Delaying School Start Times and
the Health of Adolescents

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Objectives

- What’s normal?
  - What happens to sleep in adolescence
- What’s not?
  - The consequences of insufficient sleep
- What’s the answer?
  - The evidence for delaying school start times and the impact on:
    - Health of adolescents
    - Implications for public policy at the individual school district, regional and national levels
Adolescent Sleep: The “Perfect Storm”?
Adolescents: Later Bedtimes

- Circadian rhythm changes associated with pubertal stage (rather than chronological age)
  - Shift (delay) to later sleep-wake times
  - May be exacerbated by evening light exposure
- Accumulation of sleep drive changes
  - Easier for adolescents to delay sleep onset; more difficult to initiate sleep
- Environmental factors
  - Competing priorities for sleep: homework, activities, after-school employment, “screen time”, social networking
Adolescents: Earlier Wake Times

- Earlier wake times
  - Earlier school start times
    - Often concurrent with adolescent phase delay, making it more difficult to fall asleep and to wake up
Adolescents: Irregular Sleep/Wake Schedules

- Increasing discrepancy between WD/WE BT/WT
  - Average 1.5-2 h delay BT; 3-4 h delay WT
- Adequate compensation for WD sleep loss?
  - Compromised WD alertness
  - Exacerbation circadian phase delay
    - Shift melatonin onset
    - Increased SOL Sunday night
    - Weekly “jet lag”
      - Associated EDS, poor academic performance, depressed mood
      - Effects persist up to 3 days
Adolescent Sleep: The Bottom Line

- Average sleep high school student needs: **9 - 9 1/4 hrs/night**
- Average sleep high school student gets: **7 1/4 hrs/night**
- The Ideal:
  - On a practical level, this means that the average adolescent has difficulty falling asleep before 11pm, and is best suited to wake around 8am
- The Reality:
  - 80% of adolescents get < recommended 9 h sleep amount on school nights; 45% < 8h
  - By 12th grade, average sleep on school nights is 6.9 h; 3% ≥9hrs
  - 30-41% of 6th – 8th graders getting ≥9 hrs of sleep
  - But, 71% of parents think their teens get enough sleep most nights
NSF 2006 Sleep in America Poll: The Consequences

- 70% require an adult to wake them up in the morning
- 28% fall asleep in school at least 1x/wk
- 22% fall asleep doing homework
- Less sleep=
  - Lower grades
  - Depressed mood
The Function of Sleep

“...the strongest experimental evidence supports a primary role for sleep in the regulation of brain plasticity and cognition.”

We need sleep to:
- Facilitate memory retention (procedural>declarative)
- Organize our thoughts, predict outcomes and avoid consequences, be goal-directed (“executive functions”)
- React quickly
- Work accurately and efficiently
- Think abstractly
- Be creative
- Gain insight

The only thing that replaces sleep is:
- Sleep
Effects of Sleep Loss: Mechanisms

- Sleep deprivation/prolonged wakefulness affects
  - Neuronal functions
  - Neuronal “plasticity”: ability of the brain to change structure/function in response to the environment
    - Sleep may downscale all synapses to compensate for net increase in synapse formation and strength in wake
  - Gene activation/expression
  - Neurogenesis
  - Brain cell protection/repair from stress
  - Neurotransmitters (serotonin, dopamine)
  - Melatonin production/circadian biology
    - Cellular metabolism, neurogenesis, brain/eye development
    - Highest susceptibility during critical developmental periods
- Sleep deprivation/prolonged wakefulness increases the stress response and stress hormones
This is Your Brain Without Sleep…

- Experimental sleep restriction has selective effects on PFC and “executive functions”
  - Judgment, motivation
  - Monitoring and modifying behavior
  - Modulation emotions
  - Managing frustration
Sleep and Emotional Regulation

- Sleep-deprived volunteers viewed emotional images:
  - Increased amygdala response
  - Weaker connection amygdala-PFC = less emotional control
Sleep and Mood

- NSF 2006 poll:
  - Students getting less sleep more likely to report feeling unhappy, sad or depressed, hopeless about the future, worried, or negative about life

- Adolescents with parental set bedtimes > midnight 24% more likely to report depression, 20% more likely to have suicidal ideation
Sleep and Reward-Related Brain Function

- Striatum important for reward-related brain function
  - Positive emotions
  - Motivation
  - Response to reward
- Undergoes structural/functional changes in adolescence
- Less activation by reward may lead to greater sensation-seeking, risk-taking
- Studies in adults suggest insufficient sleep linked to changes in reward-related decision making
  - Take greater risks, less concerned negative consequences
Sleep In Adolescents: A Public Health Crisis

*Save Our Sleep
AMA Resolution (2010)

- The American Medical Association (AMA) recently adopted Resolution 503, “Insufficient Sleep in Adolescents,” which states:
- RESOLVED, That our American Medical Association identify adolescent insufficient sleep and sleepiness as a public health issue; and
- RESOLVED, That our AMA support education about sleep health as a standard component of care for adolescent patients
- Testimony supported the notion that a significant percentage of the adolescent population suffers from some degree of sleep deprivation, and that sleep deprivation is associated with a number of health problems, such as depression and obesity
Sleep-Starved?

- Multiple studies suggest shorter sleep amounts associated with increased body weight in adults and children.
- Experimental sleep loss affects:
  - Insulin, cortisol, growth hormone
  - Gherlin, leptin (control hunger/satiety)
    - Food intake: increased amount, higher calorie content, more carbs
- Alterations mood, judgment, motivation → changes eating behavior?
- Increase in sedentary activities?
  - NSF Sleep in Adolescents poll: 32% too tired to exercise
Caffeine and Other Drugs

- Association of early coffee use (≤12yo) with later use illicit drugs and alcohol
- Low risk vs high (>6 cups/mth) 7th grade users 1.5-2.5x less likely to use ETOH, tobacco at 1 yr f/up
- Association twin studies alcohol/cigarettes
  - Caffeine increases reinforcing effects nicotine; increased caffeine metabolism smokers
- Possible role as “gateway drug?”
  - Energy drink consumption college students predicts subsequent non-medical stimulant use
Health Effects: Drowsy Driving

- 1% of all motor vehicle crashes; 4% of crashes involving fatality
- Young drivers age 25 or under involved in >50% of the estimated 100,000 police-report fatigue-related traffic crashes each year
- NSF poll: 68% of HS seniors have driven while drowsy; 15% at least 1x/wk
Sleep and School
Sleep and School

- Multiple studies show association decreased sleep duration with lower academic achievement
  - Students with better grades sleep longer
- NSF Poll:
  - 28% fall asleep in school at least 1x/wk
  - 22% fall asleep doing homework
  - “A” students
    - sleep 15 min more than B students
    - who sleep 11 min more than C students
    - who sleep 10 min more than D students
School Start Times

- Multiple studies comparing middle/high schools with earlier vs later start times*
  - Shorter sleep duration
  - Erratic sleep patterns
  - Increased sleepiness
  - Dozing off in class
  - Difficulty concentrating
  - Increased rates tardiness
  - More stimulant use
  - MSLT results = level of daytime sleepiness seen in patient with narcolepsy

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<thead>
<tr>
<th>Time</th>
<th>MSLT Results</th>
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<tr>
<td>7:15 a.m. – 8:00 a.m.</td>
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<td>7:15 a.m. – 8:37 a.m.</td>
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Extent of the Problem

- Internet Survey (2001):
  - 35% prior to 7:30 a.m.
  - Nearly 50% started between 7:31 - 8:14 a.m.
  - Only 16% 8:15-8:55
  - Start Time: $M = 7:55$ am ($SD = 22$ minutes)
  - End Time: $M = 2:46$ p.m. ($SD = 33$ minutes)

- Survey of public high school students’ sleep habits
  - High schools starting even earlier (on average from 8:00 a.m. to 7:30 a.m.)
Factors Influencing School Start Times

- Schools with \(1,000^+\) students started about 15 min. earlier than smaller schools (\(p < .001\)).
- Schools where students were well off-to-affluent, SST averaged about 12 min. earlier than schools with students from economically comfortable or struggling/impoveryished families (\(p < .01\)).
- Rural schools started about 12 min. later than suburban or urban/inner city schools (\(p < .001\)).
- Schools in districts with 2 or 3 bus tiers started about 18 min. earlier than schools with no buses/1 tier only (\(p < .001\)).
- 40% of schools reported a schedule change or considered change:
  - 17% later ST; 12% earlier ST
Brief History of SST

- Minnesota pioneers
  - 1996: Edina MN changed high school start times from 7:20am to 8:30am
  - 1997: Minneapolis changed high school start times from 7:15am to 8:40am; N>18,000 students

- Since late 1990’s, 44 (14 in 2000) high schools/districts report school start time delays (NSF 2004)
  - 8:30 - 9:00 or later: 39%
Outcomes

- Does delaying start time result in students obtaining more sleep, or do students just stay up later?
  - Minnesota: Average school night bedtime stayed constant at 10:40pm
  - In a study involving grades 6-12 in a school district that delayed high school start times by one hour (7:30 to 8:30am), bedtimes did not shift later
  - Independent school with delay start time of 30 minutes
    - School night BT *advanced* from 23:39 to 23:21pm
Outcomes

- **Does sleep duration increase/sleepiness levels decline?**
  - Minnesota: Sleep duration increased by 1 hr/school night; 5 hrs/week
  - Public high school sophomores and juniors at later versus earlier starting high school reported more sleep and less daytime sleepiness
  - High school students slept an additional 35 minutes on average and experienced less daytime sleepiness after their school start time was delayed from 7:35 to 8:15 am
  - High school start times delayed from 7:30 to 8:30am, students averaged 12 to 30 minutes more nightly sleep; % of students who reported >8 hours of sleep increased from 37% to 50%
  - Independent school; students report (before and after change):
    - Problem daytime sleepiness: 49% to 20% (p<.001)
    - Sleepy in class: 85% to 64% (p<.001)
    - Sleepy doing homework: 83% to 63% (p=.001)
    - Fell asleep am class: 39% to 18%(p<.001)
    - Arrived late: 36% to 22% (p<.001)
Outcomes

- **How much is enough?**
  - Start time shifted 8-8:30a independent school
  - Mean sleep duration
    - 7.11hrs $\rightarrow$ 7.86hrs

Percentage of students in each self-reported **school night** sleep duration category at Surveys 1 and 2
Outcomes

- Independent NE Boarding School: start time 8:00 → 8:25am*
- Pre-post student survey
  - No change average school night bedtimes
  - Sleep duration increased 30 minutes
  - Daytime sleepiness (napping, late to class, difficulty waking) significantly decreased
  - Decreased depression scores, caffeine consumption, health center fatigue visits
  - Students most likely to increase sleep
    - Baseline SD<8hrs (OR=5)
  - Students less likely to increase sleep
    - Being in 11th or 12th grades decreased odds of increasing sleep by 65% and 74% compared to 9th and 10th graders

*unpublished data
Outcomes

- **Does school attendance improve?**
  - Minnesota:
    - *Tardiness rates* dropped
    - Daily *attendance rates* improved
    - *Percentage of high school students continuously enrolled district/same school* increased.
    - *Drop-out rates* declined
  - Chicago public high schools: absences much more common for first period classes compared to afternoon classes
  - Kentucky: 7:30 to 8:40a start time: Attendance up
  - Independent school: First class tardies/cuts: 36% decrease
  - Appropriation of federal dollars for schools partially dependent upon student attendance data; thus, *reducing tardiness and absenteeism levels could result in increased funding and further offset costs related to moving start times later*
Outcomes

- **Does academic performance improve?**
  - Minnesota:
    - *Grades* improved slightly (not statistically significant)
    - *SAT scores* for the top 10% of students jumped from 1288 to 1500
  - Chicago public high schools:
    - Student grades and test score performance notably lower for first period classes compared to afternoon classes
    - Performance on end-of-year subject-specific standardized tests (i.e., math, English) correlated with whether or not the student was scheduled for that subject during first period
  - Kentucky: 7:30 to 8:40a start time
    - Standardized test scores up
    - No change student participation extra-curricular
Outcomes

- **Mood**
  - Independent school: Percent reporting feel unhappy, depressed: 65 → 45%

- **Health**
  - Health center visits for fatigue: 15% → 4%
  - Rest requests: 56% decrease

- **Safety**
  - Kentucky: 7:30 to 8:40a start time
    - Teens involved in car crashes down by 16% (vs 9% increase in the rest of the state)
  - Adolescent crash rates VA Beach (7:20a) vs Chesapeake (8:40a) 40% higher
    - 2007: 71 vs 55/1000 (p<.001)
    - 2008: 66 vs 47/1000
    - Peak 1 hour earlier
Comments

- Students:
  - "Well for me, ever since the 8:30 start, I have seen how much good 30 mins of extra sleep does for me, so I have been inspired to do homework even earlier to get an additional half hour on top of the 30 minutes and it has been fantastic."
  - “Because of the extra 30 min in the morning I have been able to last all of study hall. I used to get so tired and distracted around 8:45 that I would have to get my homework done before 9 or not at all. Now I am more focused for the entire study hall.”

- Faculty:
  - “On a more personal note, I have found the 8:30 start to be the single most positive impact to my general quality of life at SG since I started 12 years ago.”
Faculty Survey: How often do you get enough sleep?

Start Time: 8:00 to 8:30a

*unpublished data independent school
Middle School

- Data from the National Household Education Survey found the 2001 median middle school start time was 8:00am; more than 20% started at ≤7:45am
- 75% of school day wake times 5:45 to 6:45 AM in 6th-8th graders; sleep period 8.3hrs in 6th to 7.8hrs in 8th
- Comparing school start 7:15am vs 8:37am
  - SD 51 min less
  - 18% vs 36% < 9hrs sleep
  - More daytime sleepiness, tardiness; lower grades
Middle Schools

- Recent research shows that delaying school start times for middle school students is accompanied by positive outcomes similar to those found in high schools, including:
  - Later rise times
  - More school night total sleep
  - Less daytime sleepiness
  - Decreased tardiness rates
  - Better performance on computerized attention tasks
  - Improved academic performance
So What Do We Do About All This?

Finding Solutions
Barriers

- Perceived barriers to changing school schedules include (2005):
  - Curtailed time for athletic practices and interference with scheduling of games
  - Reduced after-school employment hours for students
  - Challenges in providing childcare for younger siblings
  - Adjustments in family schedules
  - Potential safety issues and impact on sleep duration in younger children if elementary school schedules are “flipped” with those of middle/high school students
  - Need to make alternative transportation arrangements

- 55% noted athletics as major barrier
Start Times: Cost-Benefit Ratio

- “A later start time of 50 minutes in our sample has the equivalent benefit as raising teacher quality by roughly one standard deviation”
  - Brookings Institute Report, Organizing Schools to Improve Student Achievement: Start Times, Grade Configurations, and Teacher Assignments (2011)
  - Moving school start times one hour later would have a substantial benefit:cost ratio (9:1)
  - Based on a conservative estimate of both costs per student ($0-$1950; largely related to transportation), and the increase in projected future earnings per student in present value due to test score gains (approximately $17,500)
Other Countermeasures

- Emphasize sleep as a health priority.
- Include sleep as part of student health education, biology classes.
- Help students manage their schedules so that they have time for adequate sleep.
- Decrease nightly homework hours.
- Buffer early start times by setting limits on evening activities at school as well as early morning/late evening athletic practices.
- Work with employers to decrease adolescents’ work hours.
- Include drowsy driving in driver ed.
Is Federal Legislation the Answer?

- Congresswoman Zoe Lofgren introduced bill H.R. 1267, "Zs to As Act." Bill would provide grants (up to $25,000) to local educational institutions that agree to begin school for secondary students after 9:00 am (1999, 2003)

- National Petition: Promote legislation to prevent public schools from starting before 8 a.m
  - Petition to be delivered to: The United States House of Representatives, The United States Senate and President Barack Obama
  - Sponsored by Start School Later: a national coalition working to ensure that all public schools can set hours compatible with health, safety, equity, and learning
  - There are currently >5900 signatures all 50 states
  - Delivered to national officials in DC on “Wake Up Wednesdays” (next 6/13/2012)
Pros and Cons

- Requires all school districts to comply, reducing likelihood of scheduling conflicts among schools
- Likely to result in faster implementation than “grass roots” approach
- Raises awareness of adolescent sleep as critical health issue
- School districts may view federal mandate as interfering with local community needs, circumstances, autonomy; risk of backlash
- Does not provide support and education for implementation; likelihood of “buy-in”
- Is 8am late enough?
Resources

- http://schoolstarttime.org/
- http://www.startschoollater.net/
- http://www.endtherace.org/sleep-challenge
- http://www.ci.minneapolis.mn.us/
Questions?

Got Sleep?