess eliminating high school buses and using public transit in addition to or in lieu of school buses. Based on the review of options available and the lack of evidence that changing high school bell times would result in improved student academic performance, Dr. Weast did not recommend adoption of any of the options presented.

In October 2012, Montgomery County citizens developed an online petition to express support for a later high school start time. The online petition requested that the Board recognize the research on teenage sleep needs and academic achievement and set a goal to start high schools after 8:15 a.m.

During Public Comments at the December 11, 2012, meeting of the Board, three parents, three sleep experts, and two students testified regarding their desire for later high school start times.

In December 2012, Dr. Starr directed staff to convene a work group—including community stakeholders—to develop options to address students' needs for more sleep, and in particular, to consider adjustments to school start times, often referred to as "bell times."

By January 5, 2013, ten thousand one hundred and sixty-nine online signatures had been gathered on the online petition to express support for a later high school start time. The majority of signatures indicated Montgomery County residency. It was not possible to verify how many of the signatures represented parents of MCPS students.

2013 MCPS Bell Times Work Group

Work Group Membership

The 2013 High School Bell Times Work Group was convened in January 2013 under the leadership of Mr. John Matthews, project manager and former MCPS director of transportation. The group met from January until July 2013. The work group was charged by Dr. Starr with presenting options for bell times based upon their review of current research, current trends in other school districts, previous reports and work in MCPS, and conducting an analysis of the impact of school start times on high school students (see Appendix A). The work of the group was to include analysis of past efforts, analysis of similar efforts in other jurisdictions, input from stakeholders and other experts, and a review of relevant research. Dr. Starr instructed the group not to exclude options based on cost or contractual implications. The group was not tasked with making recommendations, but rather, its task was to present options for further consideration by the superintendent of schools and the Board.

The work group comprised parents, middle and high school students, principals and former principals, and other MCPS staff members responsible for transportation, special education, community outreach, applied research, budget, and policy. Mr. Matthews brought to the work group his thorough knowledge of the history of bell times in MCPS, having participated in previous work in the late 1990s and having traveled to school districts in Minnesota and Colorado to consult with districts who implemented later high school start time schedules.

Presentations by Local Experts

The work group heard presentations by the following local experts in the fields of sleep research and school start time research and representatives from local school districts with later high school start times:

- Dr. Judith Owens, director of sleep medicine, Pulmonary and Sleep Medicine, Children's National Medical Center, Washington, DC
- Dr. Peter Hinrichs, associate professor, Georgetown Public Policy Institute, Georgetown University, Washington, DC
- Dr. Susan G. Robinson, former assistant superintendent, Information Services, Arlington Public Schools, Arlington, VA
- Mr. Fred Evans, former MCPS high school principal and former director of secondary education, Loudoun County Public Schools, Loudoun, VA
- Dr. Kecia Addison-Scott, supervisor of applied research, OSA, MCPS

A summary of the key findings presented by each speaker is summarized in Appendix C.

Collection of Data by the Work Group

The work group commissioned a survey of high school students and parents of high school students by OSA. While consultation with a range of stakeholder groups is important before any

action can be considered to change the school day for thousands of students, the work group thought it was important to approach their task in the following logical sequence of steps:

- Survey the primary intended beneficiaries first (high school students and high school parents) to determine the level of interest in a later start time.
- Develop a limited and specific set of most acceptable bell schedule options for the final report.
- Based on survey results, develop an outreach plan to seek input from stakeholder sub-groups on specific and well-defined options.

The work group considered high school students and their parents to be the primary intended beneficiaries of any changes to bell schedules that might occur. To begin the work, the group decided it was necessary to first determine the interests and issues of these two groups before reaching out to any other stakeholder groups. This should in no way be interpreted to suggest input from high school staff or middle and elementary school stakeholder groups—as well as many others—should not be considered fully.

A thorough description of the survey methodology, survey instruments, and findings is summarized in Appendices D–F. Further, a plan for outreach to additional stakeholder groups is described below, in the section titled Community Assessment Strategy.

Throughout the process, work group members were tasked with conducting conversations with colleagues, peers, and stakeholders among their respective constituencies to collect feedback on issues related to changing bell times. These insights were discussed at the beginning of every work group meeting.

Student members of the Bell Times Work Group should be commended for the initiative they demonstrated in developing and administering their own survey to middle and high school student government representatives. Their outreach to high school students participating in the Montgomery County Regional (MCR) Student Government Association General Assembly and middle school students participating in the Montgomery County Junior Council (MCJC) General Assembly was helpful to the work group in gauging relative levels of student interest in later bell times and is similar in several respects to findings from the survey developed by OSA.

Findings: Summary of the Research Since 1998

Predictors of School Start Times

A common transportation strategy used by more densely populated districts with large enrollments is to stagger school start times, reusing the same school buses to transport students at each start time. Each start time is commonly referred to as a "tier." As a large, metropolitan school district, MCPS has four start times and is referred to as a "four-tier" system.

Less densely populated areas often have only one- or two-tier structures because of the size of attendance areas and the distance buses must travel to pick up students. In these areas, age groups are mixed with younger and older students riding together. Such districts are more likely

to begin schools later, usually between 8:00 and 9:00 a.m. to allow for ride times of an hour or longer.

A 2005 survey of school districts nationwide[5] showed factors associated with earlier start times to include larger enrollments, more affluent communities, urban/inner city environments, and a larger number of bus tiers (as compared to systems with no buses or one tier only). Wolfson and Carskadon found that larger high schools started, on average, 15 minutes earlier than smaller high schools, and more affluent high schools started 12 minutes earlier than less affluent high schools. Schools in districts with two or three bus tiers started earlier than districts with no buses or one tier only. Wolfson and Carskadon's survey did not include a choice for districts with four tiers, as is the case with MCPS.

MCPS is similar to other school districts with large student enrollments, similar demographics, and three or more bus tiers, that start earlier than smaller districts with a more rural profile and fewer bus tiers.

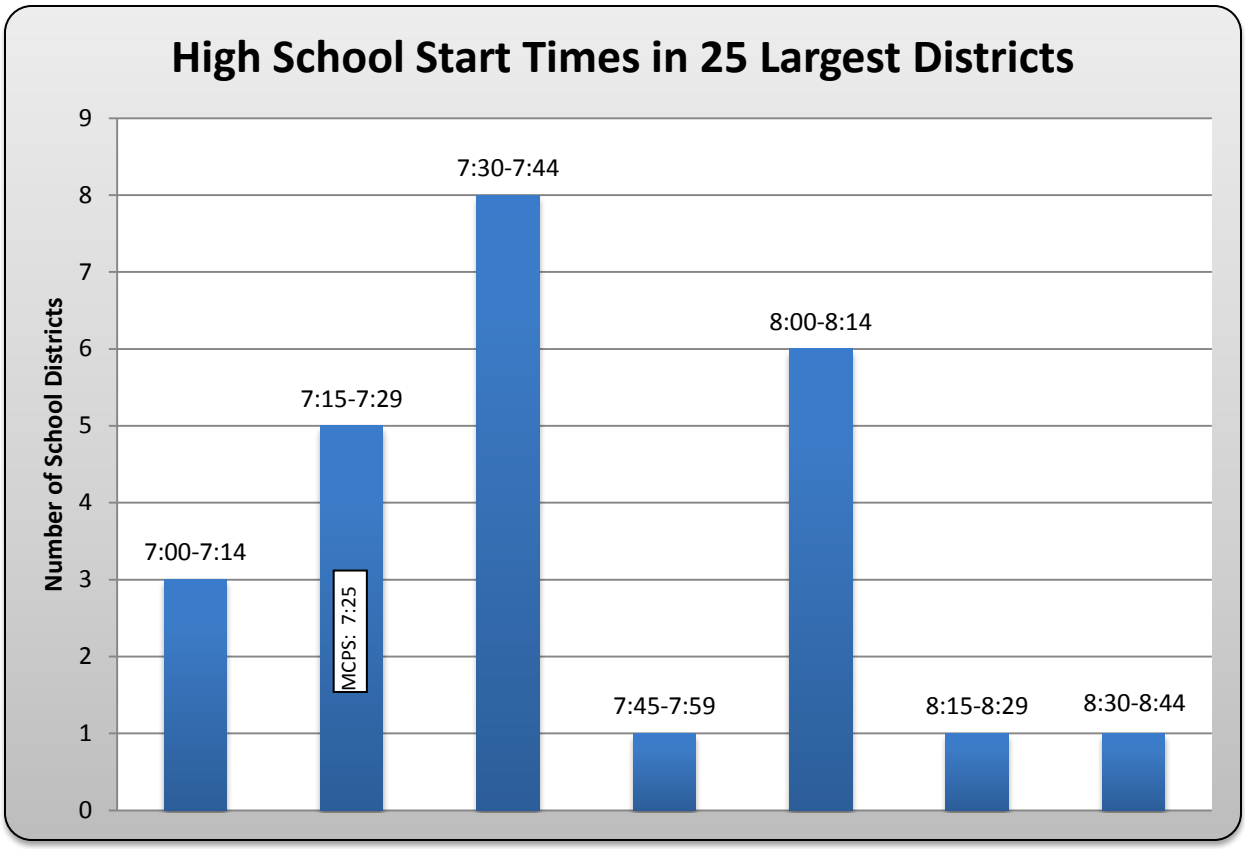
During the 2001–2002 school year, Wolfson and Carskadon found that nationally, the average high school start time was 7:54 a.m. with most high school starting between 7:30 and 8:20 a.m. MCPS's 7:25 a.m. high school start time is at the earlier end of the national profile. Edwards[6] also found the national median start time for middle schools was 8:00 a.m., with roughly 55 percent of middle schools starting between 7:45 and 8:30 a.m.

Nationally, Wolfson and Carskadon found, during the 2001–2002 school year, the average high school start time was 7:54 a.m. with most high school starting between 7:30 and 8:20 a.m.

1997 Survey of 25 Largest School Districts

Previous MCPS research also benchmarked MCPS start times against the start times in the 25 largest school districts in the United States. In 1997, the earliest high school start times in benchmarking districts[7] ranged from 7:00 a.m. to 8:30 a.m. (Appendix G). With its 7:25 a.m. high school start time, MCPS was among the approximately one-third of large school districts starting high schools before 7:30 a.m.

[5] Wolfson & Carskadon, 2005
[6] Edwards, 2012
[7] Many districts have multiple start times for high schools, sometimes as much as one and a half hours apart.


High School Start Times in 25 Largest Districts
Number of School Districts
0
1
2
3
4
5
6
7
8
9
7:00-7:14
7:15-7:29
MCPS: 7:25
7:30-7:44
7:45-7:59
8:00-8:14
8:15-8:29
8:30-8:44

Sleep Research

There is growing awareness that sleep needs vary over the lifecycle[8] and that insufficient sleep contributes to a range of physical, psychological, and public safety problems. Specifically, research shows that insufficient sleep in adolescents is associated with higher rates of obesity;[9] increased incidences of depression;[10] delayed reward-related brain function and lower levels of motivation;[11] lowered ability to complete abstract and complex tasks;[12] lower levels of attentiveness;[13] and increased numbers of traffic accidents.[14]

Adolescent Sleep Needs

As children enter puberty, they experience changes in two of the body's systems that interact to coordinate the sleep/wake cycle.[15] These systems are known as the circadian timing system and the homeostatic sleep system. The circadian timing system is a process that helps coordinate and organize regulatory mechanisms such as feeding, reproduction, and the sleep/wake cycle. These patterns of coordination, or circadian rhythms, are self-sustained and oscillate over a 24-hour time period. Though the circadian timing system oscillates with a time period slightly different than the normal 24-hour day, it synchronizes to the 24-hour day primarily by the daily variation of daylight and darkness.[16] The homeostatic sleep system is described as a process which consists of the pressure to sleep. The longer one is awake, the pressure to sleep increases. And conversely, the longer one is asleep, the pressure to sleep decreases. During puberty, developmental changes in the two systems result in sleep times being shifted later.[17]

Adolescents generally need 8.5 to 9.5 hours of sleep per night.[18] During puberty, however, developmental changes in the circadian timing system and the homeostatic sleep system result in a later shift in the time adolescents can fall asleep. This shift to later bedtimes—combined with early high school start times—results in adolescents reporting that they are not getting enough sleep. In a 2006 poll conducted by the National Sleep Foundation (NSF), adolescents reported sleeping 7.6 hours on school nights.[19] Compared to the hours of sleep adolescents generally need, this represents a sleep gap of between 0.9 and 1.9 hours.

Adolescents generally need 8.5 to 9.5 hours of sleep per night. During puberty, however, developmental changes in the circadian timing system and the homeostatic sleep system result in a later shift in the time adolescents can fall asleep.

[8] Crowley, Acebo, & Carskadon 2007
[9] Hitze et al., 2009; Chen, Beydoun, & Wang, 2008; Knutson, 2005; Al-Disi et al., 2010
[10] Killgore et al., 2008; Dagys et al., 2012; Fredriksen et al., 2004; Moore et al., 2009
[11] Holm et al., 2009; Owens, Belon, & Moss, 2010
[12] Kopasz et al., 2010; Curcio, Ferrara, & Gennaro, 2006
[13] Kim et al., 2011; Beebe et al., 2008
[14] Hutchens et al., 2008; Danner & Phillips, 2008
[15] Crowley, Acebo, & Carskadon, 2007
[16] Czeisler et al., 1981
[17] Carskadon et al., 1997
[18] Carskadon et al., 1980
[19] National Sleep Foundation, 2006

Additionally, more than 50 percent of teenagers who responded to the poll reported they feel sleepy during the day; more than 50 percent reporting driving sleepy in the past year; and only 9 percent of high school students reported getting an adequate amount of nightly sleep (i.e., greater than or equal to nine hours per night).

Obesity

Insufficient sleep is associated with higher rates of poor dietary habits and obesity.[20] Specifically, researchers have found that adolescents who sleep for short periods of time (i.e., less than 9 hours per day) are more likely to have higher body mass index standard deviation scores (BMI SDS) than adolescents who sleep 9 hours per day.[21] Additionally, the duration and quality of sleep have been found to influence diet composition with long and uninterrupted sleep being associated with a better diet.[22] In fact, a meta-analysis of sleep duration and obesity research published between January 1980 and May 2007[23] found that children with shorter sleep duration had a 58 percent higher risk of obesity than children with longer sleep duration, and with each hour increase in sleep, the risk of obesity decreased by an average of 9 percent.

Psychological Problems

In addition to the association between sleep duration and obesity, a lack of sleep also has been shown to be related to a number of psychological problems. These problems include, but are not limited to: depression;[24] delayed reward-related brain function and lower levels of motivation;[25] lowered ability to complete abstract and complex tasks;[26] lowered amounts of working memory and memory consolidation;[27] and lower levels of attentiveness.[28] Regarding depression, adolescents who receive 6.5 hours or less of sleep report decreased positive affect than when rested (receiving 8.5 hours of sleep).[29] This was the case for both adolescents who consider themselves morning persons and those who consider themselves evening persons. Additionally, sleep deprivation also has been shown to be associated with reduced self-regard, reduced empathy towards others, and reduced impulse control.[30]

Sleep facilitates working memory, memory consolidation, and performance in abstract and complex tasks involving higher brain functions.

Important brain functions that are part of the learning process are reward-related brain function, motivation, the ability to complete abstract and complex tasks, working memory and memory consolidation, and attentiveness. Similar to the

[20] Hitze et al., 2009; Knutson, 2005; Chen, Beydoun, & Wang, 2008; Al-Disi et al., 2010
[21] Hitze et al., 2009
[22] Al-Disi et al, 2010
[23] Chen, Beydoun, & Wang, 2008
[24] Killgore et al., 2008; Dagys et al., 2012; Fredriksen, Rhodes, Reddy, & Way, 2004; Moore, 2009
[25] Killgore et al., 2008; Holm et al., 2009; Owens, Belon, & Moss, 2010
[26] Kopasz et al., 2010; Curcio, Ferrara, & Gennaro, 2006
[27] Kopasz et al., 2010
[28] Kim et al., 2011; Beebe et al., 2008
[29] Dagys et al., 2012
[30] Killgore et al., 2008

association between depression and sleep deprivation, each of these brain functions has been shown to be affected negatively by inadequate amounts of sleep. A review of the literature published between 1996 and 2008 using the keywords "sleep," memory," "learn," "child", "adolescents," and "teenager" found that most research supports the hypothesis that sleep facilitates working memory, memory consolidation, and performance in abstract and complex tasks involving higher brain functions.[31] Additional research has suggested that adolescents who sleep for shorter periods of time are less attentive[32] and less responsive to reward-related brain function, thus require more exciting rewards.[33] This can lead to adolescents being difficult to motivate in the classroom and higher levels of participation in risk-taking/risky behaviors both in and out of school. In fact, a study of one Rhode Island high school[34] suggests that even an additional 30 minutes of sleep can improve adolescents' self-reported motivation and alertness.

Traffic Accidents

Through a nationally representative telephone survey of United States drivers ages 14 to 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.[35] These results held true even after controlling for gender, average hours driven per week, urban vs. suburban driving, sensation-seeking driving, and hours slept per night.

School Start Time Research

Outcomes of Changing Start Times

The following articles examined outcomes associated with school districts that changed school start times. To be included in this group of articles, the subject of the study needed to be a school system that shifted start times later, and there had to be some basis of comparison: either outcome data from a similar school district that did not make the change, or outcome data gathered from the same district before and after the schedule change. Few studies met these search criteria. The search yielded only one study involving a school district of comparable size to MCPS and only one systemwide study that demonstrated academic gains associated with later start times.[36] Two studies showed lowered teen driving car crash rates during morning school commute time, and three studies showed students obtained more sleep with later start times.[37]

Edwards' 2012 study[38] of Wake County, NC (WCPSS) schools compared middle schools within the same district with varying start times. WCPSS enrollment was 120,504 in 2005–2006.

[31] Kopasz et al., 2010
[32] Beebe et al., 2008
[33] Holm et al., 2009
[34] Owens, Belon, & Moss, 2010
[35] Hutchens, Senserrick, Jamieson, Romer, & Winston, 2008
[36] While not focused on a K–12 school district, a related study of undergraduates at the United States Air Force Academy (Carrell, Maghakian, & West, 2011) showed improved academic achievement among first-year students associated with delay in start time from 7:00 a.m. to 7:50 a.m. A similar study of recruits at the U.S. Navy's Recruit Training Command (Miller, Shattuck, Matsangas, & Dyche, 2008) showed that recruits who received 8 hours of sleep performed better than recruits receiving 6 hours of sleep on an academic performance assessment.
[37] However, only one of the three articles focused on a school district. The other two studied single schools.
[38] Edwards, 2012

The district was characterized as mostly urban and suburban with a three-tier bus structure. Increased enrollment during a six-year period from 1998–1999 to 2005–2006 resulted in new schools opening and several changes in start times, allowing Edwards to measure variation in academic performance and school start times within and across WCPSS schools. Edwards found gains in mathematics and reading test scores associated with later start times. Further analyses revealed larger positive effects for students on the lower end of the distribution of test scores, and, consistent with research on the sleep needs of pubescent adolescents, a delayed start time had a positive effect on achievement for 13- and 14-year olds but no effect for 11- and 12-year olds.

Hinrichs[39] compared Minneapolis Public Schools (MPS) and St. Paul Public Schools, two adjacent, demographically similar districts, to assess the relationship between later start time and ACT scores. MPS high schools shifted start times from 7:15 a.m. to 8:40 a.m. in 1996. St. Paul high schools started at 7:30 a.m.[40] MPS enrollment was 32,236 in 2012, compared to St. Paul's enrollment of 39,000. His analysis of data from 1993–1994 to 2001–2002 found no effect of school starting times on achievement or attendance. He also assessed statewide, standardized test scores from Kansas and Virginia and similarly found no relationship.

A related 2002 study by Walstrom[41] of the Minneapolis Public Schools that compared outcomes three years before and three years after the schedule change similarly found no effect on grades.

A 2005 study[42] of nearby Arlington Public Schools (APS) evaluated middle and high school outcomes comparing data from 2001–2002, the first year APS implemented later high school start times (2001–2002), to the prior year (2000–2001). High school teachers and students reported increased participation in first period classes after high school start times shifted 45 minutes later, from 7:34 a.m. to 8:19 a.m. Conversely, middle school teachers and students reported decreased participation in first period classes after middle school start times shifted 20 minutes earlier, from 8:10 a.m. to 7:50 a.m. There was no effect on high school grades, and study design concerns made it difficult to interpret differences in middle school grades. Thirty-six percent of high school students reported there was no difference in their participation in extracurricular activities, and 29 percent reported they were participating more. Forty-four percent of high school students reported they liked the adjusted start time, and 21 percent said it made no difference. Forty-two percent of middle student reported they did not like the adjusted start time, and 28 percent said it made no difference.

Although not a study of a school system, a 2007 comparison of two urban New England middle schools by Wolfson et al[43] showed that eighth grade students who started school at 8:37 a.m. performed better on academic measures than students who started at 7:15 a.m. It is interesting to note that there were no differences in academic performance for seventh graders, similar to Edwards' finding that a later start positively impacted 13- and 14-year olds, but not 11- and 12-year olds.

---

[39] Hinrichs, 2010

[40] St. Paul schools adjusted start times in 2011–2012 as follows to shift schools to a three-tier system to save transportation costs and achieve other system goals: high school start times were unchanged at 7:30 a.m.; middle schools start times were moved 30–90 minutes earlier to place all middle schools on the same 7:30 a.m.–2:00 p.m. schedule as high schools; elementary school start times were adjusted up to 60 minutes earlier or later to start all elementary schools at 8:30, 8:35, 9:30, or 9:35 a.m.

[41] Walstrom, 2002

[42] Arlington Public Schools, 2005

[43] Wolfson, Spaulding, Dandrow, & Baroni, 2007

A 2011 study[44] of adjacent, demographically similar cities showed that the teenage driving crash rate during morning school commute time was higher in Virginia Beach, VA, where high schools started at 7:20 a.m. or 7:25 a.m., compared to Chesapeake, VA where high schools started at 8:40 a.m. or 8:45 a.m. Chesapeake Public Schools enrollment was 39,630 in 2013, compared to Virginia Beach Public School's enrollment, which was 68,408 in the same year.

As seen with the shift in high school start times and adolescents' self-reported motivation and alertness,[45] a one-hour delay in high school start times in Lexington, Kentucky[46] was associated with a 16.5 percent decrease in automobile collision rates for high school-aged drivers across the county. This pre-/post-study assessed traffic data for 17- and 18-year olds two years before and two years after a change in start times in Fayette County Public Schools, Lexington, KY. Fayette County changed high school start times from 7:30 a.m. to 8:30 a.m. in 1998. This decrease in collisions was observed at the same time automobile collision rates for high school-aged drivers increased by 7.8 percent across Kentucky.

Research also shows a positive relationship between a delayed start times result and student sleep. A 2002[47] study of Minneapolis Public Schools (MPS) and a matched school district showed that MPS students slept 46 minutes longer than students in a comparable district with an earlier start time. When students in the same districts were surveyed three years later, students in the later start time group slept 58 minutes longer.

While its sample is limited to a single school, a 2010 study by Owens et al[48] showed that when start times were delayed from 8:00 a.m. to 8:30 a.m. at an independent high school in Rhode Island, students slept 45 minutes longer. A similar 2008 study by Htwe et al[49] of 259 students at a single high school showed that when start times were delayed by 40 minutes, from 7:35 a.m. to 8:15 a.m., students slept 33 minutes longer, on average.

Impact on Family

A 1999 study[50] of 18 Minnesota school districts documented impacts of changing school start times on family life.

Families were differentially impacted by school start time changes, depending on their level of affluence. While more affluent families reported having to change job schedules, less affluent families reported having less flexibility in their jobs, often having to change jobs entirely to meet the demands of the new schedules. Less affluent families were more likely to report concerns about transportation and childcare.

[44] Vorona et al,, 2011
[45] Owens, Belon, & Moss, 2010
[46] Danner & Phillips, 2008
[47] Wahlstrom, 2002
[48] Owens, Belon, & Moss, 2010
[49] Htwe, Cuzzone, M. O'Malley, & E. O'Malley, 2008. Available documentation does not provide identifying information about the high school that is the subject of the study, except to say that the enrollment of the high school was 977 in 2004.
[50] Wrobel, 1999

Ten thousand study participants included students, parents, school staff members, and key community stakeholders.

Wrobel found that families were differentially impacted by school start time change, depending on their level of affluence. While more affluent families reported having to change job schedules, less affluent families reported having less flexibility in their jobs, often having to change jobs entirely to meet the demands of the new schedules. Less affluent families also were more likely to report concerns about transportation and childcare. Specifically, less affluent families were more likely to report limited transportation alternatives and "non-existent" child-care options that were affordable and reliable. By comparison, more affluent families were more likely to report that their primary concern about school start times was what was in the best interest of students.

Families' ability to adjust work and family needs to new schedule demands also were positively impacted by sufficient forewarning about the schedule change. Among the findings were recommendations about the policy process of instituting change. Wrobel reports that communities that had ample warning about impending changes in start time schedules had less difficulty adjusting. Wrobel specifically recommends not making a quick change. Similarly, community stakeholders who described the policy process as open and sensitive to their needs were able to make more informed decisions and adjust better to the change in schedule.

Students who reported having discussed sleep and the impacts of sleep on school performance in school were better prepared for the schedule change, reportedly making better decisions about sleep habits and time management. Students who reported little involvement in or preparation for the change in start time were more likely to report simply staying up later as a result of the later start times.

Families whose children attended schools that moved to later elementary start times reported the negative impact of adding morning child care and the resulting additional transition in the morning from home to day care to school. Similarly, families reported elementary students viewing two or three hours of television before school. Teachers reported later elementary schedules took away optimum hours of elementary students' prime learning time early in the day.

Families of special needs students reported mixed effects. Parents of students with substantial needs for personal care reported advantages to a later start in the morning, while teachers reported that behavior of some students with special needs deteriorated in the later afternoon hours.

MCPS Research: 2013 Survey of High School Start Times

In spring 2013, OSA surveyed high school students and parents of high school students. The findings are summarized below, and a complete report of the methodology, survey instruments, and findings are included in Appendices D–F.

The 2013 survey included a random sample of 4,335 parents of MCPS students in Grades 9–11. The response rate for the parent survey was 23 percent. A sample was selected of 150 high school classes across 25 MCPS high schools, resulting in feedback from 3,034 students in

Grades 9–11. Ninety-one percent of classes sampled responded..

Seventy percent of parents who responded reported that high school started "too early," and 69 percent preferred high school start later, either 30 minutes or one hour. (See the inset below to compare 2013 findings to 1996 findings.) Twenty-eight percent of parents reported start times should remain the same, and 3 percent reported no preference. Sixty-three percent of high school students surveyed reported high school started "too early," and 54 percent indicated they wanted high school to start later, either by 30 minutes or one hour. Thirty-eight percent of students reported start times should stay the same, and 8 percent reported no preference.

Comparison to 1996

The 1996 MCPS School Calendar Survey was conducted shortly after MCPS moved to the current standardized start schedule for all high schools. Parents of high school, middle school, and elementary students assessed school start times as follows:

- High school parents reported high school started "too early" (45 percent) or "at the right time" (55 percent)
- Middle school parents reported middle school started "too early" (24 percent), "at the right time" (75 percent), or "too late" (1 percent)
- Elementary school parents reported elementary school started "too early" (2 percent), "at the right time" (74 percent), or "too late" (24 percent)

Detailed in the findings are students' and parents' perceptions of benefits and drawbacks to starting school later, students' self-reports about the amount of sleep they receive each night, as well as students' perceptions of the degree to which they sleep in class. When asked to rate eight categories of possible impacts to family life such as child care, employment, or transportation, 44 percent of parents reported a later bell time would have a positive impact on the safety of their child, and approximately one-half or more responded that a later bell time would have no impact on the remaining categories: child care before or after school (86 percent and 84 percent, respectively), the employment schedule for their child (74 percent), and after-school activities/clubs or practices/events (52 percent and 53 percent, respectively).

Students were asked to respond to a number of positive and negative statements about how a later start time would be better for them or a problem for them. On the positive side, 85 percent responded "I will get more sleep," but problems students anticipated were that it would be harder for them to get a job after school (36 percent), participate in after-school activities/clubs (31 percent), or participate in athletic practices/events (30 percent).

Students were asked to indicate the average number of hours of sleep they get a night. Based on responses, students sleep about 7 hours or less each night. Students were asked to identify how frequently they fell asleep or lost focus in their first or second period class in the past month. About one third of respondents reported "2–4 days per week" and 30 percent reported "every day."

Student Surveys

Two surveys designed by student members of the work group polled middle and high school student government representatives. The surveys were administered to high school MCR representatives and to middle school MCJC representatives at their respective general assembly meetings. Their findings showed that MCR representatives reported sleeping less than the national average and slightly less than the MCPS average. Similar to OSA's findings from MCPS high school students generally, 38 percent of MCR respondents reported dozing off or losing focus in first or second period classes 2–4 times a week, and 28 percent reported dozing off every day. MCR representatives were about as likely to report wanting a later start time as the general MCPS high school student population.

Results from 60 MCR representatives showed 51 percent thought the 7:25 a.m. start time was too early, and 43 percent thought the bell time should change. MCR respondents reported sleeping 6 hours and 15 minutes, on average; 66 percent reported dozing off in class at least twice a week; and 67 percent reported that if start times were moved later, they would go to sleep at the same time. Sixty percent of MCR representatives responding to the survey reported that they would be interested in an option that would allow them to arrive later and take one or two of their classes online.

Sixty percent of MCR representatives reported that they would be interested in an option that would allow them to arrive later and take one or two of their classes online.

Results from 70 MCJC representatives—of which 60 percent were in Grade 8—showed that they sleep 6 hours 48 minutes on average. Sixty percent thought the 7:55 a.m. middle school start time was too early. Fifty-seven percent reported that if start times were moved later, they would go to sleep at the same time. Forty-three percent of MCJC respondents reported dozing off or losing focus in first or second period classes 2–4 times a week, and 22 percent reported dozing off every day.

Sleep in the News

Public awareness of sleep needs has been informed by the popular press and recent public statements of organizations such as the American Medical Association (AMA). For example, a 2010 AMA resolution identified insufficient sleep and sleepiness in adolescents as a public health issue and supported education about sleep health as a standard component of care for adolescent patients. In the period during which the 2013 MCPS Bell Times Work Group was convened, articles such as the following appeared in the popular press:

- A 2013 *Newsweek* article notes similarities between sleep disorders and attention deficit hyperactivity disorder (ADHD) and describes one physician's success negating patients' ADHD symptoms by treating them for lost sleep.
- The British Broadcasting Company (BBC) reported out a set of findings from the Trends in International Mathematics and Science Study (TIMSS) and Progress in International Reading Literacy Study (PIRLS) study conducted by Boston College. The international comparison study found the United States to have the highest numbers of sleep-deprived

9- and 10-year olds and 13- and 14-year olds. Comparisons of sleep habits and test results showed that students who obtained more sleep achieved higher on mathematics, science, and reading tests. The lack of sleep in affluent countries like the United States and Saudi Arabia was attributed, in part, to students having cell phones and tablets and the impact of the light from the screens on their ability to fall asleep.

- The *Huffington Post* updates its sleep web page daily with emerging research—including a recent article from the Centers for Disease Control, sleep hygiene advice, and blogs by researchers from such institutions as the Stanford Center for Sleep Sciences and Research.

Options and Implications

Bell Times Work Group Process

The following lists describe what the work group considered "must haves" and "deal breakers" for any option under review:

Must haves

- Must address needs of primary stakeholders
- Must have "sleep education"/health education campaign for students, parents, and staff
- Benefits must be clear and unassailable
- Must be the right thing to do (willing to consider costs for options that will produce real benefits)
- Must be a true net gain (described in more detail below)

Deal breakers

- May not be too costly (but would consider a plan that phases in a change, thereby spreading increased costs over multiple years)
- Is not the right thing to do for students
- Is not focused on student achievement
- Adversely affects non-affluent students/families
- Creates inappropriate start times for any student
- Has a significant negative impact on non-school activities/extracurricular activities

Who is a primary stakeholder? While the current 7:25 a.m. start time for high school students provided impetus for the work group to convene, middle school students and elementary students and their families clearly are stakeholders who would be impacted by any change to the school start time schedules. The group was unanimous in their concern for students at any school level traveling to or from school in the dark. Similar concern was expressed for any schedule change option that would delay elementary school start times in such a way that created unintended negative consequences such as creating a need for morning child care or depriving students and teachers of key morning hours when elementary students are most awake and attentive for learning. There was general agreement that earlier start times for elementary schools would be beneficial to elementary students. A related discussion of the length of the elementary school day is described below in Table 1: Options for Consideration.

The group was unanimous in their concern for students at any school level travelling to or from school in the dark. Similar concern was expressed for any schedule change option that would delay elementary school start times in such a way that created unintended negative consequences such as creating a need for morning child care or depriving students and teachers of key morning hours when elementary students are most awake and attentive for learning.

Group members were similarly unanimous in their concern for equity and any unintended negative consequences that could adversely affect non-affluent families more than other families. Research on impacts of changing school start times on families[51] summarized above describes the kinds of issues that tend to vary with levels of affluence, such as flexibility of work and the availability of transportation and child care.

The work group encountered disagreements primarily in the area of what types of evidence from the research were considered sufficiently compelling to justify changes to school start times, with resulting costs and impacts on other stakeholders. The group did not reach agreement on what it considered "clear and unassailable benefits." The large body of research reviewed showed numerous benefits of sleep and numerous psychological, physical, and public health problems associated with sleep deprivation. However, some group members interpreted "clear and unassailable benefits" to mean only gains in academic achievement that could be shown to result directly from starting high school later. The current body of research did not appear to conclusively demonstrate that changing start times would result in academic outcome gains. The lack of substantive gains in grades or test scores led many group members to conclude that available research was not sufficiently compelling to support changing the bell time schedule.

While most group members focused on academic benefits, a few members focused on more broad outcomes such as more sleep for high school students and the associated psychological, physical, and public health benefits. As a whole, the group acknowledged the value of these benefits. The group used the term "true net gain" to weigh the various benefits and various costs—to think through the possible benefits to students at all levels against the financial impact on the operating budget and the disruption and adjustments associated with widespread schedule changes at all school levels. For example, would changing the high school schedule by 30 minutes or one hour produce enough of a difference in high school students' sleep to end sleep deprivation or only partially mitigate it? Would sizable academic gains result, or would they be only minimal, if at all? Could other benefits result for elementary or middle school students that would make disruption of school schedules at all levels appealing to stakeholders at those levels? Would they be worth the costs?

The following options presented represent the outcome of work group deliberations, but no single option represents group consensus. Expected benefits associated with each option as well as concerns expressed about each option are presented.

Sleep Education Campaign

Presentations by local experts on sleep needs were compelling to many group members, and consensus emerged that MCPS should conduct a sleep education campaign for students, parents, and staff. The American Medical Association passed a similar resolution in 2010 to include sleep hygiene education in members' care of adolescent patients. Evidence presented to the work group about the wide discrepancy between the hours of sleep needed versus the hours of sleep typically achieved by students, the impact of electronic devices on sleep habits, and other important findings in the sleep research literature regarding the academic, psychological, physical, and public safety problems associated with sleep deprivation should be shared with the

[51] Wrobel, 2005

general public. However, sleep experts argue that sleep education alone will not resolve the sleep deficit experienced by high school students who need to rise early. To obtain the recommended nine hours of sleep, a high school student who needs to rise at 5:30 a.m. would need to be asleep by 8:30 p.m., which is unlikely. Similarly, to best align with the biological clock of adolescents, students would need to sleep from 11:00 p.m. to 8:00 a.m. and arrive at high schools around 9:00 a.m.

During the course of the work group meetings, many articles appeared in the news about sleep and are summarized above. The volume of coverage in the popular press demonstrates the emerging awareness of the science of sleep. The work group became attuned to these articles which often talked about adult and child sleep needs, sleep deprivation, and its impact on long-term health outcomes which included increased hypertension, obesity, and other health impairments. These studies showed that Americans in general are sleep deprived. This lack of regard for sleep needs carried over into Americans' opinions about what they value about children's sleep and what they consider acceptable and normal for students. The work group agreed that a holistic approach including education on sleep for students and adults was a worthwhile endeavor.

Current Schedule

The current bell times schedule for MCPS is as follows:

Level	Time	Length of Day
High School (HS)	7:25 a.m.–2:10 p.m.	6 hours, 45 minutes
Middle School (MS)	7:55 a.m.–2:40 p.m.	6 hours, 45 minutes
Elementary School Tier 1 (ES1)	8:50 a.m.–3:05 p.m.	6 hours, 15 minutes
Elementary School Tier 2 (ES2)	9:15 a.m.–3:30 p.m.	6 hours, 15 minutes

Schedule Changes

The group considered schedule configurations and other strategies to address insufficient sleep in teens. Table 1 summarizes proposed schedules and anticipated benefits and key concerns. Appendix H provides additional information on cost calculations.

Table 1: Options for Consideration

OPTION	OPTION DESCRIPTION	SCHEDULE
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	MS 7:45–2:30 HS 8:15–3:00 ES1 9:00–3:25 ES2 9:25–3:50
1A	(Modification of Option #1) • Switch order of high schools and middle schools • 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	MS 7:45–2:30 HS 8:15–3:00 ES1 8:50–3:25 ES2 9:15–3:50
Discussion of Options 1 and 1A: Starting middle schools before high schools, before 8:00 a.m., allows high school students to start school 50 minutes later and leaves elementary school families' lives minimally impacted. However, research shows the sleep needs of pubescent middle school students are similar to those of their high school counterparts, and the 7:45 a.m. start time would not be optimal for older middle school students. The delayed start for elementary schools in option 1 further exacerbates the already late beginning of their day. **Estimated Costs**: Option 1: $9,054,495 (transportation) + $260,000 (utilities) = $9,314,495 Option 1A: $11,500,301 (transportation) + $515,000 (utilities) = $12,015,301 (*See Appendix H for additional information on cost calculations*)		
OPTION	**OPTION DESCRIPTION**	**SCHEDULE**
2	• All start times are moved 35 minutes later • Order and length of day remain the same	HS 8:00–2:45 MS 8:30–3:15 ES1 9:25–3:40 ES2 9:50–4:05

2A	(Modification of Option # 2) • All start times are moved 25 minutes later • Order and length of day remain the same	HS 7:50–2:35 MS 8:20–3:05 ES1 9:15–3:30 ES2 9:40–3:55
Discussion of Options 2 and 2A: Starting all schools 25–35 minutes later incurs no additional costs and creates more desirable start times for high school (7:50 a.m. or 8:00 a.m.) and middle school (8:20 a.m. or 8:30 a.m.). However, 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). **Estimated Costs**: $0 (no transportation impact/no utilities impact)		
OPTION	**OPTION DESCRIPTION**	**SCHEDULE**
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[52] 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	ES1 7:50–2:35 HS 8:20–3:05 MS 8:50–3:35 ES2 9:20–4:05

[52] One of the factors that limits MCPS's flexibility to change the opening order of schools is the difference in the length of the school day for elementary (6 hours 15 minutes) versus middle and high schools (6 hours 45 minutes). Under the existing bell schedules, schools end roughly 30 minutes apart. But because the length of school day is not uniform, start times are not all 30 minutes apart. While there is a 30-minute gap between middle and high school start times, there is a 55-minute gap between the middle school start time and the first elementary start time. Equalizing the length of the school day for all levels makes changing the order less problematic from a transportation scheduling perspective.

Discussion of Option 3: Starting elementary schools before middle and high schools is consistent with elementary students' sleep patterns and their tendencies to be alert and active in the early part of the day. An earlier start time for elementary schools appears to be a favorable option for many elementary school parents, teachers, and principals. Further, Option 3, as presented, proposes adding 30 minutes to the elementary school day and extending needed instructional time to assist elementary students in developing foundational skills. This brings the length of the MCPS elementary school day more in line with other Maryland school districts.[53] Option 3, as presented, starts high schools on the second tier and middle schools on the third tier to minimize the impact to after school activities. An undesirable feature of this arrangement is that the second elementary start time is on the fourth tier, and two elementary start times one and a half hours apart may make it more difficult to coordinate planning, training, and meeting times for staff members at elementary schools on different schedules. However, if high schools or middle schools move to the third or fourth tiers, the school day would end at 3:35 p.m. or 4:05 p.m., cutting into coveted after-school hours and leaving some families with the challenge of supervising elementary students after their school day ends, and several months of the year some elementary students may return home after sunset.

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

OPTION	OPTION DESCRIPTION	SCHEDULE
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.	No Change

Discussion of Option 4: Leaving the schedule the same and depending on existing within-day flexible scheduling practices and other instructional strategies to minimize students falling asleep in first period classes causes minimal disruption to existing patterns and, in some cases, permits some high school students to arrive after the first period. However, without providing transportation for second period, schedules that allow high school students to arrive after first period assumes that students will provide their own transportation to school for second period, making it difficult for students without transportation of their own or access to public transportation. Further, taking full advantage of this option requires that students and their parents possess a degree of scheduling savvy to pursue and attain a non-traditional schedule.

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

[53] Data from the Maryland State Department of Education (Appendix I) showed that MCPS had the shortest elementary school day of all Maryland counties. Sixteen of 24 Maryland counties had elementary school days of six hours and thirty minutes or longer.

Explanation of Option 4 existing within-day scheduling practices that may address concerns about first period classes:

Abbreviated student schedules: Existing practices allow for students to construct an optional abbreviated schedule with their principal's approval. However, these practices may not be widely known or understood. These strategies typically assume the student is providing his/her own transportation.

- Students may ask, on an individual basis, to have an abbreviated schedule so they may arrive after first period (or leave before the last period), or they may arrive for first period but spend that time getting ready for the day by using the school media center or other appropriate space. Students also may request to take an online class occasionally, and taking such a course also enables them to arrive late.

- Many students have sufficient credits to take an abbreviated schedule at some point in their high school careers. With a seven-period day, most students earn 28 credits over four years, but only need 22 credits to graduate.

Optional abbreviated schedules have been used for the following purposes:

- Allow students to leave school early to participate in internships or college courses
- Accommodate students with special health needs
- Transport students to a class offered at only one MCPS school (e.g., students from Seneca Valley High School, Quince Orchard High School, and Northwest High School attending a "singleton" class—a class not taught at all schools)

For abbreviated schedules to be a viable option for addressing sleep deprivation, the process for obtaining an abbreviated schedule would need to be better known and accessible to all students, not just those requiring documented accommodations.

Rotating class periods: "Rotating class periods" is defined, for purposes of this discussion, as classes that meet during different class periods, depending on the day of the week. It was suggested that a first-period class, for example, might meet in a later class period during some days of the week. This option was offered as a possible way to address students who may not do well in their first-period classes because they are sleepy but may be more awake during a later period of the day.

Explanation of Option 4 instructional practices that may address concerns about first period classes:

Flipped instruction: "Flipped classroom" is defined, for the purposes of this discussion, as a teaching technique whereby students first study a topic outside of class, possibly with a teacher-created videotape. Classroom time then is used for application of the content through a variety of practices that might include problem-solving, project-based learning, or other applied learning. This option was offered as a possible way to make first-period classes more active for the potentially sleepy student or to offer the student who has mastered the content outside of class the opportunity to sleep late.

Tele-learning or online learning: Students utilizing remote learning options may create more flexible school day schedules.

Community Assessment Strategy

Next Steps for Community Dialogue

While the work group surveyed high school students and their parents to gain preliminary data regarding interest in adjusting school start times, any further efforts to change the bell time schedule require a comprehensive approach to determine the community's needs, interests, and impact. The community assessment strategy should present information about the relationship between sleep and learning and seek feedback from students, parents, and staff members at all school levels and youth-serving organizations, day-care providers, businesses, and other communities of interest. The lesson learned from the research and from the experience of a neighboring school district was that successful implementation of change depends on community engagement.

Particular effort should be made to elicit feedback from minority, low-income, and other groups that do not broadly participate in discussions of this kind and who, as research in other districts showed, tended to be disproportionately affected by efforts to change school start times. Information should be gathered by a variety of means, including surveys, focus groups, discussion forums, and social media. The intent of community meetings and focus groups should be as follows: 1) provide background information and an overview of the assessment process; 2) garner information regarding impact to stakeholders; 3) present proposed solutions/scenarios; and 4) offer a time for community comment on the proposals.

Particular effort should be made to elicit feedback from minority, low-income, and other groups that do not broadly participate in discussions of this kind, who, as research in other districts showed, tended to be disproportionately affected by efforts to change school start times.

Experience from past MCPS efforts, historical data, and preliminary discussions with parent groups showed that support for or resistance to later high school bell times fluctuates when stakeholders consider effects of later start times and later end times on schools at other levels, after-school jobs and activities, and supervision of younger students. Rather than conducting community outreach on the general idea of a later high school bell times, the work group considered it vital that future community conversations focus on a set of specific proposed schedules, thereby making the benefits and trade-offs more concrete and the feedback more meaningful.

Rather than conducting community outreach on the general idea of a later high school bell times, the work group considered it vital that future community conversations focus on a set of specific proposed schedules, thereby making the benefits and trade-offs more concrete and the feedback more meaningful.

The timeline of the work group required the 2013 Bell Times Work Group to define and consider options at the same time as surveys to high school students and their parents were developed and administered. The group felt it was important to delay meeting with additional stakeholders until a limited and specific set of options could be put forward.

Therefore, an outreach plan, such as the one described above, should be implemented to continue the discussion toward exploring acceptable solutions for all stakeholder groups.

Conclusion

The student who sleeps in class misses an opportunity to learn. The student who drives while sleepy is a danger to him- or herself and others. The evolving science of sleep shows ever more clearly why adolescent students do not sleep as much as they should and what necessary and important things do not happen when they are sleep deprived.

The reevaluation of the sleep research and the school start time research by the 2013 High School Bell Times Work Group shows very clearly that since 1998, when similar analyses were last conducted, scientists have demonstrated that sleep is even more important than previously thought. It also shows that students, their parents, and MCPS staff members need to take sleep, for students—as well as for themselves—more seriously. A volume of articles in the popular press, not just the academic press, shows that this is starting to happen.

While sleep science tells us the "whys" and "what happens" of sleep and sleep deprivation, the answer to the question of "how to make it better" is much like putting a puzzle together. Students and parents of students can learn more about sleep hygiene and take proactive steps to get students more sleep. However, in a community that places a high value on well-rounded, busy students and with students who place a high value on near-constant communication, those particular pieces of the puzzle are not easy to put in place, as any parent of a teenager will readily testify. But they are important parts of the puzzle.

Equally important are the pieces of the puzzle that school districts can initiate. Even though the science of school start time research does not demonstrate conclusively that shifting high school start times later produces academic gains, the options offered above demonstrate a variety of ways school start times can be reconfigured and within-day schedules can be adjusted to allow the possibility for high school students to get more sleep. Each has its basis in research or public opinion, and each has benefits and drawbacks.

The next question is not necessarily "how to get students more sleep"—it is already abundantly clear that busy students' demanding schedules need to be reassessed and electronic screens need to be turned off earlier. Several options for later high school start times are possible, but each has a cost—either a financial cost, an opportunity cost, or an impact on one's own life or another's. However, the questions need to be asked, "how much are we, collectively, willing to change" and "what are we, collectively, willing to give up?"

Appendices

Appendix A: Charge Statement to the Bell Times Work Group

Charge Statement: The work group will review current research and previous reports and conduct an analysis of the impact of school start times on high school students in order to develop options for high school bell times. Work will include analysis of past efforts, analysis of similar efforts in other jurisdictions, input from stakeholders, and scientific data from sleep experts/studies. The work group will report on findings and options.

Deliverables: (SMART Goals—Specific, Measurable, Agreed to, Realistic, and Time specific)

- By January 15, 2013, the project manager, with input from the chief operating officer, will identify and contact the members of the work group.
- By February 1, 2013, the work group will meet and review the charge statement; the project manager will present a comprehensive set of materials to group members to familiarize members on all aspects of this topic which will include community interests, historical background, contemporary sleep studies, and other related materials to begin discussions; and define the schedule for work.
- By March 1, 2013, the work group will be well versed on the subject matter and will structure questions and begin seeking stakeholder input.
- By April 2013, the group will have identified other school districts where changes have been implemented and begin gathering critical data and information regarding costs, challenges, and outcomes.
- By April 2013, the work group will have a full understanding of the issues and begin in-depth examination of information gathered and begin to define options.
- By April 2013, the work group will have received all input from stakeholders; analyzed all available scientific data, performance outcomes, social outcomes, cost factors, and related potential outcomes of bell time changes implemented elsewhere; and begin final examination and consideration of workable options.
- By May 2013, the work group will summarize options and present their findings to the chief operating officer.

Project Scope:

- In scope: Consider all available data on teenage sleep needs, available experiential data, cost data, and comparable school system efforts.
- Out-of-scope: Limiters such as funding, contract changes, or other tasks needed to implement options.

Initiative Manager: Mr. Larry Bowers, chief operating officer

Steering Committee: Association Leaders/Deputies/Chief Operating Officer (ADC)

Project Manager: Mr. John Matthews, retired director, Department of Transportation

Team Members:

Dr. Kecia Addison-Scott, *supervisor, Office of Shared Accountability*
Ms. Traci Anderson, *assistant to the chief engagement and partnership officer, Office of the Chief Engagement and Partnership Officer*
Dr. William Beattie, *director, Systemwide Athletics*
Ms. Susan Burkinshaw, *treasurer and co-chair of Health and Safety Committee, MCCPTA*
Mr. Matthew Devan, *principal, Viers Mill Elementary School*
Ms. Carol L. Goddard, *principal, Gaithersburg Middle School*
Dr. Alan S. Goodwin, *principal, Walt Whitman High School*
Mrs. Ruth Green, *director, High School Instruction and Achievement, Office of School Support and Improvement*
Miss Dahlia Huh, *student, Clarksburg High School*
Miss Omisa Jinsi, *student, Herbert Hoover Middle School*
Mr. Thomas Klausing, *director, Department of Management, Budget, and Planning*
Ms. Mandi Mader, *chair, Montgomery Chapter, Start School Later*
Ms. Charlene Parilla, *supervisor, Department of Special Education Services, Office of Special Education and Student Services*
Ms. Sheri Phillips, *special education teacher, Winston Churchill High School*
Mr. Steve Schwartz, *SEIU Local 500 representative*
Mrs. Caroline Snelson, *teacher, Bells Mill Elementary School*
Mr. Todd Watkins, *director, Department of Transportation*

Staff Support:

Ms. Robin Confino, *executive director, Office of the Chief Operating Officer*
Ms. Sally Davis, *policy specialist, Office of Shared Accountability*

Critical to Quality:

- Access to relevant experiential data supporting critical analysis
- Balanced inclusion of all stakeholder input
- Understanding the impact on groups of stakeholders and community groups

Appendix B: History of Activities on Changing Bell Times

March 31, 1998	Public hearing and comment on ***Changing Bell Times: Report of the Bell Times Work Group***
April 20, 1998	Board of Education (Board) commissions a *Citizens Task Force*, including representatives of the health care, commerce, traffic, public transportation, recreation, juvenile justice, student, parent, teacher, principal, and staff communities to study all of the multifaceted aspects of changes to bell times.
October 26, 1998	The *Citizens Task Force* presents its report to the superintendent. Three scenarios are presented: *Delay high school starting times by 50 minutes, split high school schedule and offer two starting times, and reverse starting times of middle and high schools and start all schools 15 minutes later.* They recommend the second (split starting times) scenario.
November 10, 1998	The Board passes a resolution to pilot test *Split Starting Times* and requests the superintendent to establish a **Bell Times Work Group** to seek volunteer schools and to provide guidance in implementing a split starting time schedule
February 9, 1999	The Board requests the superintendent and staff to investigate the feasibility of using private bus contractor(s) to provide high school bus service so high schools can start later.
March 9, 1999	Staff reports to the Board that no vendors expressed an interest in providing contractual service for high school transportation; that such a contract (if awarded) would add significant costs to the MCPS budget; and that the logistics required, should a contractor come forward, would preclude implementation for September 1999. The Board requests the staff to reexamine the options for a later bell time for high schools and specifically to add options that eliminate school bus transportation for high school students and/or rely on public transit as an alternative to school buses for high schools.
March 29, 1999	The **Bell Times Implementation Work Group,** soliciting volunteer schools and developing guidelines for implementing *Split Starting Times*, reports to the superintendent and the Board that no high school has volunteered and that the estimated cost per high school to implement the *Split Start Times* scenario could be as much as $802,000.
October 2012	Montgomery County citizens develop an online petition to express support for a later high school start time.
December 2012	Superintendent Dr. Joshua Starr directs staff to convene a work group to develop options to address students' needs for more sleep and in particular to consider adjustments to school start times
January–July, 2013	The 2013 Bell Times Work Group meets.
May–June, 2013	The MCPS Office of Shared Accountability surveys high school students and parents of high school students regarding school start times.

Appendix C: Presentations by Local Experts

The work group heard presentations by the following local experts in the fields of sleep research and school start time research and representatives from local school districts with later high school start times:

- Dr. Judith Owens, director of sleep medicine, Pulmonary and Sleep Medicine, Children's National Medical Center, Washington, DC
- Dr. Peter Hinrichs, associate professor, Georgetown Public Policy Institute, Georgetown University, Washington, DC
- Dr. Susan G. Robinson, former assistant superintendent, Information Services, Arlington Public Schools, Arlington, VA
- Mr. Fred Evans, former MCPS high school principal and former director of secondary education, Loudoun County Public Schools, Loudoun, VA
- Dr. Kecia Addison-Scott, supervisor of applied research, Office of Shared Accountability, MCPS

Dr. Owens' presentation addressed a variety of topics related to adolescent development, sleep deprivation research on children and adolescents, and trends in high school bell times. She presented her own research, as well as summarizing key topics and findings from available sleep research, which included the following:

- Changes in circadian rhythms associated with puberty make it more difficult for adolescents to fall asleep and to wake up.
- The average high school student needs 9–9.25 hours of sleep per night but gets, on average, 7.25 hours of sleep per night. By Grade 12, the average sleep on school nights is 6.9 hours.
- Research on brain cognition shows that sleep is needed to facilitate memory retention, organize thoughts, predict outcomes and avoid consequences, be goal-directed ("executive functions"), work accurately and efficiently, think abstractly, be creative, and gain insight.
- Sleep deprivation increases the stress response and stress hormones and results in greater sensation-seeking and risk-taking, increased body weight, depression, and suicidal ideation.
- Studies of schools that delayed start times showed that students went to bed at the same time or earlier, contrary to expectations that students would just stay up later.

Dr. Hinrichs' presentation summarized key topics and findings from available school start time research, focusing in particular on studies where effects of school start times on particular outcomes were demonstrated through comparisons of matched school districts. He presented his own research on school start times and student achievement, which included the following:

- Dr. Hinrichs acknowledged the laboratory sleep research on adolescent sleep patterns but questioned the effects of changing school bell times on student achievement.
- Comparing two school districts matched on regional and demographic factors (Minneapolis and St. Paul), Dr. Hinrichs estimated the effects of school start times on attendance and the achievement of college-bound students (ACT scores). He found that changing school start times did not improve attendance or achievement consistently.

- Using state assessment data from Kansas and Virginia that was not limited to college-bound students, Dr. Hinrichs similarly found no effect of changing school start times on school-level state assessment data.

Dr. Robinson's presentation summarized Arlington Public Schools' (APS) experience of implementing a change to later high school start times in the 2001–2002 school year. Dr. Robinson also summarized findings from the evaluation APS conducted to assess the implementation of the schedule change.

- The Arlington County Board of Education voted unanimously in December 1999 to change start times, giving instructions that no school was to start earlier than 7:50 a.m., and the change was to be implemented for the 2001–2002 school year.
- In the fall of 2001, high school start times shifted 45 minutes later from 7:34 a.m. to 8:19 a.m (with the exception of a magnet secondary school whose start time remained unchanged at 9:24 a.m.); middle school start times shifted 20 minutes earlier from 8:10 a.m. to 7:50 a.m.; and elementary schools started at 8:00 a.m., 8:25 a.m., and 9:00 a.m., with various shifts in time to accommodate transportation needs under the adjusted plan for middle and high schools.
- A 2005 evaluation of the schedule change showed the following: high school teachers and students reported more engagement and participation in first period classes, but there were no significant changes in course grades; high school attendance in first period classes improved, but there was a light increase in tardiness for middle school students; while high school staff members concerned about difficult commutes were offered options of shifting to middle school for the earlier commute, no staff transfers were requested.
- The community was favorable to the process of community engagement used to implement the change, and the APS Board of Education was pleased that the change was well received in the community.

Mr. Evans summarized issues relevant to Loudoun County Public Schools (LCPS) where the district schools open in the following order: two groups of elementary schools start first (at varying start times), followed by middle schools, then high schools. The schedule has been in place for more than 20 years. Mr. Evans offered the following observations:

- Elementary schools start at 7:50 a.m., 8:15 a.m., 8:30 a.m., 8:35 a.m., and 9:00 a.m.
- Middle schools start at 8:35 a.m.
- High schools start at 8:54 a.m.
- The schedule is accepted by the community and not the topic of debate. The more pressing concern currently in Loudoun County is rapid population growth that results in opening more schools and changing attendance boundaries.
- Most athletic teams compete in intra-county competition, so the schedule does not present problems for start times of competitions.

Dr. Kecia Addison-Scott and Mr. Thomas C. (Chris) West of the MCPS Office of Shared Accountability presented a review of available research on sleep needs of students and also on school districts that have shifted start times. Their findings were summarized earlier in this report.

Appendix D: OSA 2013 HS Start Times Survey Findings

2013 Parent Survey Findings

A sample of 4,335 parents of high school students in Grades 9–11 were randomly selected to respond to the survey. An online survey was developed and parents selected to participate were sent a survey mailer that included a password to access the online survey. If the home language of the family was not English, then a paper copy of the survey was mailed to the home in the language indicated on record with MCPS. Paper copies in English also were available for those respondents who requested it.

A response rate of 23 percent was obtained from the parent survey. Based on feedback from parents who responded to the survey, 69 percent preferred school start later, either 30 minutes or one hour. Similarly, approximately 70 percent of parents reported that school started "too early" for high school students, with the remaining reporting "at the right time" (30 percent) and "too late" (0.5 percent). Sixty-six percent of parents responded that it was important that school starts later for their high school child.

Table 1: Number and Percent for School Start Time Preference

	Number	Percent
Start 30 minutes later and end 30 minutes later	294	27
Start one hour later and end one hour later	455	42
Remain the same (start at 7:25 a.m. and end at 2:10 p.m.)	312	28
No preference	34	3

Parents were asked to indicate how specific aspects of their life would be impacted by moving school start times later. The response categories include positive, negative, and no impact. Overall, nearly 50 percent or more of respondents indicated a later high school start time would have "no impact" on their family (See Table 2). Additionally, parents were asked to identify the perceived impact a later high school start time would lead to based on eight categories (see Table 3).

Table 2: Percent Reporting Impact of Moving Start Time

	Positive	Negative	No Impact
Transportation to school	36	15	49
Transportation from school	30	9	61
Afterschool activities/clubs	26	22	52
Athletic practices/events	24	23	53
Employment schedule for parent/guardians	31	15	54
Safety for my child	44	7	48
Employment schedule for my child	15	11	74
Child care before school	10	4	86
Child care after school	12	4	84

Table 3: Number and Percent of Parents Reporting Perceived Impact of a Later High School Start Time

	Number	Percent
Attendance		
Improved attendance	648	61
More absenteeism	68	6
No opinion	354	32
Tardiness		
Lower tardy rates	748	70
Increased tardy rates	72	7
No opinion	249	23
Grades		
Lower grades	52	5
Better grades	683	64
No opinion	327	31
Student mood		
Happier students	806	76
Moodier students	58	5
No opinion	202	19
Teacher Satisfaction		
Decreased teacher satisfaction	88	8
Increased teacher satisfaction	511	48
No opinion	457	43
Athletic Participation		
Less participation in athletics	200	19
Increased participation in athletics	316	30
No opinion	548	51
Parental Involvement		
Reduced parental involvement	155	15
Increased parental involvement	325	31
No opinion	576	54

	Number	Percent
Health		
Improved health	713	67
No impact	199	19
No opinion	147	14

Note: Not all parents responded to each statement. Numbers and percentages reported are for those who responded.

Results also were examined based on time preference. For the 27 percent of parents who preferred high school start and end 30 minutes later, 50 percent or more reported "no impact" of a later start time on their family. Additionally, most of these same respondents reported positive benefits of adjusting high school to a later time. Almost all of the parents (96 percent) who indicated a time preference of 30 minutes later reported school starts "too early," and 92 percent of these respondents reported it is important high school starts later.

For the 42 percent of parents who preferred high school start and end one hour later, most reported "positive" or "no impact" of a later start time on their family. Nearly all of the parents (99 percent) who indicated a time preference of one hour later reported school starts "too early," and 98 percent of these respondents reported it is important that high school starts later.

Of the 27 percent of parents who preferred the high school start remain the same, over 60 percent reported a negative impact on two areas: after-school activities/clubs and athletic practices/events. Additionally, most of these same respondents reported "no opinion" to the eight categories mentioned previously as it related to adjusting high school to a later time. Ninety-four percent reported school starts "at the right time," and 89 percent of these respondents reported it is important that the high school start time remain the same.

2013 Student Survey Findings

A sample of 150 high school classes across 25 MCPS high schools were selected to obtain feedback from students in Grades 9–11 on starting school later. English classes were selected and regular and non-regular (honors/AP/IB) classes were included. Only classes with more than 15 students total enrolled were considered for inclusion. A response rate of 91 percent was obtained based on the number of classes sampled. The percentage of respondents for each grade was 33 percent for Grades 9 and 11 and 34 percent for Grade 10.

Feedback from students revealed that slightly more than half want school to start later—either 30 minutes or one hour (See Table 1). Although only about half of students indicated they wanted school to begin later, 63 percent of student respondents reported "too early" when asked whether the school day starts "too early," "at the right time," or "too late." Additionally, regardless of the preference for starting school later, 85 percent of respondents indicated they would get more sleep if school started later (See Table 2). Slightly more than one third of respondents reported it will harder for them to get a job if school start times were changed to a later time (Table 3). Other areas students perceived as challenges to moving school start times were participating in afterschool activities/clubs (30 percent) and participating in afterschool practices/events (31 percent) (Table 3).

Table 1: Number and Percent of Students Reporting School Start Time Preference

	Number	Percent
Start 30 minutes later and end 30 minutes later	705	23
Start 1 hour later and end 1 hour later	917	31
Remain the same	1153	38
No preference	235	8

Table 2: Number and Percent of Student Responses to Statements

If school starts later than it does now, tell us why it will be better for you	Number	Percent
It will be easier for me to get transportation to school.	516	19
It will be easier for me to have transportation home from school.	328	12
It will be easier for me to participate in afterschool activities/clubs.	287	10
I will be easier for me to participate in athletic practices/ events.	294	11
It will be easier for me to get a job after school.	182	7
It will be easier for my parents/guardians to attend my after-school activities.	294	11
I will be more safe going to school (e.g., darkness).	563	20
I will be more safe going home after school (e.g., darkness).	116	4
I will get more sleep.	2381	85

Note: Respondents could select more than one statement, thus percentages will sum to more than 100 percent.

Table 3: Number and Percent of Student Responses to Statements

If school starts later than it does now, tell us why it will be a problem for you	Number	Percent
It will be harder for me to get transportation to school.	443	19
It will be harder for me to get transportation home from school.	200	9
It will be harder for me to participate in afterschool activities/clubs.	732	31
It will be harder for me to participate in athletic practices/events.	710	30
It will be harder for me to get a job after school.	830	36
It will be harder for my parents/guardians to attend my after-school activities.	151	7
I will be less safe going to school (e.g., darkness).	121	5
I will be less safe going home from school (e.g., darkness).	292	13

If school starts later than it does now, tell us why it will be a problem for you	Number	Percent
It will be harder for me to get transportation to school.	443	19
It will be harder for me to get employment after school.	652	28

Note: Respondents could select more than one statement, thus percentages will sum to more than 100 percent.

When asked to identify benefits of starting school later, the most frequently reported benefit was getting more sleep (79 percent). Students also were asked to identify problems that might arise if schools started later. The following responses were the most frequently selected: a) harder to get a job after school (28 percent); b) harder to participate in after school (24 percent); and c) harder to participate in after-school practices/events (24 percent).

Students were asked to indicate the average number of hours of sleep they get a night. Based on responses, students sleep about 7 hours or less each night (See Table 4). In addition, students were asked to identify how frequently they fell asleep or lost focus in their first or second period class in the past month. About one third of respondents reported "2–4 days per week" and 30 percent reported "Every day" (see Table 5).

Table 4: Number and Percent of Students Reporting Average Hours of Sleep

	Number	Percent
5 hours or less	685	23
6 hours	948	32
7 hours	825	28
8 hours	406	14
9 hours	89	3
10 or more hours	31	1

Table 5: Number and Percent of Students Indicating Frequency of Dozing Off or Losing Focus in Class Periods 1 or 2 Within Past Month

	Number	Percent
Every day	910	30
2-4 days of the week	1,003	34
1 day a week	567	19
Never	513	17

Similar to the analysis for parents, student results also were examined based on time preference. For the 23 percent of students who preferred high school start and end 30 minutes later, 92 percent reported a benefit would be the ability to get more sleep. Perceived problems reported by these students included: harder to participate in afterschool activities/clubs; harder to participate in athletic practices; and harder to get a job. On average, these students reported getting 7 hours of sleep or less.

For the 30 percent of high school respondents who preferred high school start and end one hour later, 9 percent reported getting more sleep as a benefit of adjusting the start time. Additionally, some students reported a benefit to their transportation to school (28 percent) and from school (21 percent). These students reported getting 7 hours of sleep or less on average.

Of the 38 percent of high school respondents who preferred the high school start remain the same, slightly more than 60 percent reported getting more sleep as a benefit of starting school later. Some perceived problems reported by these students included: harder to participate in after-school activities/clubs; harder to participate in athletic practices; harder to get a job; and harder to get to school. On average, these students reported getting 8 hours of sleep or less.

APPENDIX E

Montgomery County Public Schools

High School Parent Survey
School Start Times
Montgomery County Public Schools
Rockville, Maryland

TELL US YOUR OPINIONS ABOUT CHANGING THE HIGH SCHOOL START TIME

Montgomery County Public Schools (MCPS) is interested in gathering your opinions about changing the high school start time. A workgroup was created in January 2013 to investigate research on the topic and conduct an analysis of the impact of a later high school start time. Your family was randomly selected to provide input on this topic. By completing this survey, you will help to supply information that will assist the district with its research about changing the high school start time. Your answers will not be reported with your name or the name of your child. Your responses are confidential and will be summarized together with the responses from other parents. As you complete this survey, please keep in mind that if high school start and end times change, it will likely impact the start and end times of elementary and middle school levels.

Instructions:

Please think about your child who attends high school when answering this survey. If you have more than one child in a Montgomery County public school, please answer for the child whose name is printed on the outside address label of the survey information you received.

1. How many children do you have enrolled in Montgomery County Public Schools?

   _____

2. What are the school levels of your children? (**Mark all that apply.**)

   ○ Pre-school/Head Start ○ Elementary School ○ Middle School ○ High School

3. If Montgomery County Public Schools considers changing the school start time for high schools, do you prefer your child's school to. . . . . (**Mark one answer choice.**)

   ○ Start 30 minutes later and end 30 minutes later
   ○ Start one hour later and end one hour later
   ○ Remain the same (start at 7:25 a.m. and end at 2:10 p.m.)
   ○ No preference

4. Indicate the impact of a later high school start time on your family. For each item, please select positive, negative, or no impact.

	Positive	Negative	No Impact
a. Transportation to school	○	○	○
b. Transportation from school	○	○	○
c. Afterschool activities/clubs	○	○	○
d. Athletic practices/events	○	○	○
e. Employment schedule for parent/guardians	○	○	○
f. Safety for my child	○	○	○
g. Employment schedule for my child	○	○	○
h. Child care before school	○	○	○
i. Child care after school	○	○	○

j. Please share other positive impacts it may have on your family.

k. Please share other negative impacts it may have on your family.

5. In your opinion, would a later high school start time lead to . . . . . (**Mark one answer choice for each option.**)

a.	O Improved attendance	O More absenteeism	O No opinion
b.	O Lower tardy rates	O Increased tardy rates	O No opinion
c.	O Lower grades	O Better grades	O No opinion
d.	O Happier students	O Moodier students	O No opinion
e.	O Decreased teacher satisfaction	O Increased teacher satisfaction	O No opinion
f.	O Less participation in athletics	O Increased participation in athletics	O No opinion
g.	O Reduced parental involvement	O Increased parental involvement	O No opinion
h.	O Improved health	O No impact	O No opinion

6. The school day for my high school child starts (**Mark one answer choice.**)
   - O Too early
   - O At the right time
   - O Too late

7. It is important that school for my high school child . . . . . (**Mark one answer choice.**)
   - O Starts later
   - O Remains the same
   - O No opinion

8. In thinking about your response to item 7, how strongly do you feel about your response? (**Mark one answer choice.**)
   - O Very strong
   - O Somewhat strong
   - O Not at all strong
   - O No opinion

9. On average, how many hours of sleep does your high school child get on school nights? (**Mark one answer choice.**)
   - O 5 hours or less
   - O 6 hours
   - O 7 hours
   - O 8 hours
   - O 9 hours
   - O 10 hours or more
   - O Don't know

10. Please provide any other comments you may have about starting the high school day later.

Thank you for completing this survey.

APPENDIX F

High School Student Survey
School Start Times

Montgomery County Public Schools
Rockville, Maryland

TELL US YOUR OPINIONS ABOUT CHANGING THE HIGH SCHOOL START TIME

Montgomery County Public Schools (MCPS) is interested in gathering your opinions about changing the high school start time. A workgroup was created in January 2013 to investigate research on the topic and conduct an analysis of the impact of a later high school start time. By completing this survey, you will help to supply information that will assist MCPS with its research about changing the high school start time. Your individual answers will not be given to your school or your teachers. Your answers are confidential and will be summarized together with the answers from other high school students. As you complete this survey, please keep in mind that if high school start and end times change, it will likely impact the start and end times of elementary and middle school levels.

Instructions:
Please use a pencil to answer the questions on this survey. Please answer the survey in terms of yourself as a high school student.

Right	Wrong	
●	☑	⊙

1) This year I am in? (**Mark one answer.**)
① Grade 9
② Grade 10
③ Grade 11

2) If Montgomery County Public Schools considers changing the school start time, what time would you like your school to start and end? (**Mark one answer choice.**)
① Start 30 minutes later and end 30 minutes later
② Start 1 hour later and end 1 hour later
③ Remain the same (start at 7:25 a.m. and end at 2:10 p.m.)
④ No preference

3) If school starts later than it does now, tell us why it will be better for you? (**Mark all that apply.**)
① It will be easier for me to get transportation to school.
② It will be easier for me to have transportation home from school.
③ It will be easier for me to participate in after-school activities, clubs.
④ I will be easier for me to participate in athletic practices/events.
⑤ It will be easier for me to get a job after school.
⑥ It will be easier for my parents/guardians to attend my after-school activities.
⑦ I will be more safe going to school (e.g., darkness).
⑧ I will be more safe going home after school (e.g., darkness).
⑨ I will get more sleep.
⑩ Other, please list _____

PLEASE DO NOT WRITE IN THIS AREA

05500

Turn Over

4) If school starts later than it does now, tell us why it will be a problem for you? (**Mark all that apply.**)

1. It will be harder for me to get transportation to school.
2. It will be harder for me to get transportation home from school.
3. It will be harder for me to participate in after-school activities, clubs.
4. It will be harder for me to participate in athletic practices/events.
5. It will be harder for me to get a job after school.
6. It will be harder for my parents/guardians to attend my after-school activities.
7. I will be less safe going to school (e.g., darkness).
8. I will be less safe going home from school (e.g., darkness).
9. It will be harder for me to get employment after school.
10. Other, please list _____

5) On average, how many hours of sleep do you get on school nights? (**Mark one answer choice.**)

1. 5 hours or less
2. 6 hours
3. 7 hours
4. 8 hours
5. 9 hours
6. 10 or more hours

6) The school day starts (**Mark one answer choice.**)

1. Too early
2. At the right time
3. Too late

7) Will you get more sleep if high school started and ended later?

1. Yes
2. No

8) Would you be interested in arriving at school later and taking one or two of your classes online if MCPS transportation to school was not provided?

1. Yes
2. No

9) If high school start and end times were to change, would this negatively impact your after-school job?

1. Yes
2. No
3. I do not have an after-school job

10) In the past month, in your 1st or 2nd period classes, how often do you dose off or lose focus due to sleepiness?

1. Every day
2. 2-4 days of the week
3. 1 day a week
4. Never

Thank you for completing this survey.

PLEASE DO NOT WRITE IN THIS AREA

05500

Appendix G: Start Times in 25 Largest School Districts (October 30, 1997)

School District	Student Enrollment	Students Transported	Start/End ES	Start/End JR/MS	Start/End HS	Tiers Used	# Bus/ Routes	Walk Distance ES	Walk Distance JR/MS	Walk Distance HS
Baltimore County, MD	105,000	88,000	8:40–3:10 9:00–3:30 9:15–3:45 9:20–3:50	8:15–2:45	7:45–2:15	1 to 5	564 Public 123 Contract	1 mile	1 mile MS 1.5 mile JR	1.5 mile
Broward County, FL	224,000	66,000	8:00–2:00	9:00–4:00	7:40–2:40	3	1,122	2 miles	2 miles	2 miles
Charlotte Mecklenburg District, NC	98,000	57,000	8:25–3:30 8:30–3:30	8:25–3:30 8:30–3:30	7:10–2:20 7:20–2:30	3+	926 Buses	1.2+ miles	1.4+ miles	1.5+ miles
Chicago City, IL	420,000	50,100	8:00–1:30 9:00–2:30 9:00–3:15	8:00–1:30 9:00–2:30 9:00–3:15	8:00–1:30 9:00–2:30 9:00–3:15	2	2,500	1.5 miles	1.5 miles	1.5 miles
Clark County, NV	192, 344	81,801	9:00–3:11	8:00–2:11	7:00–1:21	3	888 Buses 824 Routes	2 miles	2 miles	2 miles
Cobb County, GA	89,000	62,500	8:00–2:30	9:00–4:00	8:15–3:15	3 to 4	1,968	.5 miles	1 mile	1 mile
Dade County, FL	340,904	68,000	8:30–3:00 8:30–2:00 (K–1)	9:00–3:40	7:30–2:30	3	1,385	2 miles	2 miles	2 miles

School District	Student Enrollment	Students Transported	Start/End ES	Start/End JR/MS	Start/End HS	Tiers Used	# Bus/ Routes	Walk Distance ES	Walk Distance JR/MS	Walk Distance HS
Dallas County, TX	150,000	57,000	8:00–3:00	8:45–3:45	8:30–3:30	3	1,270	2 miles	2 miles	2 miles
Detroit City, MI	180,000	28,000	8:00–2:45 8:45–3:15 9:30–4:00	8:45–3:15 9:30–4:00	8:00–3:50 (varies on # of classes)	3	775	1.3 miles	1.8 miles	Public Transp. Unless SPED
Duval County, FL	126,000	57,000	8:27–3:04	9:12–4:04	7:17–2:24	18 Adjusted w/in Window	928	1.5 miles	1.5 miles	1.5 miles
Fairfax County, VA	143,278	102,810	8:30–3:05 9:00–3:30	7:25–2:20	7:20–2:05	3	1,084 Buses5,167 Routes	1 mile	1.5 miles	1.5 miles
Gwinnett County, GA	93,325	68,000	8:00–2:30 9:15–3:45	9:10–3:40	7:20–2:00	3/4 in 2 Clusters	772 Buses 3,560 Routes	0 miles	0 miles	1.5 miles w/ limited service
Hillsborough County, FL	165,368	79,000	8:00–2:15	8:45–3:30	7:30–2:50	3	1,040	2 miles	2 miles	2 miles
Houston District, TX	212,000	79,000	7:45–2:45	8:35–3:35	8:05–3:05	2	1,350 Buses 1,250 Routes	0–.3 miles	0–.5 miles	0–.5 miles
Jefferson County, KY	95,391	74,000	9:05–3:35	7:40–2:20	7:40–2:20	3	783 Buses	1 mile/less	1 mile/less	1 mile/less

School District	Student Enrollment	Students Transported	Start/End ES	Start/End JR/MS	Start/End HS	Tiers Used	# Bus/ Routes	Walk Distance ES	Walk Distance JR/MS	Walk Distance HS
Los Angeles County, CA	670,000	65,000	8:00–2:30 (approx.)	8:00–3:00 (approx.)	8:00–3:00 (approx.)	2 AM/ 2 PM	1,400 Buses (District owned) 2,200 Routes	SPED Magnet/ 2 miles	SPED Magnet/ 2 miles	SPED Magnet/ 2 miles
Milwaukee District, WI	104,697	71,320	7:55–2:40 8:55–3:40	7:35–2:30 8:40–3:40	7:30–2:40	2	1,450 Buses 2,330 Routes	.25 miles	.50 miles	.50 miles
Montgomery County, MD	125,713	90,900	8:50–3:05 9:15–3:30	7:55–2:40	7:25–2:10	4	1,016 Buses 943 Routes	1 mile	1.5 miles	2 miles
New York City, NY	1,450,000	760,000	7:15–2:00 10:00–3:30	7:15–2:00 10:00–3:30	7:15–2:00 10:00–3:30	3 or 4	4,300	.5 mile (K–2) 1 mile (3–6)	1.5 miles	1.5 miles
Orange County, FL	134,333	61,000	7:45–2:00 8:00–2:15 8:15–2:30 8:30–2:45	9:00–3:209:15–3:35	7:10–2:10 7:15–1:40 7:30–1:55	3	1,100 Buses899 Routes	2 miles	2 miles	2 miles
Palm Beach District, FL	140,000	60,000	8:00–2:07 (90%)	9:00–3:37 9:15–3:52	7:30–2:52	3	580 Buses most 3 trips	2 miles	2 miles	2 miles
Philadelphia District, PA	215,000	17,980 public 11,850 (non) 23,600 public 6,350 (non)	8:45–3:00	8:30–2:45 Use public transp.	8:00–2:00 Use public transp.	1	550 District 460 Contract 80 Cabs incl.	1.5 miles	Public Transport.	Public Transport.

School District	Student Enrollment	Students Transported	Start/End ES	Start/End JR/MS	Start/End HS	Tiers Used	# Bus/ Routes	Walk Distance ES	Walk Distance JR/MS	Walk Distance HS
Pinellas County, FL	107,253/K–12 1,500 PK	44,275	7:50–1:50 8:45–2:45 9:30–3:30	9:30–3:50	7:30–2:00	3	569	2 miles	2 miles	2 miles
Prince George's County, MD	125,888	90,567	8:00–2:10 9:30–4:10 (varies)	8:00–2:10 9:30–4:10 (varies)	8:00–2:10 9:30–4:10 (varies)	4	1,042 Routed	1.5 miles	2 miles	2 miles
Wake County, NC	89,441	51,032	8:00–2:15 9:15–3:00 (varies)	7:30–2:15 8:15–3:00 (varies)	7:30–2:15 8:00–2:40 (varies)	3	694	.3 miles	.5 miles	.5 miles

Appendix H: Cost Implications

The following information represents preliminary estimates of the transportation, utility, and school-based staff costs for each of the four options presented in this report. Additional detailed analysis is required before any option should be considered for adoption.

The work group made a decision to focus attention on options with little or justifiable costs. Options with exceptionally high costs were eliminated from consideration.

I. Transportation Cost Implications

Option 1

- Option 1 reduces the overall daily operating window for transportation by 10 minutes per day. The resulting savings in bus operator and attendant salaries is $1,214,723.
- Computer models estimate that 94 additional regular education and 32 additional special education routes would need to be added to accommodate the altered bell schedule. The annual cost of these additional routes is estimated to be $10,269,218.
- Prior to conducting the computer models, it was predicted that this option would be relatively inexpensive for transportation. Moving the high schools—which have the largest attendance areas and corresponding longest bus routes—to the middle of the start times window appears to be the factor that led to so many additional routes being required. It is possible that small changes of five or ten minutes in the start and end times of the four tiers would dramatically reduce the number of additional routes required. Additional research would be needed to determine the effects of each potential change.
- *Net annual transportation cost for this option: $9,054,495*

Option 1A

- Option 1A reduces the overall daily operating window for transportation by 20 minutes per day. The resulting savings in bus operator and attendant salaries is $2,429,447.
- Computer models estimate that 100 additional regular education and 64 additional special education routes would need to be added to accommodate the altered bell schedule. The annual cost of these additional routes is estimated to be $13,929,848.
- Prior to conducting the computer models, it was predicted that this option would be relatively inexpensive for transportation. Moving the high schools—which have the largest attendance areas and corresponding longest bus routes—to the middle of the start times window appears to be the factor that led to so many additional routes being required. It is possible that small changes of five or ten minutes in the start and end times of the four tiers would dramatically reduce the number of additional routes required. More study would be needed to determine the effects of each potential change.
- *Net annual transportation cost for this option: $11,500,401*

Option 2, 2A, and 4

- No transportation impact

Option 3

- More study would be required to determine transportation costs for this option once the preferred order of the tiers is determined.

II. Utility Cost Implications

- Increasing the length of the elementary school day by 10, 20, or 30 minutes had the following annual estimated impact on utilities:

10 minutes	$260,000
20 minutes	$515,000
30 minutes	$775,000

- While the extension of the school day at the elementary schools has some utility cost implications as noted above, the change of the school day from earlier or later was believed to have little or no significant impact on utility costs.

III. School-based Staff Cost Implications

- It is estimated that hourly school-based employees who work directly with students and who do not already have a seven- or eight-hour daily assignment may be impacted by a change.
- Eight-hour, school-based staff may see an adjustment to their shift assignments, earlier or later, but no impact on total daily hours is foreseen. However, further discussion with the employee organizations will be needed.
- Additional detailed analysis is required for any option considered for adoption.

Appendix I: MSDE Total School Days/Hours

School Year 2011–2012

Revised 7/11/2011

SCHOOL SYSTEM	MIN DAYS (1)	TOTAL # OF DAYS EMERGENCY CLOSINGS (2)			LENGTH OF SCHOOL DAY (HOURS) (3)			TOTAL # OF SHORTENED DAYS (5)			TOTAL # OF YEARLY SCHOOL HOURS (9)			REMARKS (EMERGENCY MAKE UP DAYS)
		(a)	(b)	(c)	Elem	Middle	High	Elem	Middle	High	Elem	Middle	High	
Prince George's	180	4	4	4	6.17	6.67	6.67	0	0	0	1116.77	120727	1207.27	4 days added to end of calendar if needed
Montgomery	184	4	4	4	6.25	6.75	6.75	5	5	3	1137.50	1229.50	1234.50	5 days added to end of calendar if needed
Garrett	180	5	5	5	6.40	6.83	6.83	9	9	9	1125.00	1202.40	1202.40	5 days in cal. Will deduct if not used
Allegany	180	9	9	9	6.41	6.91	6.86	6	6	6	1135.80	1225.80	1216.80	I 0 days added to end of cal if needed
Anne Arundel	181	4	4	4	6.42	6.66	6.80	15	15	15	1132.02	1175.46	1200.80	4 days built into end of calendar
Baltimore	182				6.50	6.50	6.50	3	3	4	1174.00	1174.00	1171.00	7 days in calendar
Carroll	180	4	4	4	6.50	6.50	6.75	9	6	6	1145.25	1153.50	1198.50	4 days in cal. Will deduct if not used
Charles	180	4	4	4	6.50	6.50	6.75	15	15	15	1140.00	1140.00	1185.00	4 days added at end of calendar
Dorchester	180	5	5	5	6.50	6.50	6.75	0	0	0	1170.00	1170.00	1215.00	5 days in cal. Will deduct if not used
Frederick	180	5	5	5	6.50	7.00	6.83	12	11	11	ll37.00	1231.00	1200.40	5 days in cal.Will deduct if not used
Harford	180	6	6	6	6.50	6.50	6.75	11	1	5	1143.00	1168.00	1200.00	6 days-2 in cal. 4 at end. Will deduct
Howard	180		4		6.50	6.75	6.75	9	9	10	1143.00	1180.00	1185.00	4 days added to end of calendar if needed
Kent	180	0	0	5	6.50	6.60	7.00	1	1	1	1167.00	1185.00	1257.00	5 days in cal. Will deduct if not used
Washington	180	8	8	8	6.50	6.75	6.75	6	6	6	1155.00	1200.00	1200.00	8 days in cal. Will deduct if not used
Wicomico	180	5	5	5	6.50	7.00	7.00	3	3	3	1155.00	1245.00	1245.00	5 days-make up days designated
Calvert	180	0	0	0	6.54	6.73	6.92	7	7	7	1163.20	1197.40	1231.60	5 days incal. Will deduct if not used
Cecil	180	0	5	4	6.66	6.66	6.66	39	3	3	1134.00	1194.00	1194.00	5 days at end,others identified
Caroline	180	0	0	4	6.75	6.75	6.83	6	6	6	1198.50	1198.50	1212.00	4 days in cal. Will deduct if not used
StMary's	180	0	0	5	6.75	6.75	6.75	10	10	10	1195.00	1195.00	1195.00	5 days in cal. Will deduct if not used
Talbot	180	0	0	0	6.75	6.90	7.00	5	5	5	1192.50	1217.50	1234.60	0 days in cal. Will add as needed.
Baltimore City	180	0	0	5	6.83	6.83	6.83	2	2	8	1222.80	1222.80	1203.00	5 days in cal. Will deduct if not used
Queen Anne's	180			5	6.83	6.92	6.76	5	5	7	1216.30	1232.90	1200.21	5 days in cal. Will deduct if not used
Somerset	180			3	7.00	6.75	7.00	6	2	2	1242.00	1210.00	1252.00	3 days in cal. Will deduct if not used
Worcester	180	0	0	3	7.00	7.15	6.82	3	3	4	1249.50	1276.50	1214	3 days in cal. Will deduct if not used

Appendix J: Bibliography

Al-Disi, D., Al-Daghri, N., Khanam, L., Al-Othman, A., Al-Saif, M., Sabico, S., & Chrousos, G. (2010). Subjective sleep duration and quality influence diet composition and circulating adipocytokines and ghrelin levels in teen-age girls. *Endocrine Journal*, 57 (10), 915–923.

Arlington Public Schools (2005). *Impact of 2001 Adjustments to High School and Middle School Start Times.* Office of Planning and Evaluation. Arlington, VA.

Beebe, D.W., Fallone, G., Godiwala, N., Flanigan, M., Martin, D., Schaffner, L., & Amin, R. (2008). Feasibility and behavioral effects of an at-home multi-night sleep restriction protocol for adolescents. *The Journal of Child Psychology and Psychiatry*, 49 (9), 915–923.

Carrell, S.E., Maghakian, T., & West, J.E. (2011) A's from ZZZZ's? The causal effect of school start time on academic achievement of adolescents. *American Economic Journal,* 3(3), 62–71.

Carskadon, M.A., Harvey, K., Duke, P., Anders, T.F., Litt, I.F., & Dement, W.C. (1980). Pubertal changes in daytime sleepiness. *Sleep,* 2 (4), 453–460.

Carskadon, M.A., Acebo, C., Richardson, G.S., Tate, B.A., & Seifer, R. (1997). An approach to studying circadian rhythms of adolescent humans. *J Biol Rhythms*, 12 (3), 278–289.

Chen, X., Beydoun, M.A., & Wang, Y. (2008). Is sleep duration associated with childhood obesity? A systematic review and meta-analysis. *Obesity*, 16, 265–274.

Crowley, S.J., Acebo, C., & Carskadon, M.A. (2007). Sleep, circadian rhythms, and delayed phase in adolescence. *Sleep Medicine,* 8, 602–612.

Curcio, G., Ferrara, M. & Gennaro, L. (2006). Sleep loss, learning capacity and academic performance. *Sleep Medicine Reviews*, 10, 323–337.

Czeisler, C.A. (1981). Entrainment of human orcadian rhythms by light-dark cycles: A reassessment. *Photochemistry and Photobiology*, 34 (2), 239–247.

Danner, F. & Phillips, B. (2008). Adolescent sleep, school start times, and teen motor vehicle crashes. *Journal of Clinical Sleep Medicine,* 4 (6), 533–535.

Dagys, N., McGlinchey, E.L., Talbot, L.S., Kaplan, K.A., Dahl, R.E., & Harvey, A.G. (2012). Double trouble? The effects of sleep deprivation and chronotype on adolescent affect. *The Journal of Child Psychology and Psychiatry*, 53 (6), 660–667.

Downs, Gail C. (2001). On my own time: The conflict between adolescent sleep needs and high school start times. *Center of Education and Human Development at the University of Maine and the Penquis Superintendents' Association, Occasional Paper, (39),* 1–11.

Edwards, F. (2012). Early to rise? The effect of daily start times on academic performance. *Economics of Education Review, 31,* 970–983.

Fredriksen, K., Rhodes, J., Reddy, R., & Way, N. (2004). Sleepless in Chicago: Tracking the effects of adolescent sleep loss during the middle school years. *Child Development,* 75 (1), 84–95.

Hinrichs, P. (2010). When the bell tolls: The effects of school starting times on academic achievement. *Education Finance and Policy, 6*(4), 486–507.

Hitze, B., Bosy-Westphal, A., Bielfeldt, F., Settler, U., Plachta-Danielzik, S., Pfeuffer, M., Schrezenmeir, J., Mönig, H., & Müller, M.J. (2009). Determinants and impact of sleep duration in children and adolescents: data of the Kiel Obesity Prevention Study. *European Journal of Clinical Nutrition*.

Holm, S.M., Forbes, E.E., Ryan, N.D., Phillips, M.L., Tarr, J.A., & Dahl, R.E. (2009). Reward-related brain function and sleep in pre/early pubertal and mid/late pubertal adolescents. *Journal of Adolescent Health*, 45, 326–334.

Htwe, Z.W., Cuzzone, D., O'Malley, M.B., & O'Malley, E.B. Sleep patterns of high school students before and after delayed school start time. *Journal of Sleep and Sleep Disorders Research,* Abstract Suppl. 2008;31, A74–5.

Hutchens, L., Senserrick, T.M., Jamieson, P.E., Romer, D., & Winston, F.K. (2008). Teen driver crash risk and associations with smoking and drowsy driving. *Accident Analysis and Prevention*, 40, 869–876.

Joo, S., Shin, C., Kim, J., Yi, H., Ahn, Y., Park, M., Jim, J., and Lee, S. (2005). Prevalence and correlates of excessive daytime sleepiness in high school students in Korea. *Psychiatry and Clinical Neurosciences, 59,* 433–440.

Killgore, W.D.S., Kahn-Greene, E.T., Lipizzi, E.L., Newman, R.A., Kamimori, G.H., & Balkin, T.J. (2008). Sleep deprivation reduces perceived emotional intelligence and constructive thinking skills. *Sleep Medicine*, 9, 517–526.

Kim, S.J., Lee, Y,J., Cho, S., Cho, I., Lim, W., & Lim, W. (2011). Relationship between weekend catch-up sleep and poor performance on attention tasks in Korean adolescents. *Arch Pediatr Adolesc Med*., 165 (9), 806–812.

Kopasz, M., Loessl, B., Hornyak, M., Riemann, D., Nissen, C., Piosczyk, H., & Voderholzer, U. (2010). Sleep and memory in healthy children and adolescents. *Sleep Medicine Reviews*, 14, 167–177.

Knutson, K.L. (2005). *Sex differences in the association between sleep and body mass index in adolescents*. Chicago, IL: University of Chicago.

Miller, N.L., Shattuck, L.G., Matsangas, P., & Dyche, J. (2008). Sleep and academic performance in U.S. military training and education programs. *Mind, Brain, Education, 2(1),* 29–33.

Moore, M. (2009). Relationships among sleepiness, sleep time, and psychological functioning in adolescents. *Journal of Pediatric Psychology*, 34 (10), 1175–1183.

National Sleep Foundation (NSF) (2006). *2006 Sleep in America Poll: Summary of findings*. Washington, DC: National Sleep Foundation.

Owens, J.A., Belon, K., & Moss, P. (2010). Impact of delaying school start time on adolescent sleep, mood, and behavior. *Arch Pediatr Adolesc Med*, 164 (7), 608–614.

Vorona, R.D., Szklo-Coxe, M, Wu, A., Dubik, M., Zhao, U., & Ware, J.C. (2011). Dissimilar teen crash rates in two neighboring southeastern Virginia cities with different high school start simes. *Journal of Clinical Sleep Medicine*, 9(2), 145–151.

Wahlstrom, K. (2002). Accommodating the sleep patterns of adolescents within current educational structures: An uncharted path. In M. Carskadon (Ed.) *Adolescent sleep patterns: Biological, social, and psychological influences*. Cambridge University Press: New York and Cambridge, England, 72–197.

Walstrom, K. (2002). Changing times: Findings from the first longitudinal study of later high school bell times. *National Association of Secondary School Principals Bulletin, 86(633),* 3–21.

Wolfson, A.R., Spaulding, N.L., Dandrow, C., & Baroni, E.M. (2007). Middle school start times: The importance of a good night's sleep for young adolescents. *Behavioral Sleep Medicine, 5,* 194–209.

Wrobel, G.D. (1999). Impact of school starting time on family life. *Phi Delta Kappan, 80*(5), 360–364.