

School Start Time Change: An In-Depth Examination of School Districts in the United States

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ABSTRACT— In response to the scientific evidence documenting both profound developmental changes in sleep and circadian biology during adolescence and the myriad of negative health, performance, and safety outcomes risks associated with chronic sleep loss, at least 70 public school districts in the United States, representing approximately 1,000 schools, have successfully implemented a delay in high school start times. However, despite the compelling evidence supporting school start time change as a key strategy in addressing the epidemic of adolescent sleep loss, many school districts across the country with early high school start times have not considered the option to implement later bell schedules for adolescents. Moreover, while the current scientific literature has clearly documented the positive *outcomes* associated with delayed high school start times, these studies contain limited information regarding the *process* by which school districts consider, approve and implement bell schedule changes. Thus, this in-depth examination of those school districts that have been successful in changing their bell schedules is intended to support the efforts of other districts in various stages of contemplating this measure. We utilized a multi-pronged approach (literature review, case studies, telephone interviews, online survey) to summarize the experiences of school districts across the United States in regard to challenges faced, strategies employed, and lessons learned in the hope that this

information will be a useful tool for other school districts looking to chart a course forward to promote the health, safety, and academic opportunities of their students.

Many studies have documented that the average adolescent in the United States is chronically sleep-deprived and pathologically sleepy, placing adolescents at risk for adverse consequences, including impairments in mood, affect regulation, attention, memory, behavior control, executive function, and impulse control. In particular, many studies have shown an association between decreased sleep duration and lower academic achievement at the middle school, high school, and college levels, as well as higher rates of absenteeism and tardiness, and decreased motivation to learn (Curcio, Ferrara, & De Gennaro, 2006; Wolfson & Carskadon, 2003). Other documented health-related effects of sleep loss in adolescents include increased use of stimulants (e.g., caffeine, prescription medications) to counter the effects of chronic sleepiness, which in turn may increase the risk of substance use later in adolescence and early adulthood (Gromov & Gromov, 2009). Adolescents are also at greater risk for drowsy driving-related crashes, as well as athletic and other injuries, due to insufficient sleep (Hutchens, Senserrick, Jamieson, Romer, & Winston, 2008). Chronic sleep restriction increases subsequent risk of both cardiovascular disease and metabolic dysfunction such as type 2 diabetes (Verhulst et al., 2008). An association between short sleep duration and obesity in children and adolescents has been demonstrated in numerous cross-sectional and prospective studies, underscoring how chronic sleep restriction can undermine the health of our nation's youth (Cappuccio et al., 2008). While a number of factors, including biological changes in sleep, lifestyle,

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social, extracurricular activities, and academic demands contribute to decreased sleep in students, the evidence points to early school start times (SST) (i.e., before 8:00 am) as a key contributor to sleep loss in high school students (Carrell, Maghakian, & West, 2011; Hansen, Janssen, Schiff, Zee, & Dubocovich, 2005; Hinrichs, 2011). Numerous studies have demonstrated that early start times significantly impede high school students' abilities to obtain sufficient sleep and to maintain levels of alertness commensurate with optimal daytime functioning, adequate physical and mental health, and good quality of life (Epstein, Chillag, & Lavie, 1998; Spaulding, Butler, Daigle, Dandrow, & Wolfson, 2005).

The mechanisms through which early school start times adversely impact sleep and wakefulness and consequently health, safety, and performance involve both the resultant inability of adolescents to obtain sufficient sleep on a chronic basis and disruption of circadian regulation of sleep-wake rhythms. From a biological perspective, at about the time of the onset of puberty, adolescents begin to experience a sleep-wake "phase delay" (later sleep onset and wake times), as a result of well-documented changes in circadian rhythms. This is manifested as a shift in the fall-asleep time to at least two hours later, relative to middle childhood. At the same time, adolescent sleep *needs* do not decline significantly from pre-adolescent levels, and optimal sleep amounts remain in the range of 8.5 to 9.5 hours per night for most teens (Carskadon et al., 1980). On a practical level, this means that the average adolescent cannot fall asleep much before 11 pm and has significant difficulty in waking before 8:00 am (Carskadon, Acebo, & Jenni, 2004).

A substantial body of research has now demonstrated that delaying school start times is an effective countermeasure to chronic sleep loss and has a wide range of potential benefits for students in regard to physical and mental health, safety, and academic achievement. Studies comparing high schools with start times even just 30 min earlier to those with later start times demonstrate adverse consequences associated with earlier start times, such as shorter sleep duration, increased sleepiness, difficulty concentrating, behavior problems, and more school absences (Htwe, Cuzzone, O'Malley, & O'Malley, 2008; Owens, Belon, & Moss, 2010; Wahlstrom, 2002). Scientific literature has confirmed that delaying high school start times results in increased total sleep time, decreased tardiness rates and absenteeism, improved performance on standardized tests, reduced self-reported depression, and fewer automobile crashes (Danner & Phillips, 2008; Vorona et al., 2011; Wahlstrom, 2014). For a comprehensive summary of studies examining outcomes associated with later high school and middle school start times, as well as the impact of chronic sleep loss on adolescents, see Appendix 1 or Owens et al. (2014a, 2014b).

However, it is an important but under appreciated fact that early high school start times are a relatively recent

phenomenon that evolved as a result of many factors which had little to do with academics or the health and well-being of students. The overwhelming majority of modern-day bell schedules in U.S. public high schools are historically based on such "adult" considerations as school budgets, transportation logistics, parent work schedules, athletics, staff commute times, and community use of fields and facilities. By and large, districts have not taken into consideration the evolving scientific literature on biologically based changes in sleep patterns and circadian rhythms associated with puberty and the evidence linking early school start times with detriments in the health, safety, and well-being of students. Historical and media sources suggest that school districts in United States began advancing school start times, especially at the high school level, first in the late 1950s and 1960s and then increasingly so during the 1970s. The move to earlier start times was likely in reaction to a number of increasing pressures (e.g., fiscal, political, sociological) faced by school districts to cut costs, to close neighborhood schools in favor of larger "feeder" schools, and basically to "do more with less." An historical timeline of public school bell schedule changes, contributing factors and the relationship to scientific advances in our understanding of sleep and circadian biology is included in Appendix 2.

However, it should be noted that there are many school districts in United States that always have maintained healthy start times for their high school students. For example, Loudon County, Virginia has had the same bell schedule since 1954, with high schools starting at 9:00 am, middle schools at 8:30 am and elementary schools at 7:50 am. Similarly, some large Texas districts, such as Dallas and Austin, have started their high schools at 9:00 am or later since the early 1990s. According to the U.S. Department of Education's National Center for Education Statistics, a majority (60%) of the 19,000 public high schools in the United States currently start at 8 am or later, with 45% starting between 8 and 8:30 a.m., and 15% starting 8:30 a.m. or later (Harpaz, 2013; National Center for Education Statistics, 2014).

Currently, there is no comprehensive national repository of information regarding start time change. Thus, a precise tally of public high schools in United States that have prioritized and implemented a delay in school start times nationwide is not available. To the best of our knowledge, approximately 1,000 schools in some 70 school districts have taken this step, yet there is little available information regarding the process by which these school districts have weighed the scientific evidence, maneuvered political and financial challenges, and developed strategies to implement school start time change. This process can, in fact, be extremely challenging, as bell changes impact not only the obvious stakeholders in the community (e.g., parents, students, teachers, school personnel) but also those citizens

who may not have direct involvement in the school system (e.g., employers of adolescents, community members using school facilities). Thus, a summary of the experiences of communities that have implemented start time change and an integration of the most common and salient points likely to best inform other school districts would clearly provide a source of valuable information, guidance, and support.

The purpose of this review, therefore, was twofold: first, to summarize what is known about the extent and nature of high school start time change in the United States and second, to integrate these findings into a “blueprint” for other school districts contemplating this measure. To provide an up-to-date and comprehensive review, we used a multi-pronged approach, including a literature and media review, a compilation of existing databases, a national survey, and in-depth interviews of personnel from three distinctive districts. After reviewing all of the available information on the process of school start time change from a wide variety of sources as described below, we developed a summary of the most common and salient points likely to best inform other school districts.

METHODOLOGY

The data collection process involved in generating this analysis included three basic components: (1) the identification and review of relevant scientific literature and existing information from a number of diverse but complementary sources, including online and print media articles, individual reports from school districts that have successfully changed start times, and case studies from other organizations (i.e., National Sleep Foundation, Start School Later Inc., School Start Time.org), as well as personal notes of discussions with sleep experts, parents, and district officials conducted over the years; (2) conducting in-depth telephone interviews with personnel and stakeholders in three school districts (Wilton, CT; Arlington, VA; Milwaukee, WI) to collect qualitative data on challenges, opportunities, and lessons learned in more detail; and (3) administration of a brief web-based national survey to a select number of school districts that have successfully changed their school start times to obtain more specific information on methods and the process used to change schedules and gain community support.

The outcomes of this review process are presented in the Results section as follows: (a) summary grid of selected school districts (see inclusion criteria below) which provides information on the process and logistics of delaying start times along with demographic information, change strategies, and comments (Table 1); (b) a summary of in-depth school case studies that represent the scope, process, and outcomes of individual high schools and school districts across the country that have successfully implemented a

delay in high school start times (Appendix 3); and (c) National School Start Times Survey results. For non-U.S. readers, a glossary of terminology used is also included (Table 1). This is followed by a discussion integrating the available information and summarizing lessons learned.

To provide the best possible overview of the process and experience of school start times change, the public school districts listed in Table 2 met the following inclusion criteria: (1) start time changes were successfully implemented and maintained; (2) there were sufficient data available for the district regarding the key details of the start time change process (e.g., year of change, original and changed start times); (3) they had the widest range possible of initial and final school start times; (4) they represented a broad variety in regards to size of the district, demographics (e.g., socioeconomic status, racial/ethnic composition), geographic distribution across the United States, and location (e.g., inner city, suburban, rural); and (5) they had a range of motivations for (e.g., budgetary, sleep health) and employed a variety of strategies (e.g., transportation, curriculum, class scheduling, community engagement) to implement change.

Importantly, while a number of districts included in Table 2 reported anecdotal or informal outcomes following start time change, only a small minority of districts (references included below) conducted a systematic data-based analysis of outcome and actually published the results in scientific or educational peer-review journals, highlighting the critical need for more empirically supported data. Finally, there have been several published studies of school start time change outcomes in individual independent/private schools; these are included at the end of Table 2.

RESULTS

Selected School District Data

While extensive details regarding the “mechanics” of school start time change are provided above in Table 1, a number of summary points should be considered:

- The majority of school districts cited “sleep science” and/or the evidence supporting the negative impact on health and performance as key motivators in the decision to delay start times.
- While many (nearly half) of the school districts listed are small (<10,000 students), the considerable variability in size and demographics (urban, suburban, rural) suggest that a wide range of school district types have successfully implemented start time change.
- While the majority of districts moved their start times to between 8:30 am and 9:00 am later, there were a number of schools that remained at a start time before

Table 1
Glossary of Terms

Bell Schedules	Schedule of class periods
Block Schedule	Class schedules that change across days and/or weeks
Bus Depot	Central location where students are dropped off to catch a school bus
Carpool	Multiple students are driven in one car
Civil Twilight	Definition of morning and evening twilight onset time that changes over the course of the year. Typically, transportation schedules are set to avoid having elementary schools students waiting for the bus or coming home in the dark
Elementary School (ES)	Grades 1–6
Flexible (flex time)	Student/parent choice of start time and class schedule
Flip Strategy	Start time change strategy that substitutes the bell schedules for one tier with another
High School (HS)	Grades 9–12 or 8–12 (can also be referred to as secondary school)
Magnet School	Specialty schools typically for high achieving students
Middle School (MS)	Typically Grades 5–8 or 7–8 (also referred to as “Junior High School”)
Parent Teacher Association/Organization (PTA/PTO)	Elected or appointed group of parents and teachers who serve in advisory capacity to principals, school boards, and district administration
Phased-in Strategy	Start time change which is implemented gradually over two or more years; typically starting Year 1 in selected schools
Public Transportation	State- or county-funded transportation system (not funded by school district)
Rolling Window Busing	Variable start and school bus delivery times across a tier or tiers (i. e., all schools in the same tier do not start at the same time)
School Board	Governing and advisory body, typically of elected community officials who review budgets and make decisions regarding educational policy
School District	A unified group of schools that serve a county or defined region and has its own administration and governing body
School Principal	Head of an individual school
School Start Time-Change (SST-C)	District-wide policy regarding change of bell schedules
Secondary School (SS)	Grades 7–12; combined HS and MS or synonym for either
Slide Strategy	Start time strategy which delays or advances bell schedules by the same amount of time for each tier
Stakeholder	Individual or groups of individuals who will be impacted by policy change
Study Hall	Non-class period when student may study/complete homework
Superintendent	Chief executive of a school district
Tier	Groupings of school types, i.e., HS tier, MS, tier, etc.
Tiered Busing	Transportation schedule in which individual buses make multiple runs in the morning and afternoon to deliver students to each tier
Traffic Patterns	School bus routes (often multiple bus stops every two blocks that slow non-school traffic and parent delivery of students) causing congestion around schools
Transportation Fees	While most districts are mandated to provide free transportation for regular bus service, sometimes fees for special services are charged
Zero Period	Non-class or class period offered before the start of the school day

Table 2
Selected School Districts that Changed Start Times

School District	Year of SST Change	Original Bell Times	Change Bell Times	Absolute SST Change	#Students #Schools	Change Strategies	Additional Strategies	Outcomes/Additional Comments	Reference
Fayette County, KY	1998	HS: 7:30–2:20 MS: 8:00–2:50 ES: Abt. 8:30	HS: 8:25–3:15 MS: 9:05–3:55 ES: 7:45–2:35	HS: +55 MS: +55 ES: –45	40,000 66	HS/ES flip.	Parents went school board after <i>earlier</i> HS times were first proposed. Superintendent was looking for way to boost attendance. Pre and post studies conducted. Plan was announced 10 months ahead of change.	Pre and post study 1 year after showed improved sleep and reduced auto crashes, increased sleep across all grades. District reported better attendance and a decrease in tardiness in 1999.	Danner & Phillips, 2008
Edina, MN	1996	HS: 7:25–2:10 MS: n/a ES: n/a	HS: 8:25–3:10 MS: 7:40–2:38 ES: 8:30/9:15–3:05/3:50	HS: +60 MS: — ES: —	8,300 9	HS shift.	Superintendent led based on sleep science and MN Medical Association actions.	One of the first districts to change; outcomes extensively documented. One year after, 92% of parents preferred the change. Decline in tardiness and absenteeism reported.	Wahlstrom, 2002
Minneapolis, MN	1997	HS: 7:15–1:45 MS: 7:05–1:35 ES: 9:40–4:10	HS: 8:10/8:35–3:00 MS: 9:40–4:10 ES: 7:30/8:05–2:00/2:35	HS: +55/+85 MS: +155 ES: –130/–95	36,370 75	HS/MS flip.	School board led to reduce transportation costs. Sleep health of students was secondary motivation.	Most extensively documented outcomes of all school districts delaying start times. Students reported more sleep, less daytime sleepiness, fewer depression symptoms. Lower tardiness rates also reported.	Wahlstrom, 2002
North Clackamas, OR	1999	HS: 7:30–2:20 MS: n/a ES: n/a	HS: 8:45–3:20 MS: 9:30–4:05 ES: 8:20–2:45	HS: +75 MS: n/a ES: n/a	17,439 31	HS shift.	HS principals pushed change for a decade. Full-year study preceded change.	Improved attendance and GPA in 1st period. Large community acceptance.	

Table 2
Continued

<i>School District</i>	<i>Year of SST Change</i>	<i>Original Bell Times</i>	<i>Change Bell Times</i>	<i>Absolute SST Change</i>	<i>#Students #Schools</i>	<i>Change Strategies</i>	<i>Additional Strategies</i>	<i>Outcomes/Additional Comments</i>	<i>Reference</i>
Bonneville Joint, ID	2000	HS: 7:45–2:39 MS: n/a ES: n/a	HS: 8:45–3:39 MS: 7:15–1:30 8:45–3:34 ES: 8:05–2:31 8:25–2:51	HS:+60 MS: n/a ES: n/a	11,200 21	HS shift.	Superintendent led based on sleep science.	Study showed absences dropped 15% and tardiness 22%. Students got 44 min more sleep on average.	
Brevard, FL	2000	HS: 7:30–2:15 MS: 8:50–3:35 ES: 9:50–4:20	HS 8:30–3:15 MS: 9:15–4:00 ES: 8:00–2:30	HS:+60 MS:+25 ES:–115	96,000 137	HS/MS shift. ES moves earlier.	MS activities changed to before school with own transportation required.	District reported large reduction in tardiness and absences.	
Arlington, VA	2001	HS: 7:30–2:15 MS: 8:10–2:45 ES: 8:30–3:10	HS: 8:19–3:01 MS: 7:50–2:24 ES: 8:00–2:40 9:00–3:40	HS:+49 MS:–20 ES:–30	19,000 38	HS/MS flip.	School board and superintendent led. Formed a large task force with working groups. Formed district team for implementation. 4-tier bus system.	Teachers and parents reported students were more alert and focused. Teachers raised concerns, but none left the district.	
Brunswick County, ME	2001	HS: 7:25–1:50 MS: 7:40–2:10 ES: 8:40–2:55	HS: 7:45–2:10 MS: 8:08–2:30 ES: 9:00–3:30	HS:+20 MS:+28 ES:+20	2,645 5	MS/HS 30 min shift. ES 15 min shift	Superintendent and school board influenced by neighboring Topsham district and sleep science. Conducted district-wide student survey.	Decision based on sleep health & community and student body support.	
Mahtomedi, MN	2002	HS: 7:30–2:10 MS: n/a ES: n/a	HS: 8:00–2:30 MS: 8:00–2:30 ES: 9:10–3:30	HS:+30 MS: n/a ES: n/a	3,305 4	HS/ES flip.	Encouraged use of personal transportation. 4-period day before and after change. Students agreed to shorten “passing” time between classes.	District saw improved attendance, test scores, and grades. Decreased costs and tardiness rates. 65% decrease in auto crashes.	Wahlstrom, 2014

Table 2
Continued

School District	Year of SST Change	Original Bell Times	Change Bell Times	Absolute SST Change	#Students #Schools	Change Strategies	Additional Strategies	Outcomes/Additional Comments	Reference
Wilton, CT	2003	HS: 7:35–2:10 MS: 7:35–2:10 ES: 8:15–2:45	HS: 8:15–2:50 MS: 8:15–2:50 ES: 7:40–2:10	HS: +40 MS: +40 ES: –35	4,300 5	HS (6–12) and ES Flip	Inspired by state senator, a community group formed a task force to study the issue and conduct stakeholder outreach. Conducted survey of students after change.	Students reported to be more alert and better behaved. More participation in HS athletics and ES after school activities. HS students reported high satisfaction and 35 min more sleep.	
Needham, MA	2004	HS: 7:40–2:20 MS: 7:40–1:55 ES: 8:20/9:00–2:30/3:00	HS: 8:00–2:35 MS: 7:50–2:10 ES: 8:35–2:35	HS: +20 MS: +10 ES: +15/–25	5,523 8	HS shift.	Superintendent formed advisory committee to study all issues.	Change based on concerns about sleep health.	
Jessamine County Schools, KY	Prior to 2005	HS: 7:30–2:15 MS: 7:40–2:25 ES: 8:30–3:15	HS: 8:40–3:25 MS: 8:50–3:35 ES: 8:00–2:45	HS: +70 MS: +70 ES: –30	7,000 11	MS/HS shift. ES 30 min earlier.	Superintendent led. Community and student engagement was key.	Change based on sleep health. District reported lower tardiness and increased attendance.	
Denver, CO	2005	HS: 7:30–2:30 MS: 7:25–2:55 ES: 8:15–3:10 9:00–3:55	HS: 7:30–4:30 MS: 7:25–2:55 ES: 8:15–3:10 9:00–3:55	HS: – MS: – ES: –	84,424 176	Added 2 hours to HS day for flexibility. Student's pick their own start and end times.	District provides public transportation passes to eligible students & allows for flexible schedules.	Superintendent used change to allow students to choose their schedule. Saved \$750,000 and 60 buses by encouraging the use of public transportation.	
Holyoke, MA	2005	HS: 7:15–1:52 MS: 7:15–1:52 ES: 9:05–3:05	HS: 8:15–2:52 MS: 8:15–2:52 ES: 9:05–3:05	HS: +60 MS: +60 ES: –	5,573 14	Shift HS & MS	School board led based on sleep science.	School Board voted with hopes to improve sleep and tardiness.	
Topsham, ME	2005	HS: 7:30–2:00 MS: 7:20–2:00 ES: n/a	HS: 7:50–2:21 MS: 7:40–2:10 ES: n/a	HS: +20 MS: +20 ES: n/a	2,739 7	MS & HS shift	HS and MS shared buses.	Transportation cost savings by having HS and MS students share buses.	

Table 2
Continued

<i>School District</i>	<i>Year of SST Change</i>	<i>Original Bell Times</i>	<i>Change Bell Times</i>	<i>Absolute SST Change</i>	<i>#Students #Schools</i>	<i>Change Strategies</i>	<i>Additional Strategies</i>	<i>Outcomes/Additional Comments</i>	<i>Reference</i>
Santa Rosa County, FL	2006	HS: 8:00–2:45 MS: 8:20–2:55 ES: 7:30–1:30	HS: 9:15–3:15 MS: 8:30–2:30 ES: 7:30–1:30	HS:+75 MS:+10 ES:—	26,144 36	HS shift.	Used 3-tier bus system, MS and ED rolling windows.	Increased graduation rates, decreased delinquency and lowered bus costs.	
Ithaca City, NY	2006	HS: 8:00–2:37 MS: 8:00–2:21 ES: 7:55–1:55 9:00–3:00	HS: 8:55–3:32 MS: 9:10–3:25 ES: 8:00–2:00	HS:+55 MS:+70 ES:+5	5,273 11	HS/MS shift.	Superintendent led because buses were not arriving on time and students were late. Sleep expert's advocacy over a few years helped bring the change. Discussions held with employers, athletic clubs and public at board meetings.	Change primarily made to reduce bus costs. District realized about \$400–600 K.	
Bentonville, AK	2007	HS: 7:45–2:45 MS: 8:00–3:00 ES: 8:00–3:00	HS: 8:45–3:45 MS: 7:40–2:40 ES: 7:30–2:30	HS:+60 MS:–20 ES:–30	11,100 14	Flip HS with MS and ES	HS uses A/B block schedule.	Change due to address sleep health and growing traffic issues. Cost savings.	
West Hartford, CT	2007	HS: 7:30–2:15 MS: n/a ES: n/a	HS: 7:30/8:15–2:15 MS: 8:00–2:50 ES: 8:35–3:20	HS:+45 MS: n/a ES: n/a	10,222 16	Flex time for HS.	Made first hour a study hall and allowed students to use "flex" time to start 2nd period.	District reported positive impacts on emotional health, stress and academic performance.	
South Washington County, MN	2009	HS: 7:35–2:05 MS: 7:30–2:00 ES: n/a	HS: 8:35–3:05 MS: 7:55–2:25 ES: 8:10–2:40 9:20–3:50	HS:+60 MS:+25 ES: n/a	17,418 26	HS/MS shifted later.	Superintendent formed task force to study to optimize learning and sleep. Initiated a 4 × 4 block schedule.	Part of 2014 study. Grades in 1st and 3rd period classes rose by as much as a full point. Scores on standardized tests improved. 58% of HS students slept 8 hours or more. Auto crashes fell by 6%.	Wahlstrom, 2014

Table 2
Continued

School District	Year of SST Change	Original Bell Times	Change Bell Times	Absolute SST Change	#Students #Schools	Change Strategies	Additional Strategies	Outcomes/Additional Comments	Reference
Hudson City, OH	2010	HS: 7:30 MS: 7:20 ES: 8:30-9:15	HS: 8:00-3:00 MS: 7:56-2:50 ES: 8:55-3:40	HS:+30 MS:+36 ES:-25	4,941 6	All shifted later.	Superintendent and school board formed advisory committee to review health, transportation, and other outreach, and other school districts. Subcommittees held separate public meetings and conducted surveys. Phased in over three years.	The whole process took about two years. Superintendent and school board worked together to study the issues and gain public support.	
North Andover, MA	2011	HS: 7:15-1:57 MS: 7:20-2:05 ES: 8:15-2:50	HS: 7:40-2:15 MS: 7:55-2:20 ES: 8:35-3:00	HS:+25 MS:+35 ES:+20	4,502 7	All shifted later.	Superintendent formed advisory committee to collect research, speak to sleep experts and conduct stakeholder meetings.	Did not shift as much as recommended. Reported outcomes included improved grades and attendance and decreased tardiness and disciplinary action.	
River Falls, WI	2011	HS: 7:25-2:35 MS: 7:30-2:35 ES: 8:35-3:40	HS: 7:45-2:50 MS: 7:45-2:50 ES: 8:45-3:50	HS:+20 MS:+15 ES:+10	3,109 8	15-min shift for all.	Superintendent formed committee. Surveyed parents, staff and others. Added change goal to strategic plan. Implemented 2-tier bus system.	Change based on sleep science. Bell times did not change as much as leadership recommended. Saved \$700,000 in transportation costs.	
Moore County, NC	2012	HS: 8:00-3:00 MS: n/a ES: 8:00	HS: 9:00-4:00 MS: 8:00-3:00 ES: 7:45/7:30	HS:+60 MS: n/a ES:-15/-30	12,491 23	HS shift.	Announced change in January to allow parents to make changes.	State's second-largest district. Change done to improve sleep health and savings on buses.	
Pulaski County, AK	2012	HS: 7:30-2:40 MS: 7:30-2:40 ES: 7:20-2:20	HS: 8:35-3:45 MS: 8:20-8:40 ES: 7:20-2:20 7:50-2:35	HS:+65 MS:+50 ES:-/+30	17,501 38	HS & MS shift; ES 1 tier to 2 tiers.			

Table 2
Continued

School District	Year of SST Change	Original Bell Times	Change Bell Times	Absolute SST Change	#Students #Schools	Change Strategies	Additional Strategies	Outcomes/Additional Comments	Reference
Milford County, DE	2012	HS: n/a MS: n/a ES: n/a	HS: 8:16–3:20 MS: 8:00–3:00 ES: 7:45–2:15	HS: n/a MS: n/a ES: n/a	4,195 6	HS and ES flip.	Superintendent led. HS start at 9:35 on Wed. Block scheduling.	Decision based on sleep health, improvements in learning and bus cost savings.	
Hattiesburg, MS	2013	HS: 7:20–2:45 MS: 8:30–3:50 ES: n/a	HS: 8:30–3:50 MS: 7:30–2:45 ES: 8:00–3:00	HS: +70 MS: –60 ES: n/a	4,528 10	MS/HS flip	Superintendent implemented in the last few days of the previous school year as an experiment. Added tier to bus system and students shared buses. Added online early classes and early dismissal for athletes.	Changed based on sleep science.	
Bedford County, VA	2013	HS: 8:30–3:00 MS: 8:30–3:00 ES: 8:30–3:00	HS: 8:55–3:35 MS: 8:55–3:35 ES: 7:55–2:35	HS: +25 MS: +25 ES: –35	10,000 21	HS/MS flip with ES.	Added tier to bus system and students shared buses. Added online early classes and early dismissal for athletes.	Changes led to cost savings.	
Academy District 20, CO	2013	HS: 7:05–2:10 MS: 7:25–2:25 ES: n/a	HS: 7:45–2:45 MS: 7:45–2:45 ES: 8:30–3:30	HS: +40 MS: +20 ES: n/a	22,460 35	HS/MS shift.	ES to start no later than 8:45. Reduced tiers from 4 to 3. Rolling MS Window. Principal of pilot HS chose to implement based on science provided by superintendent. Students' feedback was solicited.	Decision based on sleep health and transportation efficiencies. Evaluation is expected following the 1-year pilot period.	
Beaufort County, SC	2014	HS: 7:45–2:30 MS: n/a ES: n/a	HS: 8:35–3:25 MS: n/a ES: n/a	HS: +50 MS: n/a ES: n/a	20,000 36	Pilot 1 HS first.			
Albany Unified, CA	2014	HS: 7:40–3:10 MS: 8:00–3:05 ES: 8:30–3:05	HS: 8:00–3:30 MS: 8:00–3:05 ES: 8:30–3:05	HS: +20 MS: — ES: —	3,807 6	20-min shift as pilot HS/MS.	Evaluate and consider future changes. Elimination of MS 7:00 zero hour proposed.	HS principal very influential in promoting sleep science.	
Long Beach Unified, CA	2014	HS: 7:50–2:40 MS: 8:00–2:40 ES: n/a	HS: 8:50–3:40 MS: 9:00–3:40 ES: 8:00–2:10; 9:00–3:10	HS: +60 MS: +60 ES: n/a	81,000 84	Pilot in 1 HS and changed 1/2 of all MS.	ES have 40 min preparation period on 1 day during the week.	Third-largest district in state. Primary impetus for change was cost savings. 1/2 of MS already start at 9:00.	

Table 2
Continued

<i>Independent/ Private School Location</i>	<i>Year of SST Change</i>	<i>Original Bell Times</i>	<i>Change Bell Times</i>	<i>Absolute SST</i>	<i># of Students</i>	<i>Change Strategies</i>	<i>Additional Strategies</i>	<i>Outcomes/ Additional Comments</i>	<i>Reference</i>
RI; boarding school with 10% day students	2008–2009	8:00	8:30	+30 min	201	Initiative led by headmaster; initial protest from faculty; invited sleep experts to present rationale and conduct outcome study	Changed SST in winter term with plan to go back to original SST in spring term	All outcomes measured (e.g., self-reported sleep duration, sleepiness, depression; attendance; tardiness, health center visits) significantly improved. Mean bedtimes shifted 20 min <i>earlier</i> ; high level teacher/student satisfaction—did not return to earlier SST	Owens et al., 2010
New England; boarding school with 20% day students	2010–2011	8:00	8:25	+25 min	197 (all boarding students)	Initiative led by headmaster; invited sleep experts to present rationale and conduct outcome study	Implemented SST change winter term only	Average increase sleep duration post SST change 29 min; students getting ≥8 hours sleep increased from 18 to 44%; self-reported sleepiness, depression, caffeine use decreased; no change extracurricular participation Results suggest outcomes return to baseline when original SST resumed; currently at later SST	Boergers, Gable, & Owens, 2014

n/a = information not available.

8:00 am; very few districts moved start times to after 9:00 am.

- The most common strategy was a “flip,” typically reversing start times of elementary and high schools; and the next most common strategy was a “shift” of high schools and in some districts middle and/or elementary schools to later start times. Flexible schedules were implemented by a small percentage.
- Many school districts actually realized cost savings due to increased utilization of their current bus fleet in making multiple “runs.”
- Strategies revolving around the length of the school day (e.g., extending the length of day, making it uniform across tiers (ES, MS, HS)) enabled increased transportation flexibility in some districts by allowing for “staggered” bus runs and thus fewer buses.
- Most districts implemented bell time changes in all schools simultaneously, although a few utilized a “pilot” or “phased-in” approach (Hudson City OH, Beaufort SC, and the two independent schools).

Selected Case Studies of Start Time Change Successes

The number of published outcome studies on the impact of delaying high school start times is still somewhat limited, and the motivations and implementation strategies of schools and school districts deciding to adopt bell schedule changes are not well characterized. Publicly available materials, such as those collated and presented above, examine the challenges involved and the solutions generated but may fail to do so in adequate detail and may not fully explore important nuances of the process. Thus, it is useful to supplement the available descriptive data with more anecdotal information from communities that have been involved in changing start times. A more in-depth understanding of the process of school start time change in other districts can yield important information that may guide other school districts, suggest strategies that might not have been considered and help to avoid both repeating mistakes and “re-inventing the wheel.” We developed a number of brief case studies to serve as examples of the scope, process, and outcomes of individual high schools and school districts across the country that have successfully implemented a delay in high school start times. The sheer variety in the size of the student populations, geographic considerations, initial and final bell schedules, and strategies employed are a bit daunting; nonetheless, valuable lessons can be gleaned, which can inform other school districts in various stages of change contemplation. The case studies presented in Appendix 3 were chosen based on the availability of detailed information, instructional value, and the various types of school districts they represent. Most involved conducting interviews with school personnel as well as obtaining documents from other school districts, local press accounts, and

online sources provided by advocacy organizations. They are listed in alphabetical order by state.

National School Start Time Survey

Our approach to compiling successful strategies to delaying high school start times also involved a survey of public school districts across the country that had changed their bell schedules within the past decade. We then developed an online National School Start Time Survey and contacted a number of identified school districts that were successful in changing their start times. The survey consisted of three parts: Part One—background information on the districts; Part Two—in-depth information about their experience with school start time change strategies and implementation; and Part Three—actual and perceived costs and savings (financial and otherwise) and benefits associated with the changes (Appendix 4). This survey was intended to solicit input on a variety of experiences with later bell schedule changes and to supplement Table 1 data and the case studies in this report; thus the results should neither be interpreted in isolation, nor viewed as a “scientific” survey.

The survey was designed to be completed by a single individual/superintendent with input as needed from ancillary school personnel. Over the summer of 2013, our team identified 70 school districts that had previously delayed high school start times in the past 10 years, using existing online compilations, scientific literature, documents previously collected by the team, media clips, and previous FCPS and other school reports. In the fall of 2013, the online survey was emailed to district superintendents in identified districts.

Results

Part One: General Information. There were 24 initial survey responses; however, many surveys were excluded from the final results due to incomplete crucial data that precluded further analysis (i.e., only surveys that reported at minimum the pre- and post-start times for high schools were included). A total of eight completed surveys were included in the final analyses. All participating districts for this report were de-identified. There was a fair amount of variability in terms of the districts’ sizes (Table 3) and in their final bell schedules (Table 4). The districts’ average delay in high schools’ bell schedules was 45 min with a range of 20–75 min. About 75% (6/8) of the districts moved high school start times to after 8:30 am; only one district (FL) set the new start time to after 9:00 am.

Four districts moved middle school start times earlier (range 10–70 min), while the other districts moved middle school bell times later within a much narrower range (20–30 min). With two exceptions (VA and FL), all new middle school bell times were at 8:00 am or earlier. With regard

Table 3
Participating Districts and Population Indicators

<i>District</i>	<i>Population Sizes</i>	<i>High School Start Time Change (Old SST→New SST)</i>	<i>Middle School Start Time Change (Old SST→New SST)</i>	<i>Elementary School Start Time Change (Old SST→New SST)</i>
VA District	550 students (1 HS) 550 students (1 MS) 1,200 students (2 ES) 16 buses	8:30→8:55	8:30→8:55	7:55→8:30
CA District	1,200 students (1 HS) 900 students (1 MS) 1,800 students (3 ES) Buses unknown	7:40→8:00	8:00 (No change)	8:30 (No change)
CT District	300 students (1 HS) 1,050 students (1 MS) 1,900 students (2 ES) 33 buses	7:35→8:15	8:15→7:35	(Pre-K –2) 9:00→8:55; (3–5) 8:10→7:40
MA District	1,200 students (1 HS) 1,200 students (1 MS) 2,300 students (5 ES) 20 buses	7:15→7:45	7:50→7:20	8:15→8:25
MN District	2,900 students (1 HS) 2,300 schools (2 MS) 4,600 students (6 ES) 50 buses	8:00→8:40	9:15→7:50	8:00→8:40
AK District	3,600 students (1 HS) 4,500 students (5 MS) 4,500 students (9 ES) 85 buses	8:00→8:55	7:40→8:00	7:30→8:00
MO District	5,100 students (HS) 9,100 students (6 MS) 9,100 students (19 ES) 190 buses	7:45→8:55	7:30→8:00	8:20→8:50
FL District	7,500 students (7 HS) 6,200 students (8 MS) 14,500 students (18 ES) 200 buses	8:00→9:15	8:30→8:20	7:30 (No Change)

Listed in ascending order by total (ES/MS/HS) number of students in the district.

to elementary schools, one district (CT) moved bell times earlier (by 5–30 min), two remained the same, and the rest delayed elementary start times (range 10–40 min). Two districts set new start times before 8:00 am; the latest ES start bell time was 8:50 am (MO).

Part Two: Change Strategy and Implementation (N=6). assessed districts’ overall bell change strategies (with particular focus on transportation components) and concerns associated with these changes. The districts surveyed reported employing an array of change strategies: three districts employed a “slide” (moving ES/MS/HS bell times later), and two used a “modified slide” (moving ES/HS later with MS earlier). None of the districts responding to the survey employed a straight “flip” (i.e., exchanging ES and HS bell times). Several ancillary strategies were also used; these included a zero period (i.e., a class offered before the start of the school day) in two districts and student choice (i.e., flexible scheduling based upon student preference) in one district. While only two districts (MA and MO) had

tiered busing (i.e., separate delivery of ES, MS, and HS) prior to bell changes, all schools used tiered busing after SST change. All districts eventually had middle and high schools share buses, with three districts making the change as part of a comprehensive set of bell-related transportation changes (MA, VA, CA). Additional strategies employed in other districts included: the consolidation of bus depots (MO), the continuation of a flat fee for transportation (MA), and maintaining public transit use (CA). Notably, no districts cut transportation funding for magnet schools, and only one school used a phased-in approach (CA), which involved changes only for part of the district in Year 1 and the remainder of the district in Year 2.

Part Two also assessed the top identified challenges associated with changing school start times. When weighted to give more credence to higher-ranked options, the top five concerns were: (1) traffic flow at school, (2) changes in parents’ work schedules, (3) after-school extracurricular program attendance, (4) changes in teachers’ work schedules,

Table 4
Costs and Benefits Associated with School Start Time Change

<i>District</i>	<i>AK</i>	<i>MA</i>	<i>FL</i>	<i>VA</i>
Benefits				
Increased daily attendance	No	Yes	No	No
Reduced tardiness rates	No	Yes	No	No
Improve standardized test scores	No	N/A	Yes	Yes
Improved grades	No	Yes	Yes	No
Higher graduation rates	No	N/A	Yes	No
Fewer referrals for disciplinary action	No	Yes	No	No
Improved sports team performance	No	N/A	No	No
Fewer sports-related injuries	No	N/A	Yes	No
Cost savings for public school system	Yes	N/A	Yes	Yes
Fewer student visits to student health centers	No	N/A	Yes	No
Lower rates of depression/suicidal thoughts	No	N/A	No	Yes
Lower rates of car accidents	No	N/A	No	No
Costs				
Financial cost incurred by the school district	No	No	No	No
Loss of community support	No	No	No	No
Impact on parent work schedules	No	No	Yes	Yes
Limitations on student after-school employment	No	No	Yes	No
Financial cost incurred by families	No	No	Yes	No
Changes in traffic patterns	No	No	No	No
Reduction of student involvement in extracurricular activities/athletics	No	No	No	No
Negative impact on teacher schedules	No	No	Yes	No
Safety concerns for elementary students	No	No	No	Yes

and (5) before-school athletics practices schedules. Of note: when all athletic-related items (i.e., before/after school athletics and games) were combined, athletics represented the most significant concern. Finally, Part Two included a select-all-that-apply question that solicited information about additional strategies employed; these included substituting early morning classes with online courses, giving athletes early dismissal, adding lighting to athletic fields, and allowing for more flexible academic scheduling.

Part Three: Benefits/Costs (N=4). assessed benefits and costs associated with bell changes. With more weight given to higher ranked items, the top five identified benefits were: (1) increased daily attendance, (2) cost savings, (3) reduced tardiness rates, (4) improved standardized test scores, and (5) improved grades (Table 3). Districts varied widely in terms of perceived benefits, with one district reporting no benefits other than cost savings. Attendance and academic measures were the most consistently reported benefits and all schools listed cost savings as a benefit, likely attributable to adaptation of an increased number of busing tiers. In regards to perceived costs, no districts identified loss of community support, changes in traffic patterns, or a reduction in student involvement in extracurricular activities as a consequence of SST change. The negative impact was largely perceived to be on families (e.g., work schedules, financial issues).

Survey Conclusions

Given the small sample size, the conclusions that can be drawn from this survey are very limited but nonetheless valuable, as they add to our understanding of how and why school districts choose to delay high school start times and what benefits/costs they perceive as a result. While it is not possible to generalize from this limited sample or speculate on why particular districts did or did not respond to the survey, a few key points can be made. First, the districts responding were quite varied in the strategies employed in changing bell times across all tiers. Moreover, none of the districts changed to a bell schedule that could be termed “biologically optimal” from a circadian/sleep perspective for all three groups (i.e., MS and HS later and ES earlier). Cost savings, presumably largely as a result of increasing the number of busing tiers, was the most prominent benefit (and may have been the real “driver” for the change in some cases). The districts surveyed tended to perceive academic-related benefits resulting from adopting later start times for secondary schools.

DISCUSSION: A BLUEPRINT FOR CHANGE

We used a three-pronged approach to summarize the experiences of a variety of school districts that have implemented school start time change in order to identify both

commonly used and novel strategies potentially applicable to other districts across the country. The sheer variety of (as well as lack of universally endorsed) successful implementation strategies employed strongly suggest that there is no “one size fits all” plan and indicates that school districts should explore a wide range of bell scenarios, transportation, curriculum, and other strategies. Additionally, several secondary strategies merit further consideration; these include consolidating bus depots, charging a flat-rate transportation fee, and bundling MS/HS on buses. Furthermore, it is important to note that most of the concerns raised by school districts prior to changing start times were not actualized. In addition, many of the districts did not systematically measure health, academic, or satisfaction outcomes, again underscoring both the need for additional research on bell change-related data and highlighting the unique opportunity to contribute to public health and policy research and to provide districts considering similar changes a roadmap and a menu of approaches.

After reviewing all of the available information on the process of school start time change from a wide variety of sources as described above, including in-depth case examples, we compiled a summary of the most common and salient points to best inform school districts that are actively contemplating a change in bell schedules. While we acknowledge that these points are based in part on our collective interpretation of qualitative data, we also believe that the ten key messages listed below, categorized according to major content themes, represent principles that have a basic foundation in successful implementation of start time change and are likely most applicable to the majority of school districts, no matter their size, or complexity of issues.

The Importance of Leadership

In our sample of school districts, successful change appeared to be associated with strong leadership on the part of the superintendent, district staff, and the school board. Specific areas of leadership include valuing the scientific justification for healthy school start times, commitment to working with key community organizations to address logistical and financial challenges, and promoting the benefits to student health, safety, and academic and athletic performance (e.g., Jessamine, KY; Bentonville, AR; Edina, MN; Minneapolis, MN; Needham, MA; Brunswick, ME; South Washington County, MN). Very often, the publicly stated position of the district superintendent is the key determinant as to whether or not a school district is successful in changing school start times. This individual can set the tone for other staff, and can direct communications, planning, logistics, and community engagement. The relationship and trust (i.e., political capital) that the superintendent has established in the community and with the school board is also extremely important. If

the superintendent and district officials do not communicate their strong support for the bell time change and do not keep discussions focused on the health, safety, and academic performance of students, then the process may get bogged down with special-interest concerns.

The school board’s public support for the superintendent and for school start time change is also critical. The school board’s support is especially vital in communicating to the broader public both the justification (e.g., health and safety benefits) for changing bell schedules and the message that any challenges can be addressed and most likely overcome.

Education of the Entire Community

Districts should seek to provide appropriate targeted education for the entire community (e.g., students, parents, teachers, school nurses) about justification for healthy school start times and approaches to optimizing sleep health. Change agents and stakeholders should have a working knowledge of the research on adolescent sleep and early start times in order to effectively communicate the rationale for changing bell schedules (e.g., Arlington, VA). It also is important for school district leadership to refute misconceptions (e.g., “if school starts later, teens will just stay up later and won’t get more sleep”) while also responding to legitimate concerns of students, parents, and teachers. Partnering with health experts is one possible strategy (e.g., Albany, CA; Fayette, KY). It is extremely important to emphasize the health and safety benefits associated with providing students the opportunity to get more sleep and that the potential benefits go far beyond academic improvements. When communicating the short and long-term consequences of chronic sleep loss (and, by implication, the potential dangers associated with failing to delay high school start times), it should be emphasized that these extend not only beyond the school grounds (e.g., drowsy driving, depression, obesity) but very well may set students up for debilitating (e.g., insomnia) or life-threatening medical conditions (e.g., cardiovascular consequences such as hypertension or metabolic dysfunction such as type 2 diabetes) in the future.

Teachers and other school personnel, especially health and counseling professionals, should be well educated about adolescent sleep needs and patterns, taught to recognize the signs of sleep-related difficulties among their students, and report such symptoms to parents and school health providers (National Sleep Foundation, 2014; Wolfson & Carskadon, 2005). Superintendents, school boards, and principals should consider integrating sleep-related education into curricula so students can learn about the physiology of sleep, the consequences of sleep deprivation, and the importance of sleep to their overall health. This education can be provided in science, health, and

athletic classes. Finally, it is particularly important that information be provided to support families throughout the implementation phase in culturally sensitive ways. This includes translating basic print educational materials into multiple languages, providing translation services at community-wide online forums and reaching out to local press venues that serve minority communities.

Consensus Building Among Stakeholders

It is important to inform and engage all stakeholders early in the process to understand potential concerns and to seek potential solutions. This includes community members or organizations that use school district fields and facilities on a regular basis as well as other city or county agencies that provide programs and services to students (i.e., libraries, parks and recreation, police, employers). The district should notify these groups of any changes once the decision is made in order to allow them time to adjust their schedules and for planning, and should continue to engage them throughout implementation in a spirit of partnership.

Districts should consider the views of school staff and teachers in decision-making about implementation and develop policies that provide flexibility for teachers and other staff to adapt to the changes (e.g., easing periods to make transfer requests). It is also important to involve principals from all three levels (elementary, middle, and high schools) in internal discussions because it is likely that all schools and students in the district will be impacted to some degree, whether or not their own bell times change. Engagement of the students themselves is also critical in garnering support for the change, and often they can be the most passionate and articulate voices in the community.

For all stakeholders, it should be noted that expressed concerns are sometimes based on contractual or personnel issues rather than what is good for the health, safety, and well-being of students. In these situations, the superintendent, school board and stakeholder group leaders' public support for start time change will be critical in overcoming any staff or community opposition.

Early in the process of considering bell time changes, the district should bring together key staff representing several areas (e.g., transportation, curriculum, special or health services, athletics) to do their own fact-finding before engaging additional outside consulting groups. This allows internal staff to identify logistical issues early and begin to develop potential solutions before opening up the debate to the wider community.

In regard to process, it may be prudent to engage the leadership of key community groups in face-to-face meetings in order to build trust, air mutual concerns, and establish an open dialog prior to engaging the broader community. In

general, smaller working groups focused on unique concerns and specific tasks may be more efficient and productive than large groups that include many stakeholders.

Transportation as a Major Logistical and Cost Factor

In most districts, transportation logistics are a key factor in determining start time schedules and typically represent the largest cost. In fact, in many districts, transportation is actually the main driver for seeking changes in an attempt to lower costs by moving from a delivery system where all students are transported at the same time to a multi-tiered bus schedule where the bell times are staggered (e.g., Academy District 20, CO; Santa Rosa, CO). Districts that already employ a multi-tiered delivery schedule may have to use more creative strategies to find transportation savings. One strategy that is commonly used to overcome potential transportation costs is what is commonly referred to as "flipping" secondary/high school and elementary bell schedules. This may have the added benefit of being more "in sync" with circadian rhythms in both groups (e.g., younger children typically fall asleep earlier and wake earlier). For some districts, new approaches should be considered; these include encouraging carpools, providing incentives for using public transportation (e.g., Denver, CO), creating bus depots for special program and centers, charging parents who have sufficient financial resources a flat-rate transportation fee for special activities (e.g., Brevard, FL), and allowing middle school and high school students to ride on the same buses.

The Role of Athletics and Community Use of Recreational Facilities

Community members in districts contemplating school start time changes frequently are concerned about the impact on after-school programs, and athletics practices and competitions; however, most of these concerns do not actually materialize or can easily be mitigated by scheduling or policy changes (e.g., game day early dismissal, more flexible instruction time and scheduling). We identified no districts in which athletic programs were canceled or significantly adversely affected by school start time change. To the contrary, a number of districts found that more students participated in athletics and that sports programs grew after high school bell times were delayed (e.g., Edina, MN), and reported that their teams performed better following the change (e.g., Wilton, CT; Edina, MN; Seattle, WA). Thus, it is important for administration officials, coaches, and student athletes not only appreciate the likely lack of negative impact on athletics of delayed start times, but to also understand the potential repercussions on relevant health (e.g., metabolic dysfunction, weight gain), performance and safety (e.g., increased sport-related injuries) outcomes related to

chronic sleep loss in student athletes (Milewski et al., 2014; Spiegel, Leproult, & Van Cauter, 1999).

One Size Does Not Fit All

While there are clearly general overarching principles that can (and should) be applied across diverse communities, it should also be emphasized that the extent to which changing school start times impacts a given community and the relative importance of the different challenges and benefits (anticipated and experienced) varies widely across school districts. Thus, it follows that there is also no “one-size-fits-all” or singular optimal approach to tackling this issue. Among the myriad of variables that need to be considered on a case-by-case basis include average (and range of) student commute times, number and length of school bus routes, availability of public transportation, traffic patterns, community use of school recreational facilities, the number of students enrolled in free breakfast programs, and the impact of later dismissal times on after-school programming both for disadvantaged students and for high-achieving students seeking additional academic enrichment opportunities. For example, concerns about access to personal transportation tend to be more prevalent in less affluent school districts than in more affluent ones. Similarly, transportation plans are more complex and may have more financial implications in larger districts, especially those in urban or metropolitan centers with high traffic congestion (e.g., Denver, CO).

Prioritizing Sleep Health Is an Important Corollary to School Start Time Change

Despite the best of efforts, there is likely to be some variability in how much individual students within a district benefit from start time change. While studies definitively show that students overall obtain more sleep when start times are delayed, there will be families and students who choose not to take advantage of the additional sleep opportunity (Boergers, Gable, & Owens, 2014; Wahlstrom, 2002). This underlines the importance of providing education about sleep health behavior and time management to both parents and students in conjunction with schedule changes. In addition, schools may undermine the benefits of delayed start times by rescheduling after-school programs and activities to before school (e.g., early morning sports practices). Excessive homework, an issue frequently raised by students and parents, may also diminish students’ abilities to obtain optimal sleep. Districts should consider using the change in start times as an opportunity to make other adjustments that are in the best health interests of students and which complement the benefits associated with increased sleep.

Adjustments Take Time

It is critical to allow adequate time prior to implementing changes for families and other community members to become informed and make sufficient plans (e.g., childcare, transportation, family time). Once finalized, district leadership should communicate the details of the new schedules as early as possible, along with information on the rationale for making changes (e.g., Pulaski, AR). District-level organized and comprehensive communication and outreach efforts are absolutely key in conveying information in a timely manner to the community and in addressing the misinformation and misconceptions that often circulate in the advent of such an important (and often controversial) societal change.

Anticipation Is Often Worse Than the Reality

Similar to concerns regarding the impact of delayed start and dismissal times on athletic practices and games, many of the other potential problems typically raised in the community prior to the change are often not substantiated (e.g., Arlington, VA; Wilton, CT). For example, studies have shown that participation by students in extracurricular activities does not decline when start times are delayed (Danner & Phillips, 2008; Owens et al., 2010). Teacher retention (related to their own childcare and commuting times) is another commonly expressed concern that may not be realized; in Arlington VA, for example, this district offered teachers the opportunity to change school or tiers to aid retention, and the predicted mass exodus of teachers in the district never occurred. Communities often make adjustments to accommodate changes in schedule; for instance, employers shift work hours for working students and parents shift from before-school to after-school childcare arrangements for elementary school students. Finally, some problems dissipate over time; for example, traffic may temporarily worsen when bus routes are changed, until drivers in the community adjust their commuting patterns. To address concerns and ease the impact of change, school districts have set up hotlines, resource guides, and community meetings to assist adjustment for parents, staff, and the community.

Monitoring Outcomes Is Crucial

Districts should monitor the results and outcomes following the change to later start times, communicate positive results to the community and seek ways to mitigate or address negative or unforeseen impacts (e.g., Arlington, VA). Ideally, districts should work with county health professionals or local university or medical centers to design pre- and post-surveys and other methods to measure the impact of changing school start times on student health, safety, and academics. School districts that have conducted outcomes research have been able to communicate the findings to the community to foster

further acceptance of changing school start times. Additionally, they have been able to provide important data for the growing scientific literature in this area as well as invaluable resources for other districts contemplating school start time change.

CONCLUSIONS

Establishing healthy school start times has a clear scientific rationale but can introduce considerable challenges for communities, including school administrators, families, students, and other stakeholders. While the potential benefits to the health, safety and performance of students are irrefutable, many school districts remain reluctant to “take the plunge” and commit time, effort, resources, and political capital to this effort. It is our hope that providing this “blueprint for change” with general recommendations regarding the process involved in changing school start times will be an impetus for school districts across the country take this important step.

REFERENCES

- Boergers, J., Gable, C. J., & Owens, J. (2014). Later school start time is associated with improved sleep and daytime functioning in adolescents. *Journal of Developmental and Behavioral Pediatrics*, 35(1), 11–17. [PubMed: 24336089]
- Cappuccio, F., Taggart, F. M., Kandala, N.-B., Currie, A., Ed Peile, Stranges, S., & Miller, M. A. (2008). Meta-analysis of short sleep duration and obesity in children and adults. *Sleep*, 31, 619–626. [PubMed: 18517032]
- Carrell, S. E., Maghakian, T., & West, J. E. (2011). A's from Zzzz's? The causal effect of school start time on the academic achievement of adolescents. *American Economic Journal: Economic Policy*, 3, 62–81.
- Carskadon, M. A., Acebo, C., & Jenni, O. G. (2004). Regulation of adolescent sleep: Implications for behavior. *Annals of the New York Academy of Sciences*, 1021, 276–291. [PubMed: 15251897]
- Carskadon, M. A., Harvey, K., Duke, P., Anders, T. F., Litt, I. F., & Dement, W. C. (1980). Pubertal changes in daytime sleepiness. *Sleep*, 25, 453–460. [PubMed: 12224838]
- Curcio, G., Ferrara, M., & De Gennaro, L. (2006). Sleep loss, learning capacity and academic performance. *Sleep Medicine Review*, 10, 323–337. [PubMed: 16564189]
- Danner, F., & Phillips, B. (2008). Adolescent sleep, school start times, and teen motor vehicle crashes. *Journal of Clinical Sleep Medicine*, 4, 533–535. [PubMed: 19110880]
- Epstein, R., Chillag, N., & Lavie, P. (1998). Starting times of school: Effects on daytime functioning of fifth-grade children in Israel. *Sleep*, 21, 250–256. [PubMed: 9595603]
- Gromov, I., & Gromov, D. (2009). Sleep and substance use and abuse in adolescents. *Child and Adolescent Pediatric Clinics of North America*, 18, 929–946. [PubMed: 19836697]
- Hansen, M., Janssen, I., Schiff, A., Zee, P. C., & Dubocovich, M. L. (2005). The impact of school daily schedule on adolescent sleep. *Pediatrics*, 115, 1555–1561. [PubMed: 15930216]
- Harpaz BJ. (2013). *Starting high school later may help sleepy teens*. Associated Press. April 2014. <www.ap.org>
- Hinrichs, P. (2011). When the bell tolls: The effects of school starting times on academic achievement. *Education Finance and Policy*, 6, 1–22.
- Htwe, Z. W., Cuzzone, D., O'Malley, M. B., & O'Malley, E. B. (2008). Sleep patterns of high school students before and after delayed school start time. *Sleep*, 31(Suppl 1), A74–A75. [PubMed: 24336089]
- 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. [PubMed: 18460353]
- Milewski, M. D., Skaggs, D. L., Bishop, G. A., Pace, J. L., Ibrahim, D. A., Wren, T. A., & Barzdukas, A. (2014). Chronic lack of sleep is associated with increased sports injuries in adolescent athletes. *Journal of Pediatric Orthopaedics*, 34(2), 129–133.
- National Center for Education Statistics. (2014). *Schools and staffing survey*. Retrieved from: https://nces.ed.gov/surveys/sass/tables/sass1112_201381_s1n.asp
- National Sleep Foundation. (2014). *Eight major obstacles to delaying school start times*. Retrieved from: https://nces.ed.gov/surveys/sass/tables/sass1112_201381_s1n.asp and <http://sleepfoundation.org/sleep-news/eight-major-obstacles-delaying-school-start-times>
- Owens, J., & Adolescent Sleep Working Group and American Academy of Pediatrics Committee on Adolescence. (2014a). School start times for adolescents AAP policy statement. *Pediatrics*, 35, 1.
- Owens, J. A., & Adolescent Sleep Working Group and American Academy of Pediatrics Committee on Adolescence. (2014b). Insufficient sleep in adolescents and young adults: An update on causes and consequences. *Pediatrics*, 35, 1.
- Owens, J. A., Belon, K., & Moss, P. (2010). Impact of delaying school start time on adolescent sleep, mood, and behavior. *Archives of Pediatrics and Adolescent Medicine*, 164, 608–614. [PubMed: 20603459]
- Spaulding, N., Butler, E., Daigle, A., Dandrow, C., & Wolfson, A. R. (2005). Sleep habits and daytime sleepiness in students attending early versus late starting elementary schools. *Sleep*, 28(Suppl), A78.
- Spiegel, K., Leproult, R., & Van Cauter, E. (1999). Impact of sleep debt on metabolic and endocrine function. *Lancet*, 354(9188), 1435–1439. [PubMed: 10543671]
- Verhulst, S. L., Schrauwen, N., Haentjens, D., Rooman, R. P., Van Gaal, L., De Backer, W. A., & Desager, K. N. (2008). Sleep duration and metabolic dysregulation in overweight children and adolescents. *Archives of Disease in Childhood*, 93(1), 89–90. [PubMed: 18156481]
- Vorona, R. D., Szklo-Coxe, M., Wu, A., Dubik, M., Zhao, Y., & Ware, J. C. (2011). Dissimilar teen crash rates in two neighboring southeastern Virginia cities with different high school start times. *Journal of Clinical Sleep Medicine*, 7, 145–151. [PubMed: 21509328]
- Wahlstrom, K. (2002). Changing times: Findings from the first longitudinal study of later high school start times.

National Association of Secondary School Principals Bulletin, 286, 3–21.

- Wahlstrom K. (2014). *Examining the impact of later high school start times on the health and academic performance of high school students: A multi-site study: final report*. Center for Applied Research and Educational Improvement. Retrieved from: <http://www.cehd.umn.edu/CAREI/sleepresources.html>
- Wolfson, A. R., & Carskadon, M. A. (2003). Understanding adolescents' sleep patterns and school performance: a critical appraisal. *Sleep Medicine Review*, 7, 491–506. [PubMed: 15018092]
- Wolfson, A. R., & Carskadon, M. A. (2005). A survey of factors affecting high school start times. *National Association of Secondary School Principals Bulletin*, 89, 47–66.

APPENDIX 1. RECOMMENDED LITERATURE FOR REVIEW

- Boergers, J., Gable, C. J., & Owens, J. (2014). Later school start time is associated with improved sleep and daytime functioning in adolescents. *Journal of Developmental and Behavioral Pediatrics*, 35(1), 11–17. [PubMed: 24336089].
- Carrell, S. E., Maghakian, T., & West, J. E. (2011). A's from Zzzz's? The causal effect of school start time on the academic achievement of adolescents. *American Economic Journal: Economic Policy*, 3, 62–81.
- Danner, F., & Phillips, B. (2008). Adolescent sleep, school start times, and teen motor vehicle crashes *Journal of Clinical Sleep Medicine*, 4, 533–535. [PubMed: 19110880].
- Dexter, D., Bijwadia, J., Schilling, D., & Applebaugh, G. (2003). Sleep, sleepiness and school start times: A preliminary study. *Wisconsin Medical Journal*, 102(1), 44–46. [PubMed: 12679971].
- Edwards, F. (2010). *Early to rise: The effect of daily start times on academic performance*. Working Paper, University of Illinois at Urbana-Champaign. Retrieved from <http://ssrn.com/abstract=1628693>.
- Epstein, R., Chillag, N., & Lavie, P. (1998). Starting times of school: Effects on daytime functioning of fifth-grade children in Israel. *Sleep*, 21, 250–256. [PubMed: 9595603].
- Fredriksen, K., Rhodes, J., Reddy, R., & Way, N. (2004). Sleepless in Chicago: Tracking the effects of adolescent sleep loss during middle school years. *Child Development*, 75, 84–95.
- Hansen, M., Janssen, I., Schiff, A., Zee, P. C., & Dubcovich, M. L. (2005). The impact of school daily schedule on adolescents sleep. *Pediatrics*, 115, 1555–1561. [PubMed: 15930216].
- Hinrichs, P. (2011). When the bell tolls: The effects of school starting times on academic achievement. *Education Finance and Policy*, 6, 1–22.

Htwe, Z. W., Cuzzone, D., O'Malley, M. B., & O'Malley, E. B. (2008). Sleep patterns of high school students before and after delayed school start time. *Sleep*, 31(Suppl), A74–A75.

Kirby, M., Maggi, S., & D'Angiulli, A. (2011). School start times and the sleep-wake cycle of adolescents: A review and critical evaluation of available evidence. *Educational Researcher*, 40(2), 56–61.

Lamberg, L. (2009). High schools find later start time helps students' health and performance. *The Journal of the American Medical Association*, 301, 2200–2201. [PubMed:19491176].

Lufi, D., Tzischinsky, O., & Hadar, S. (2011). Delaying school starting time by one hour: Some effects on attention levels in adolescents. *Journal of Clinical Sleep Medicine*, 7, 137–143. [PubMed:21509327].

McGeorge, D. (2012). Sleepless in America: School start times. *Education and Health*, 30(3), 57–59.

Onyper, S. V., Thacher, P. V., Gilbert, J. W., & Gradess, S. G. (2012). Class start times, sleep, and academic performance in college: A path analysis. *Chronobiology International*, 29, 318–335. [PubMed:22390245].

Owens, J. A., Belon, K., & Moss, P. (2010). Impact of delaying school start time on adolescent sleep, mood, and behavior. *Archives of Pediatrics and Adolescent Medicine*, 164, 608–614. [PubMed: 20603459].

Perkinson-Gloor, N., Lemola, S., & Grob, A. (2013). Sleep duration, positive attitude toward life, and academic achievement: The role of daytime tiredness, behavioral persistence, and school start times. *Journal of Adolescence*, 36, 311–318.

Short, M. A., Gradisar, M., Lack, L. C., Wright H. R., Dewald, J. F., Wolfson A. R., & Carskadon, M. A. (2013). A cross-cultural comparison of sleep duration between US and Australian adolescents: The effect of school start time, parent-set bedtimes, and extracurricular load. *Health Education and Behavior*, 40, 323–330.

Wahlstrom, K. (2002). Changing times: Findings from the first longitudinal study of later high school start times. *NASSP Bulletin*, 286, 3–21.

Wahlstrom, K. (2010). School start time and sleepy teens. *Archives of Pediatrics and Adolescent Medicine*, 164, 676–677.

Wahlstrom, K. (2014). *Examining the impact of later high school start times on the health and academic performance of high school students: A multi-site study: final report*. Center for Applied Research and Educational Improvement. Retrieved from: <http://www.cehd.umn.edu/CAREI/sleepresources.html>

Wolfson, A. R., & Carskadon, M. A. (2005) A survey of factors influencing high school start times. *NASSP Bulletin*, 89, 47–66.

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.

APPENDIX 2. HISTORY OF SCHOOL START TIMES AND SLEEP RESEARCH ON ADOLESCENTS IN THE UNITED STATES

Historically, public school bell times across the nation evolved as a result of economic, social, legal, and political pressures on school districts and municipalities—not from sleep science pertaining to adolescents (which essentially did not exist until the 1970s) or concerns about the health, safety, and academic performance of students. Below is an overview of the interplay between influential factors in the development of public education and its transportation systems as well as major milestones in science of sleep and circadian biology.

1800s

Until the 1840s, the educational system is highly localized and largely accessible only to certain privileged groups (i.e., the wealthy, whites, males).

Mid 1800s

Educational reform movement led by Horace Mann and Henry Barnard leads to free public education at the elementary level for all American children.

Late 1800s

Seventeen states had operable public school transportation programs, starting with Massachusetts in 1869 (e.g., horseback, wagon).

At the end of the nineteenth century, 93% of the highways in the country are dirt roads. Horse-drawn carriages and the railroad are the leading means of transportation. Automobiles first came into use in the 1890s, and the first auto arrived in Seattle in 1900. By the 1950s, the “Age of the Automobile” had come into its own and there is great pressure to create an improved transportation infrastructure; i.e., to build more and better roads that link new houses being built outside cities and jobs that still exist mostly in urban centers.

1900s

1910—Thirty states had programs for transporting students which consisted mostly of horse-drawn wagons.

1915—Navistar manufactures the first “school bus” for Ravinia School District in South Dakota.

By 1918, all states have passed laws requiring children to attend at least elementary school.

1919—All 48 states have laws allowing the use of public funds for transporting children to and from school.

1920s

Dr. Nathaniel Kleitman, one of the earliest and most influential sleep researchers, begins to study the regulation of sleep and wakefulness at the University of Chicago.

1925—Supreme Court rules in *Pierce v. Society of Sisters* that states cannot compel children to attend public schools and that children can instead attend private schools.

As the 20th century progresses, most states enact legislation extending compulsory education to age 16.

1930—The company Wayne Works produces the first school bus with an all-steel body and windows with safety glass. The availability of and access to affordable motor vehicle transportation helps transport children from more rural and remote areas and helps lead to the consolidation and modernization of schools (Theobald, 2004).

During the 1930s, the absorption of one-room rural school houses and more students into geographically larger school districts consisting of primary and secondary schools created a need for more transportation resources, especially for high school students; many of whom could not practically walk to school. The school bus became the most popular form of transportation of students; requiring significant resources in most school district budgets. The number of students that are bused to school have risen from 7 million students in 1950 to almost 29 million in 2013 (School Bus Fleet Magazine, 2001).

1939—Dr. Nathaniel Kleitman publishes his seminal book *Sleep and Wakefulness* (Kleitman, 1963).

1940s

In the 1940s, responsibility for financing public education becomes more regionalized at the state, district, and municipality levels. In 1940, local property taxes finance 68% of public school expenses, while state governments contribute 30%. By 1990, local districts and states each contribute 47% to public school revenues. The federal government provides most of the remaining funds.

1941–1945—United States in World War II: Industrialization and a postwar economic boom dramatically change the prosperity of Americans and they buy more houses, automobiles, and start families, which will become the “baby boomers.”

By the middle of the 20th century, most states take a more active regulatory role in public education than in the past. Many states consolidate school districts into larger units. In 1940, there are over 117,000 school districts in the United States, but by 1990, the number decreases to just over 15,000. This regionalization often results in transporting a greater number of students over longer distances.

1950s

All in all, new highways, faster and cheaper vehicles, and economic prosperity stimulate a tremendous urban sprawl and the “suburbanization of America” from the 1950s to present day.

1950s–1960s—“Baby boomers” begin to reach school age. More than 50% of today’s schools are built during this period.

1953—Dr. Nathaniel Kleitman and his graduate student, Eugene Aserinsky, make the landmark discovery of rapid eye movement (REM) during sleep. Shortly afterwards, their student, Dr. William Dement, describes the “cyclical” nature of sleep and the relationship between REM and dreaming (Dement & Kleitman, 1957).

1954—*Brown v. Board of Education* outlaws “separate but equal” facilities. “White flight” from urban centers begins, leading to the rapid development of suburban school districts. In many regions of the country, children are bused longer distances to assist in integrating schools.

1956—President Dwight D. Eisenhower signs the Interstate and Defense Highways Act and helps accelerate the suburbanization of America. 47,000 miles of federal highway are built.

1960s

By the early 1960s, there is a rapid increase in the school population due to the consolidation of remaining schools—larger and more complicated school districts are created. Educators begin looking for new ways to deal with the problem of overcrowding, which leads to staggered start times being considered and implemented in some school districts. With little or no sleep science available to guide decision making, high school start times are typically placed earlier than elementary schools.

1970s

During the 1970s, recession, inflation, increasing fuel costs, and budget cuts further contribute to a “do more with less” mentality in school systems and in state and local governments. As a result of waning enrollment and decreasing property tax revenues, many school districts look for ways to cut transportation costs and adopt tiered bell schedules so that they could move the same number of students with fewer buses.

1970—Court-ordered busing begins to help integrate schools, but in some regions of the country, this leads to an even greater exodus from urban centers. The further consolidation of schools and the creation of still larger school districts result in longer commutes for some students.

Dr. William Dement, “the father of sleep medicine,” founds the first sleep research center at Stanford University.

1972—Animal studies lead to the discovery of the suprachiasmatic nuclei in the hypothalamus is the center of the “biologic (or circadian) clock” in the human brain (Moore & Eichler, 1972; Stephan & Zucker, 1972).

1973–1974—Stock market crash causes inflation and devaluation of the dollar.

U.S. experiences an energy crisis due to an oil boycott by the Organization of Arab Petroleum Exporting Countries (OAPEC). President Nixon asks the nation to adopt measures to conserve energy. School districts lower thermostats, consider shorter days and many adopt tiered-busing to save

fuel, which will more than double in price by the end of the decade.

1974—Daylight Saving Time is expanded to more states and for a more extended time period, which leads to concerns regarding younger students waiting for the bus in the dark.

1976—Using a standardized protocol (the Multiple Sleep Latency Test), Dr. Mary Carskadon establishes sleep latency (time to fall asleep) as a physiologic measurement of sleep propensity (likelihood of falling asleep). This allows researchers to objectively measure the extent of daytime sleepiness resulting from acute and chronic sleep loss and begin to quantify the impact of sleep loss on daytime performance (Carskadon & Dement, 1975, 1977; Richardson et al., 1978).

Late 1970s

Dr. Mary Carskadon at Brown University and others conduct initial research on normal biological and circadian changes in adolescent sleep.

1979—Second energy crisis hits the nation following the Iranian revolution; increasing pressure on school districts and municipalities to lower transportation costs.

1980s

During the 1980s, an increase in the birth rate and new immigration contributes to the growth of the nation’s student population, adding pressure on many school systems.

Starting in the 1980s, important research on adolescent sleep needs and sleep schedules is conducted by Dr. Carskadon and others (e.g., Carskadon et al., 1980).

1982—Researchers develop a hypothesis about how sleep may play a key role in learning and memory consolidation.

1986—Dr. Charles Czeisler and colleagues describe for the first time how bright light influences the human biological clock (Czeisler et al., 1986).

1988—U.S. Congress appoints Dr. William Dement as Chair of the National Commission on Sleep Disorders Research to study the prevalence of sleep deprivation and sleep disorders and their impact on the health of all Americans.

1990s

Sleep researchers begin to describe delayed phase preference in teenagers and the impact of school schedules and employment on their sleep. Researchers also begin to study sleep disorders and the relationship between sleep loss and depression in adolescents.

1992—The National Commission on Sleep Disorders Research issues its report and declares, “America is seriously sleep-deprived with disastrous consequences” (Stanford Sleep Well Program, 1992).

1993—The Minnesota Medical Association adopts a resolution calling on local school districts to eliminate early start times for adolescents.

The National Center for Sleep Disorders Research (NCSDR) is established at the National Institutes of Health; its mission is to coordinate research and national educational efforts about sleep and sleep disorders.

1994—The CLOCK gene is discovered, which both demonstrates the genetic influence on normal human circadian functioning and emphasizes the importance of circadian regulation on health and disease (Vitaterna et al., 1994).

1996—Edina, Minnesota becomes the nation's first school district to delay start times for high school students based on sleep research showing the impact of sleep loss on young people.

1997—The National Institutes of Health (NIH) declares that adolescents and young adults (ages 12–25 years) are a population at high risk for problem sleepiness based on “evidence that the prevalence of problem sleepiness is high and increasing with particularly serious consequences.”

1997—As a means of mitigating after-school criminal activity by unsupervised teenagers, Congresswomen Zoe Lofgren introduces Concurrent Resolution 227 (ZZZ's to As Act) expressing the “sense of Congress that secondary schools should begin the school day no earlier than 9:00.”

1999—Congresswoman Zoe Lofgren introduces H.R. 1267, “Zs to As Act.” The bill provides grants up to \$25,000 to local educational institutions that agree to begin school for secondary students after 9:00 am. This time, the bill focuses on the sleep needs of adolescents. It does not pass, but gains significant media attention and helps spur a “national conversation” about the issue.

1999—The National Research Council holds *Sleep Needs, Patterns and Difficulties of Adolescents Workshop*, which raises awareness among federal agencies and other health professionals about more than two decades of sleep research on teens. Dr. William Dement declares, “Adolescence is the time of greatest vulnerability from the standpoint of sleep.”

Dr. Eve Van Cauter and her colleagues describe the effects of sleep debt in young adults, establishing an association between sleep loss and metabolic and hormonal function. The research later leads to findings linking sleep loss with an increased risk of obesity (Spiegel, Leproult, & Van Cauter, 1999).

2000s

Sleep researchers increasingly focus on cultural and international differences in sleep habits, including public policies related to work and school hours and their impact on sleep, etc. There is also emerging evidence that puberty-related changes in sleep patterns may affect middle school students as well, thus highlighting the importance of considering later start times in this population as well. Scientific literature establishing the relationship between sleep, memory, and learning continues to grow.

2000—The National Sleep Foundation releases an *Adolescent Sleep Needs and Patterns: Research Report and Resource Guide* at a press conference on Capitol Hill with Congresswomen Zoe Lofgren in order to draw national media attention to the consequences of early start times on the health and safety of adolescents (National Sleep Foundation, 2000).

2001—A state senator in Connecticut introduces the first statewide legislation to change school start times in the nation, but it does not pass.

2002—Dr. Kyla Wahlstrom publishes *Changing times: Findings from the first longitudinal study of high school start times*, the nation's first major study that details the positive impacts of later school start times (Wahlstrom, 2002).

2002—A bill is introduced in the Connecticut Senate that bans administering state tests before 9:00, but does not pass.

2004—The State of Connecticut passes legislation that allows districts to administer the tenth grade mastery test as early as 8:30.

2006—The National Sleep Foundation issues its first annual “Sleep in America” poll. The national poll is the first of its kind, detailing the findings of telephone interviews from a random sample of 1,602 caregivers and their adolescent children about the student's sleep and sleep habits. It finds that only 9% of high school-aged respondents get the amount of sleep recommended by physicians on school nights.

2009—The Centers for Disease Control and Prevention (CDC) release data from a national survey used to assess the prevalence of unhealthy sleep behaviors in 12 states and declares “insufficient sleep is a public health epidemic” (McKnight-Eily et al., 2011).

1900–2010—The percentage of teenagers who graduate from high school increases from about 6% in 1900 to about 85% in 1996, and then declines over the next decade and a half to 75% in 2010.

2010s

2010—The Department of Health and Human Services releases Healthy People 2020, which for the first time gives sleep its own focus area and sets the objective of increasing “the proportion of students in grades 9 through 12 who get sufficient sleep.”

2010—The American Medical Association (AMA) adopts Resolution 503, “Insufficient Sleep in Adolescents”—sponsored by the American Sleep Apnea Association—which confirms “adolescent insufficient sleep and sleepiness as a public health issue” and supports “education about sleep health as a standard component of care for adolescent patients.”

2011—Vorona et al. publish findings on adolescent automobile crash rates in Virginia Beach and Chesapeake, Virginia showing a significant increase in crashes in the district with earlier high school start times (Vorona et al., 2011).

The Brookings Institute issues its report, *Organizing Schools to Improve Student Achievement: Start Times, Grade Configurations, and Teacher Assignments*, identifying high school start time delay as one of the three most important strategies to improve America's schools and projecting a potential benefit-to-cost ratio of 9:1 (Jacob & Rockoff, 2011).

The CDC publishes an epidemiological study showing that almost 70% of high school students are not getting sufficient sleep and sleep loss is associated with 10 at-risk behaviors including smoking, alcohol and marijuana use, sexual activity, feelings of sadness, and thoughts of suicide.

2012—The Florida Chapter of the American Academy of Pediatrics issues a position statement supporting, “considerations to policy changes where students’ physical and mental health is promoted. The FCAAP/FPS supports efforts to change high school start times after 8:00 a.m.”

2013—U.S. Department of Education Secretary Arne Duncan tweets, “Common sense to improve student achievement that too few have implemented: let teens sleep more, start school later.”

Virginia Chapter of the American Academy of Pediatrics issues a statement supporting later school start times for all Virginia high schools.

2014—Dr. Kyla Wahlstrom, with funding from the CDC, publishes the findings from a 3-year research study looking at the impacts of later start times in 8 public high schools in 3 states. The study finds that later start times improve sleep, academic performance, and reduce motor vehicle crashes (Wahlstrom, 2014).

The American Academy of Pediatrics issues a Policy Statement in support of delaying school start times for high school and middle school students.

References for Appendix 2

- Carskadon, M. A., & Dement, W. C. (1975). Sleep studies on a 90-minute day. *Electroencephalography and Clinical Neurophysiology*, 39(2), 145–155. [PubMed:50211]
- Carskadon, M. A., & Dement, W. C. (1977). Sleepiness and sleep state on a 90-min schedule. *Psychophysiology*, 14(2), 127–133. [PubMed: 847063]
- Carskadon, M. A., Harvey, K., Duke, P., Anders, T. F., Litt, I. E., & Dement, W. C. (1980). Pubertal changes in daytime sleepiness. *Sleep*, 2, 453–460. [PubMed: 7403744]
- Centers for Disease Control and Prevention. (2014). *Insufficient sleep is a public health epidemic*. Retrieved from <http://www.cdc.gov/features/dssleep/>
- Czeisler, C. A., Allan, J. S., Strogatz, S. H., Ronda, J. M. Sánchez, R., Ríos, C. D., ... Kronauer, R. E. (1986). Bright light resets the human circadian pacemaker independent of the timing of the sleep-wake cycle. *Science*, 233(4764), 667–671. [PubMed: 3726555]
- Dement, W., & Kleitman, N. (1957). The relation of eye movements during sleep to dream activity: An objective method for the study of dreaming. *Journal of Experimental Psychology*, 53, 339–346. [PubMed: 13428941]
- Jacob, B., & Rockoff, J. (2011). Organizing schools to improve student achievement: Start times, grade configurations, and teacher assignments. *The Brookings Institute*, 8, 1–6. Retrieved from http://www.hamiltonproject.org/files/downloads_and_links/092011_organize_jacob_rockoff_brief.pdf
- Kleitman, N. (1963). *Sleep and wakefulness*. Chicago, IL: University of Chicago Press.
- McKnight-Eily, L. R., Liu, Y., Wheaton, A. G., Croft, J. B., Perry, G. S., Okoro, C. A., & Strine, T. (2011). Unhealthy sleep-related behaviors: 12 states, 2009. *Morbidity and Mortality Weekly Report*, 60, 233–238.
- Moore, R. Y., & Eichler, V. B. (1972). Loss of circadian adrenal corticosterone rhythm following suprachiasmatic nucleus lesions in the rat. *Brain Research*, 42, 201–206.
- National Sleep Foundation. (2000). Adolescent sleep needs and patterns: Research report and resource guide. Retrieved from: http://www.sleepin Fairfax.org/docs/sleep_and_teens_report1_NSF.pdf
- Owens J., & Adolescent Sleep Working Group and American Academy of Pediatrics Committee on Adolescence. (2014). School start times for adolescents AAP policy statement. *Pediatrics*, 35(9), 1.
- Richardson, G. S., Carskadon, M. A., Flagg, W., Van de Hoed, J., Dement, W. C., & Mitler, M. M. (1978). Excessive daytime sleepiness in man: Multiple sleep latency measurement in narcoleptic and control subjects. *Electroencephalography and Clinical Neurophysiology*, 45, 621–627. [PubMed: 81764]
- School Bus Fleet Magazine. (2001). *School bus fleet 2001 fact book*. Torrance, CA: Bobit. Retrieved from <http://education.stateuniversity.com/pages/2512/Transportation-School-Busing.html>
- Spiegel, K., Leproult, R., & Van Cauter, E. (1999). Impact of sleep debt on metabolic and endocrine function. *The Lancet*, 354, 1435–1439.
- Stanford Sleep Well Program. (1992). *Overview of the findings of the national commission on sleep disorders research*. Retrieved from <http://web.stanford.edu/~dement/overview-ncsdr.html>
- Stephan, F. K., & Zucker, I. (1972). Circadian rhythms in drinking behavior and locomotor activity of rats are eliminated by hypothalamic lesions. *Proceedings of the National Academy of Sciences of the United States of America*, 69, 1583–1586
- Theobald, M. (2004). *Wayne Works*. Retrieved from <http://www.coachbuilt.com/bui/w/wayne/wayne.htm>

Vitaterna, M. H., King, D. P., Chang, A. M., Kornhauser, J. M., Lowery, P. L., McDonald, J. D. ... Takahashi, J. S. (1994). Mutagenesis and mapping of a mouse gene, clock essential for circadian behavior. *Science*, 264(5159), 719–725. [PubMed:8171325]

Vorona, R. D., Szklo-Coxe, M., Wu, A., Dubik, M., Zhao, Y., Ware, J. C. (2011). Dissimilar teen crash rates in two neighboring southeastern Virginia cities with different high school start times. *Journal of Clinical Sleep Medicine*, 7, 145–151. [PubMed: 21509328]

Wahlstrom, K. (2002). Changing times: Findings from the first longitudinal study of later high school start times. *National Association of Secondary School Principals Bulletin*, 286, 3–21. Retrieved from <http://conser.vancy.umn.edu/bitstream/139295/1/2002%20NASSP%20Bulletin,%20Vol.%2086%20No.%20633.pdf>

Wahlstrom, K. (2014). *Examining the impact of later high school start times on the health and academic performance of high school students: A multi-site study: final report*. Center for Applied Research and Educational Improvement. Retrieved from <http://www.cehd.umn.edu/CAREI/sleepresources.html>

APPENDIX 3. SELECTED CASE STUDIES OF LATER START TIME SUCCESSES

Bentonville School District, Arkansas

In 2007, the Bentonville School District, the fifth-largest in the state (11,100 students), implemented a later start time for its one high school, moving a one later from a 7:45 am to an 8:45 am start time. District officials changed the start times to better accommodate a new “A/B block” class schedule that allowed students to rotate courses every other day. The teachers reported liking the A/B block schedule and used the extended class time to incorporate cooperative learning groups and hands-on activities. To accomplish the bell schedule change, the district moved all of the five middle schools earlier (8:00 am to 7:40 am) and also moved the nine elementary schools earlier (8:00 am to 7:30 am).

Following the changes in bell schedules, many teachers and administrators anecdotally reported a high level of satisfaction, with some teachers indicating feeling more rested and productive throughout the day. Students who were active in extracurricular activities or worked after school preferred the later start time because it allowed the opportunity for more sleep. The community also found that the bell schedule change assisted in alleviating traffic congestion. The district found that block scheduling gave their students more class choices and the later start time change gave the district more flexibility in dealing with traffic and addressing the students’ sleep needs.

Lessons: Bentonville is an example of a successful collaboration between district officials and the school board

to change class and transportation schedules. The changes resulted in the promotion of sleep health and more flexibility in students’ class schedules. Improvements in sleep and quality of life for both students and teachers were also reported.

(Source: <http://normessasweb.uark.edu/bestpractices/papers/Casestudies/401003.pdf>)

Pulaski County Special School District, Arkansas

In 2012, the Pulaski County Special School district, with a student population of 17,500, “flipped” the start times for its six middle and six high schools with those of its 24 elementary schools. The middle schools moved 50 min later from 7:30 am to 8:20 am, and high schools moved later by 65 min, from 7:30 am to 8:35 am, with all elementary schools remaining at their start times between 7:45 and 8:00 am. The changes were spurred by the district’s interest in reducing transportation costs and improving the sleep the health and safety of its students. To accomplish these changes, the district went from a single-tier to a two-tier busing schedule. The change was initiated by the district under the leadership of the new superintendent who was charged by the State Commissioner of the Department of Education with cutting costs following a period of financial mismanagement by the previous administration and the school board, which was dissolved. The district announced the change in January with implementation in September to allow enough time for parents to plan and change their childcare arrangements and utilized a toll-free line to field questions and comments from the community.

Lessons: The Pulaski County Special School district demonstrates that communities can successfully adapt to substantial changes if given appropriate time and if parents are provided with adequate information during implementation.

(Source: <http://www.thv11.com/news/article/189874/2/PCCSD-proposes-changes-to-start-times> and <http://www.pcssd.org/pcssd-bell-times-bus-schedules-may-change-for-next-school-year>)

Albany Unified School District, California

Albany High School has 1,800 students in a small school district with one other high school for at-risk students, one middle school, and three elementary schools. In 2013, the Albany High School principal proposed moving the current bell time of 7:40 am to 8:30 am, based on research from economists and sleep researchers as well as feedback from a series of community engagement sessions. A task force, named the Challenge Success Committee, was formed and included parents, students, teachers, counselors, and school administrators. The committee researched the issue

and developed a set of recommendations. After receiving the report and recommendations, the high school's Instructional Improvement Council (a small committee comprised of six staff members, two parents, and two students) agreed to move the start time to 8:00 am as a one-year pilot and proposed to solicit feedback from the community through a series of surveys in order to gauge potential impact. The high school also sought input through several governance committees and a town hall forum. After reviewing the scientific rationale and as a result of these community discussions, the Albany Middle School principal also recommended eliminating the 7:00 am zero period and moving the start time to 8:00 am, which were both adopted.

Lessons: This district is a good example of a principal immersing himself in the sleep research and working hard to educate both his staff and community. His commitment to the issue and willingness to pilot the change had a positive impact on his colleagues in the rest of the district. The superintendent utilized local sleep experts and community members to educate the community about the health and safety benefits of changing start times.

(Source: <http://web.ahs510.org/news/administrative-news/iicagreestolaterstarttime> and <http://albany.patch.com/groups/schools/p/later-daily-start-time-for-albany-high-proposed>)

Long Beach Unified School District, California

Long Beach Unified School District educates 81,000 students in six high schools, 15 middle schools, and 51 elementary schools, with four charter and five alternative schools. In the 2013–2014 school year, the Long Beach Unified School District adopted a plan to move their high schools from 7:50 am to 8:50 am with an end time of 3:40 pm, as part of a pilot program. The plan, debated about and approved by the school board early in 2013, also moved six middle schools to a 9:00 am to 3:40 pm bell schedule to be consistent with the district's nine other middle schools. As part of the plan, all affected schools were to develop action plans to provide supervision for students in the morning. Budget reductions were the driving factor for the realignment of bell schedules. District officials anticipated that the changes would save the district over \$1 million, with much of the savings resulting from bus schedule adjustments for special education students requiring home pick-up and riding smaller buses.

Community outreach prior to schedule changes indicated mixed levels of support and initial reservations from key stakeholders. An online survey on school start time change, conducted by the district, showed that the respondents were about evenly split on the issue of changing start times. Additionally, the local teacher's union expressed concern regarding contractual issues and the change's

impact on sports and other programs. The district worked closely with these groups to address their issues and ultimately to gain their support. Additionally, the district announced that it would convene a large, ad hoc committee (40–60 members) to evaluate the impact of the pilot program.

Lessons: While the motivation for changing start times in Long Beach was to cut transportation costs, this district is taking a unique approach in forming a large committee of stakeholders to evaluate the impact of the change. Most school districts typically form such committees prior to considering taking action and then disband once a decision to delay start times is made. The ad hoc committee report is due in the fall of 2014.

(Source: <http://www.dailybreeze.com/general-news/2013-03-26/long-beach-middle-schools-to-start-later-next-fall> and <http://www.lbschools.net>)

West Hartford Public High School, Connecticut

West Hartford Public Schools is a district with a student population of 10,222 in two high schools, three middle schools, and 10 elementary schools. In the fall of 2006, the West Hartford Board of Education voted 5–2 to adopt a flexible start time schedule for juniors and seniors at its two high schools beginning in the fall of 2007, with implementation for sophomores and freshmen beginning in 2008. The “flexible” start time option gave juniors and seniors the option of starting school at 8:15 am (second period), instead of at 7:30 am. The first period was converted to a study hall and the dismissal bell remained at 2:15 pm for all students, regardless of whether or not they elected the second period start. The “flexible” start time was a strategy developed in response to significant community resistance to a proposed “blanket” delay of high school start times. While acknowledging that this “flexible” option was a less-than-optimal compromise, the Board of Education concluded that at least it offered a delayed start time option to those students and parents who recognized the value of obtaining sufficient sleep. According to school administrators, the later start times had positive impacts on academic performance, student stress levels, and emotional health.

Lessons: West Hartford Public Schools is a good example of a school board and administration continuing to seek solutions to provide choices to students and to encourage better sleep health, after deciding against full implementation of start time change due to community opposition.

(Source: Author's notes, 2006.)

Wilton Public Schools, Connecticut

Wilton engaged in a two-year long process, which culminated in delayed start times for both its middle and high

school (7:35 am to 8:15 am) in 2003. Initially, legislation was proposed by State Senator Kevin Sullivan in 2001 to delay start times across Connecticut, but subsequently it was decided that this should occur on a local district-by-district level. Wilton's local chapter of the League of Women Voters became involved in the debate and distributed both a review of the literature on adolescent sleep and the results of a local survey of students and school staff and recommended that Wilton Board of Education consider delaying start times. Existing community-planning teams, consisting of teachers, administrators, parents, students, and citizens, were then engaged in studying the issue. Area superintendents met with physicians from the Connecticut Thoracic Society to ask for scientific input and to request their engagement in the process. It was decided by the superintendent with input from advisory groups that any potential solutions would need to meet three criteria: (1) be cost-neutral, (2) require student bus rides no greater than 45 min, and (3) avoid any student being picked up by a bus earlier than 7:00 am. Parents and teachers were offered the opportunity to participate in an "advisory vote" on the superintendent's recommendations regarding start times, which yielded diametrically opposed results (parents supported two to one, teachers opposed two to one). While the Wilton Sports Council published full-page ads opposing the changes on a number of grounds, including compromising Wilton's reputation of athletic excellence, the head of the Connecticut Interscholastic Athletic Conference provided a written statement in support of delayed start times. After the start time change, teachers reported that students were better rested and more alert during the school day. There was no appreciable effect on athletics, and within a year, the change became the "norm" and "part of the fabric of the community" (Robert O'Donnell, current superintendent). While there has been considerable interest expressed by neighboring school districts, no other schools in the surrounding area have followed Wilton's lead.

Lessons: Wilton provides an illustration of several common themes related to changing school start times, including the vital role of the superintendent, community concerns regarding impact on athletics which were not subsequently substantiated, and the importance of ongoing stakeholder input. It also provides some unique perspectives (i.e., the potential for community groups to assume a leadership role, enlistment of local health professional societies, use of established models such as community planning teams to provide input), which may be applicable to other districts. In particular, the community's identity as a self-styled "sports town" provides a striking example of "cultural" considerations that have the potential to derail efforts to change start times if not adequately addressed.

(Source: Owens, J. [2013, October 30]. Telephone interview.)

Denver Public Schools, Colorado

Denver Public Schools is a large district with over 84,000 students in 22 high schools, 21 middle schools and 74 elementary schools, and 59 alternative and charter schools. Due to concerns regarding the impact of early start times on adolescents and seeking a way to cut transportation costs, the district conducted a feasibility study in 2004. In 2005, the district took one of the more unique approaches to changing start times for all of its high school students. Under the leadership of the superintendent, the school district adopted a "flexible" schedule and radically changed how it provided transportation to its students. While conducting the feasibility study, the district found that 2,400 high school and 1,300 middle school students purchased bus passes from the local public transit agency, the Regional Transportation District (RTD). In the "flexible" plan, students were allowed to choose their arrival and dismissal times within a 7:30 am to 4:15 pm bell schedule, as long as they met the instructional time requirements. The new transportation plan involved switching more students to public transportation and providing free bus passes to all students who lived more than 3.5 miles from their base school and to students going to magnet schools elsewhere in the district. Other students were still provided with bus transportation by the district.

As part of the district's implementation plan, a series of public outreach sessions were held including two town hall meetings, a public hearing and a presentation by principals summarizing their discussions with parents and local communities. There were some initial concerns raised by parents about students riding on public buses. The district also conducted surveys of students and found that many of the students were not initially open to taking advantage of the later start time options because of their involvement in after-school programs. However, in the 2006 school year, about 30% students chose a start time of 8:00 am or later. As a result, the district was able to eliminate 60 buses and save \$750,000 in its transportation budget.

Lessons: The Denver public school district was open to unique solutions and working with the local public transportation system to allow options for its students. Those students who wished to take advantage of school schedule choices were presented with a number of options that were nonetheless within specific parameters. The process also involved significant community engagement through public meetings and online surveys. While the initiative lacked overwhelming community and stakeholder support, district officials decided to still pursue a course which they felt was in the best interests of the district, both financially and for the health and safety of its students.

(Source: National Sleep Foundation, <http://www.sleepinfairfax.org/docs/CS.Denver.pdf>. High School Transportation: Report to the Board, Department of

Research, Planning and Special Programs, Department of Transportation, March 18, 2004.)

Milford Public Schools, Delaware

Milford Public Schools is a small district with about 4,100 students who attend one high school, one middle school, and four elementary schools. After many years of studying ways to mitigate scheduling conflicts resulting from state requirements that mandated professional development time and standardized testing, the Superintendent of Milford Public Schools formed a task force to study potential solutions. The task force included teachers and administrators who volunteered to research the issue and develop recommendations. In 2012, the task force recommended the adoption of an “A/B block” scheduling system as well as a delay in school start times, with the high school start times moving 40 min later from 7:35 am to 8:15 am, the middle school start times moving from 7:35 am to 8:00 am, and the elementary school start times moving earlier to 7:40 am. A unique feature of the plan was to start school at 9:35 am for both middle and high school students on Wednesdays. The school accommodated parents who were concerned about leaving their older children at home unsupervised on late start time days by opening the libraries to students who needed to be at school earlier. The superintendent expressed the belief that these changes—both later start times for secondary students and earlier start times for elementary students—would be beneficial for all students and would increase daytime alertness.

Lessons: Milford Public Schools illustrates a situation in which a district initially changed its bell times to accommodate state requirements for standardized testing and professional development but subsequently realized that this schedule better accommodated the biological and learning needs of its students. Parental opinions were mixed, with some elementary school parents concerned about winter civil twilight violations, while some found the earlier times to be more accommodating for their work schedules.

(*Source:* <https://milfordlive.com/2012/06/19/msd-to-see-changes-next-year-2> and <http://www.milfordbeacon.com/article/20120710/NEWS/307109954>)

Brevard County School District, Florida

Brevard County School District is a large system with 82 elementary schools, 16 middle schools, 21 high schools, 18 specialized centers, and a student population of 96,000 that is delivered on a three-tier bus system. Each bus has three routes that service all three school tiers. In 2000, the district delayed high school start times by a full hour, from 7:30 am to 8:30 am and middle school times by 25 min from 8:50 am to 9:15 am. The elementary schools, which

incorporate grades K-6, were moved earlier by a full hour and fifty min, from 9:50 am to 8:00 am. The change was implemented after extensive community outreach was conducted through public meetings to allow stakeholders the opportunity to express their concerns and share their views. The district also conducted research on other school districts that had successfully changed their start times and provided information to the public and school staff about improvements in academic performance and attendance rates. District staff also worked with a local hospital to provide scientific and health education presentations to the community and the school board, using information from the National Sleep Foundation. A proposal was developed by the superintendent and submitted to the school board, which subsequently approved the change. In order to offset some of its transportation related costs, the district charges students for special or out-of-boundary services.

Following the change, the school district found a significant reduction in the rate of first period tardiness and absences. Some of the negative outcomes reported by the district were limited availability of school buses for field trips and an increased need for after-school childcare.

Lessons: Brevard County demonstrates that students and the community in a large county can adapt to significant changes in school bell schedules. The district solicited a tremendous amount of public input but did not let negative opinions proffered by some constituencies and individuals deter them from finding solutions. Many of the non-academic concerns typically raised by parents regarding potential impact on after-school employment and on athletics were not realized. Finally, Brevard’s strategy of charging for non-academic and magnet transportation services may help reduce costs significantly in districts that provide substantial special transportation services.

(*Source:* Author’s notes, 2006. <http://www.neola.com/brevardcofl/search/policies/po8600.htm>)

Bonneville School District, Idaho

In the 1999–2000 school year, the Bonneville School District adopted a new school start time for its two high schools by shifting from a 7:45 am start time to 8:50 am. The district, which has 21 schools (including three middle and 14 elementary schools) and a student population of 11,200, was the first in the state to move start times later. In the year following the change, the district studied the impacts on attendance and found that absences dropped by 15% and tardiness decreased by 22%. The study also found that high school students were getting about 44 min more sleep on average after the change. Many students reported that they were more alert, and their teachers concurred. Some students also reported using part of the extended period morning before school to seek help from their teachers. For unclear reasons, the start times at

the two high schools were subsequently shifted earlier to 8:25 am before 2014.

Lessons: The Bonneville School District is an example of a district evaluating the impact of the change in school start times and reporting the positive data back to its staff, students, and the local community.

(*Source:* Author's notes, 2006.)

Needham Public School District, Massachusetts

Needham Public School District is a small district consisting of six elementary schools, one middle school, and one high school with a student population of 5,476. Under the direction of the superintendent, an advisory body called the School Starting Time Advisory Committee was formed in the fall of 2002 to determine if start times for all schools should be changed to be more compatible with students' biological rhythms. The committee included one teacher, one administrator, and a parent representative from each level, a school committee representative, a school nurse, a representative from the transportation department, two high school students, and the director of the arts department.

The committee reviewed the existing sleep and education research available at the time and conducted surveys of high school teachers regarding the level of alertness of students while in class. They also surveyed a small sample of students regarding their sleep habits and preferences regarding start times. The committee launched a website to provide information about their activities and encouraged members of the community to provide feedback. The committee also made a concerted effort to contact school districts that had successfully changed their start times and consulted sleep experts, health professionals, and The National Institutes of Health.

As a result of their research and fact-finding, the committee concluded that, "the research about the educational and health benefits of a later high school starting time are clear and compelling." On the basis of a review of the potential impact on athletics, after-school programs, religious activities, performing arts and transportation, the committee recommended changing the start times later for both primary and secondary schools. The committee developed five options, all of which had the high school start time moving from 7:40 am to 8:05 am, with middle schools either staying at their current time or also moving to 8:05 am, and all elementary schools staying at their current time or starting at 8:45 am. Due to redistricting in 2003, the school board delayed their decision a full year and conducted further community engagement. In 2004, the school board moved start times for all middle and high schools close to the time recommended by the committee with high schools starting at 8:00 am, middle schools starting at 7:50 am, and elementary

school starting 15 min later, moving from 8:20 am to 8:35 am.

Lessons: Needham Public School District exemplifies many of the strategies used by other districts that have successfully changed their start times. It created a small working group composed of key department members and parent and teacher representatives to collect information on the scientific research (including interviews with sleep experts), to consider the potential impact and develop possible mitigating strategies, and to conduct meetings with stakeholders. The committee carefully studied the issues over a protracted period of time, developed and articulated a compelling rationale for changing the bell schedule and presented a range of options to the community based on an assessment of feasibility.

(*Source:* Needham Public Schools School Starting Time Report and Recommendation, January 2003.)

Arlington Public Schools, Virginia

Arlington Public Schools is a large urban district just outside of Washington, DC. Currently, the school district has more than 19,900 students in 22 elementary schools, five middle schools, and four high schools. In 1999, based on the growing interest of some parents and the school board in emerging sleep science and in order to reduce transportation costs and to improve academic performance, the district began a comprehensive and intricate two-year process to change its school start times.

The school board requested that the district's Advisory Council for Instruction (ACI), a large body of 50 members, form a School Start Time Steering Committee to compile research on sleep and adolescence and to study the potential impact of changing bell schedules on transportation and extracurricular activities. In December of 1999, the committee recommended that the school board move high school start times 45 min later (from 7:30 am to 8:45 am) starting in the fall of 2000. On the basis of this recommendation, the school board voted unanimously to direct district staff to develop plans to change start times for high schools. As part of its direction, the school board provided four guiding principles: (1) the change should improve student achievement, (2) no school should start before 7:50 for safety reasons, (3) change in high school start times should not negatively impact any group or school level, and (4) the ability of students being able to participate in extracurricular activities should not be affected. The board also expressed a desire that an evaluation study be conducted following implementation.

Following the board action, the superintendent formed a working group, comprised of both staff and community members, to review the ACI's findings, study all relevant issues, and make recommendations for implementation in

the fall of 2001. The working group consisted of a steering committee and several subcommittees to study and make recommendations regarding such issues as transportation, public engagement, after-school activities, and sleep research. The district also hired a transportation consultant to study bus schedule options and to look for additional efficiencies in the system. The consultant and the working group initially developed 12 options, eventually settling on a total of four, one of which included keeping the current bell schedules (status quo).

Once the options were refined, the steering committee and representatives from a couple of the subcommittees engaged in significant community engagement to educate the community about sleep science and to obtain feedback on the models. Materials were developed and distributed in back-to-school packets, at the superintendent's public meetings, the local county fair as well as in press releases. Information was also posted on the district's website and community feedback was requested via email through the website. Letters were sent to all of the local parent teacher associations (PTAs) and representatives from the steering committee attended meetings to provide information and answer questions. As part of its process, the working group worked with the University of Maryland to conduct surveys of parents, students and teachers and held two public forums to solicit input from the community.

On the basis of a few different periods of community engagement and staff input, the steering committee developed additional options and made further adjustments throughout. Finally, in October 2000, the steering committee made a recommendation to the school board, which voted unanimously to change start times for high schools from 7:30 am to 8:15 am, middle schools from 8:10 am to 7:50 am, and elementary schools from 8:10 am and 8:50 to three tiers of 8:00 am, 8:25 am and 9:00 am. Following the vote, the school board requested that district staff survey teachers about the proposed changes on whether or not they would leave the school district with the change taking place. The survey found that 14% reported that they would consider leaving their jobs.

During the implementation phase, the steering committee and school board continued to meet with the community and key stakeholder groups in order to discuss issues and foster support for the bell changes. A toll-free line was established to help parents and students ask questions about the implementation, but it was rarely used. A series of surveys were conducted to gauge community, teacher and student satisfaction following the

In 2005, the school district's Office of Planning and Evaluation did an analysis of surveys conducted after implementation and grades collected pre (2000–2001) and post (2001–2002) implementation. The results were

largely inconclusive and the Office stated that its analysis "should be interpreted with caution" because it was "impossible to isolate the impact of the start time change on academic performance." However, the Office found a "very slight" improvement in the first period grades for the graduating class of 2003. Other findings were insignificant improvements in academic performance but negligible or largely inconclusive results regarding tardiness and attendance. The Office did report that more high school students reported (41% vs. 47%) participating in "class discussions" and "being prepared for class" (41% vs. 47%) all of the time.

Lessons: Arlington is a good example of a district that conducted considerable research, did comprehensive planning, and included community members and key stakeholders throughout the process, including after implementation. This district staff, working group and school board conducted significant community engagement efforts and adjusted models and plans during the process but did not let any opposition deter them from achieving what they believed was best for students. This case also demonstrates that while people express strong anticipatory concerns about change, such fears rarely ever come to fruition (e.g., no teachers left as a result of the change). As time goes by, people adapt, traffic patterns and personal schedules adjust.

(*Source:* Changing School Start Times: Arlington, Virginia. Sleep for Teens Toolkit. National Sleep Foundation, 2005. Accessed by <http://www.sleepin Fairfax.org/research.htm>. Impact of 2001 Adjustments of High School and Middle School Start Times. Lewin, D. [2013, October 31] Telephone interview. Arlington Public Schools, Office of Planning & Evaluation, June 2005. <http://www.fcps.edu/fts/taskforce07/documents/arlington605.pdf>)

APPENDIX 4. NATIONAL SCHOOL START TIME SURVEY

You are being asked to fill out this survey because your school district has prior experience with delaying high school start times and you participated in and/or have knowledge about the process. Thank you for your time.

General Information

1. Name and title of individual filling out survey:
2. Name and location of school district:
- 3a. What year did your school district begin to implement school start time change?
- 3b. If your district employed a phased-in approach, over how many years was start time change implemented?

4. Please indicate the number of schools in your district in the following categories:

- Elementary School
- Middle School
- High School

5. Please indicate the approximate number of students enrolled in each category:

- Elementary School
- Middle School
- High School

6. Please indicate the total number of school buses transporting students in your district:

7. Please indicate the school start/end times PRIOR to the change for:

- Elementary School
- Middle School
- High School

8. Please indicate the school start/end times AFTER the change for:

- Elementary School
- Middle School
- High School

9. Please indicate the current school start and end times (2013–2014 academic year)

- Elementary School
- Middle School
- High School

Change Strategy and Implementation

10. Which best describes your district’s school start time change strategy (select all that apply)?

- “Flip” (e.g., switch high school and elementary school start times)
- All school start times (ES, MS, HS) delayed (“slide” later)
- Addition of a “zero period” in the morning
- Students chose late or early start times
- Other (please describe)

11. Please indicate which transportation approaches were in place before and/or after the start time change (may select more than one):

- Tiered bus delivery schedule
- Decreased transportation budget

- Increased transportation budget
- Consolidated “bus depots”
- MS/HS ride together
- ES/MS ride together
- ES/MS/HS ride together
- No Buses provided for magnet schools
- Students pay flat-rate for buses for year
- Increased utilization of public transportation
- Other (please describe)

12. Please mark “Yes” or “No” for the following *challenges* that your school district faced in changing school start times. Yes, No, N/A

- 1 Traffic flow at the school during drop off and pick up
- 2 Commuting distances
- 3 Before-school extracurricular program attendance
- 4 After-school extracurricular program attendance
- 5 Before-school academic enrichment program attendance
- 6 After-school academic enrichment program attendance
- 7 Use of school facilities by non-school community groups (e.g., Boy Scouts)
- 8 Athletic game schedules
- 9 Before-school athletics practice schedules
- 10 After-school athletics practice schedules
- 11 Use of practice fields by non-school groups (e.g., Parks and Recreation)
- 12 Before-school child care
- 13 After-school child care
- 14 Changes in parents’ work schedules
- 15 Changes in teachers’ work schedules
- 16 Changes in staff commute times
- 17 Student after-school employment
- 18 Participation in school breakfast programs
- 19 “Civil twilight” violations (i.e., leaving home before dawn or after dusk) for elementary students
- 20 Other (please specify):

13. Please rank order the top five issues that were the most challenging (from 1 = *most challenging* to 5 = *least challenging*)

- 1 Traffic flow at the school during drop off and pick up
- 2 Commuting distances
- 3 Before-school extracurricular program attendance
- 4 After-school extracurricular program attendance
- 5 Before-school academic enrichment program attendance
- 6 After-school academic enrichment program attendance
- 7 Use of school facilities by non-school community groups (e.g., Boy Scouts)

- 8 Athletic game schedules
- 9 Before-school athletics practice schedules
- 10 After-school athletics practice schedules
- 11 Use of practice fields by non-school groups (e.g., Parks and Recreation)
- 12 Before-school child care
- 13 After-school child care
- 14 Changes in parents' work schedules
- 15 Changes in teachers' work schedules
- 16 Changes in staff commute times
- 17 Student after-school employment
- 18 Participation in school breakfast programs
- 19 "Civil twilight" violations (i.e., leaving home before dawn or after dusk) for elementary students

14. Please mark "Yes" or "No" for the following strategies that your school district employed in changing school start times. Yes, No, N/A

- 1 Substitute online education for early morning classes
- 2 Substitute summer school for early morning classes
- 3 Substitute Saturday classes for early morning classes
- 4 Increasing the length of winter break to reduce early morning travel for elementary students ("civil twilight violations") and decreasing the summer break by a corresponding number of days
- 5 Flexible start and end-time scheduling (not requiring school bus transportation)
- 6 Adding lighting for selected athletic playing fields
- 7 Increased use of public transportation (e.g., providing incentives for use)
- 8 Increased use of personal transportation (e.g., "kiss and ride")
- 9 Decreased use of personal transportation
- 10 Student athletes' early dismissal
- 11 Extracurricular programs on Saturdays
- 12 Mid-morning "breakfast break" for students
- 13 Other (please specify):

15. Please rank order the top five strategies that were the most effective (from 1 = most effective to 5 = least effective)

- 1 Substitute online education for early morning classes
- 2 Substitute summer school for early morning classes
- 3 Substitute Saturday classes for early morning classes
- 4 Increasing the length of winter break to reduce early morning travel for elementary students ("civil twilight violations") and decreasing the summer break by a corresponding number of days
- 5 Flexible start and end-time scheduling (not requiring school bus transportation)
- 6 Adding lighting for selected athletic playing fields

- 7 Increased use of public transportation (e.g., providing incentives for use)
- 8 Increased use of personal transportation (e.g., "kiss and ride")
- 9 Decreased use of personal transportation
- 10 Student athletes' early dismissal
- 11 Extracurricular programs on Saturdays
- 12 Mid-morning "breakfast break" for students
- 13 Other (please specify):

Benefits/Costs

16. Please mark "Yes" or "No" for the following beneficial outcomes that your school district observed at the high school level as a result of school start time changes; if you did not measure an outcome, please check "Not Applicable" N/A Yes, No, N/A

- 1 Increase in daily attendance
- 2 Reduced tardiness rates
- 3 Improved standardized test scores
- 4 Improved grades
- 5 Higher graduation rates
- 6 Fewer referrals for disciplinary action
- 7 Improved sports team performance
- 8 Fewer sports-related injuries
- 9 Cost saving for public school system
- 10 Fewer student visits to school health centers
- 11 Lower rates of depression/suicidal thoughts
- 12 Lower rates of car accidents

Other (please describe):

17. Please rank order the top five beneficial outcomes that you believe were the most important (from 1 = most important to 5 = least important).

- 1 Increase in daily attendance
- 2 Reduced tardiness rates
- 3 Improved standardized test scores
- 4 Improved grades
- 5 Higher graduation rates
- 6 Fewer referrals for disciplinary action
- 7 Improved sports team performance
- 8 Fewer sports-related injuries
- 9 Cost saving for public school system
- 10 Fewer student visits to school health centers
- 11 Lower rates of depression/suicidal thoughts
- 12 Lower rates of car accidents

18. Please mark "Yes" or "No" for the following negative outcomes that your school district observed as a result of school start time changes; if you did not

measure an outcome, please check “Not Applicable”

N/A Yes, No, N/A

- 1 Financial cost incurred by the school district
- 2 Loss of community support
- 3 Impact on parent work schedules
- 4 Limitations on student after-school employment
- 5 Financial cost incurred by families (loss income, additional child care expenses)
- 6 Changes in traffic patterns
- 7 Reduction of student involvement in extracurricular activities/athletics
- 8 Negative impact on teacher schedules
- 9 Safety concerns for ES students

- 1 Financial cost incurred by the school district
- 2 Loss of community support
- 3 Impact on parent work schedules
- 4 Limitations on student after-school employment
- 5 Financial cost incurred by families (loss income, additional child care expenses)
- 6 Changes in traffic patterns
- 7 Reduction of student involvement in extracurricular activities/athletics
- 8 Negative impact on teacher schedules
- 9 Safety concerns for ES students

Thank you very much for completing this survey!

19. Please rank order the top five negative outcomes that you believe were the most important (from 1 = most important to 5 = least important)