The importance of sleep to optimize emotional and physical health, and academic performance

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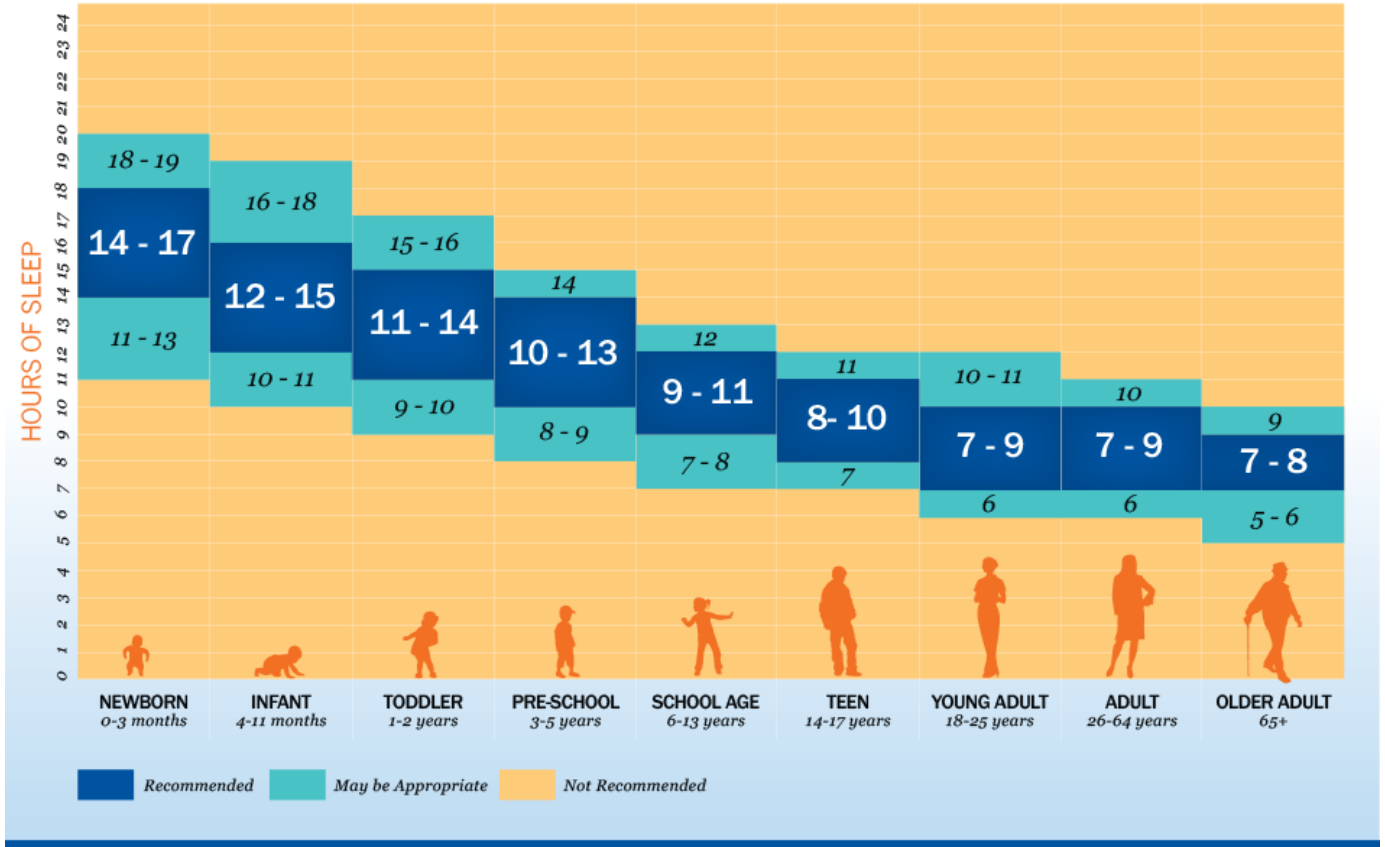
Hampton Township School District
January 22, 2018

- 1. Recommended secondary school start times to optimize health & well-being
- 2. Epidemic of sleep deprivation in teens
- 3. Changes in sleep across adolescent development
- 4. Consequences of short sleep in adolescents
- 6. Experimental evidence: Sleep restriction effects on positive and negative affective systems
- 5. Research on the benefits of later school start times

NATIONAL SLEEP FOUNDATION

2015 SLEEP DURATION RECOMMENDATIONS



SLEEPFOUNDATION.ORG | SLEEP.ORG

Hirshkowitz M, The National Sleep Foundation's sleep time duration recommendations: methodology and results summary, Sleep Health (2015), http://dx.doi.org/10.1016/j.sleh.2014.12.010

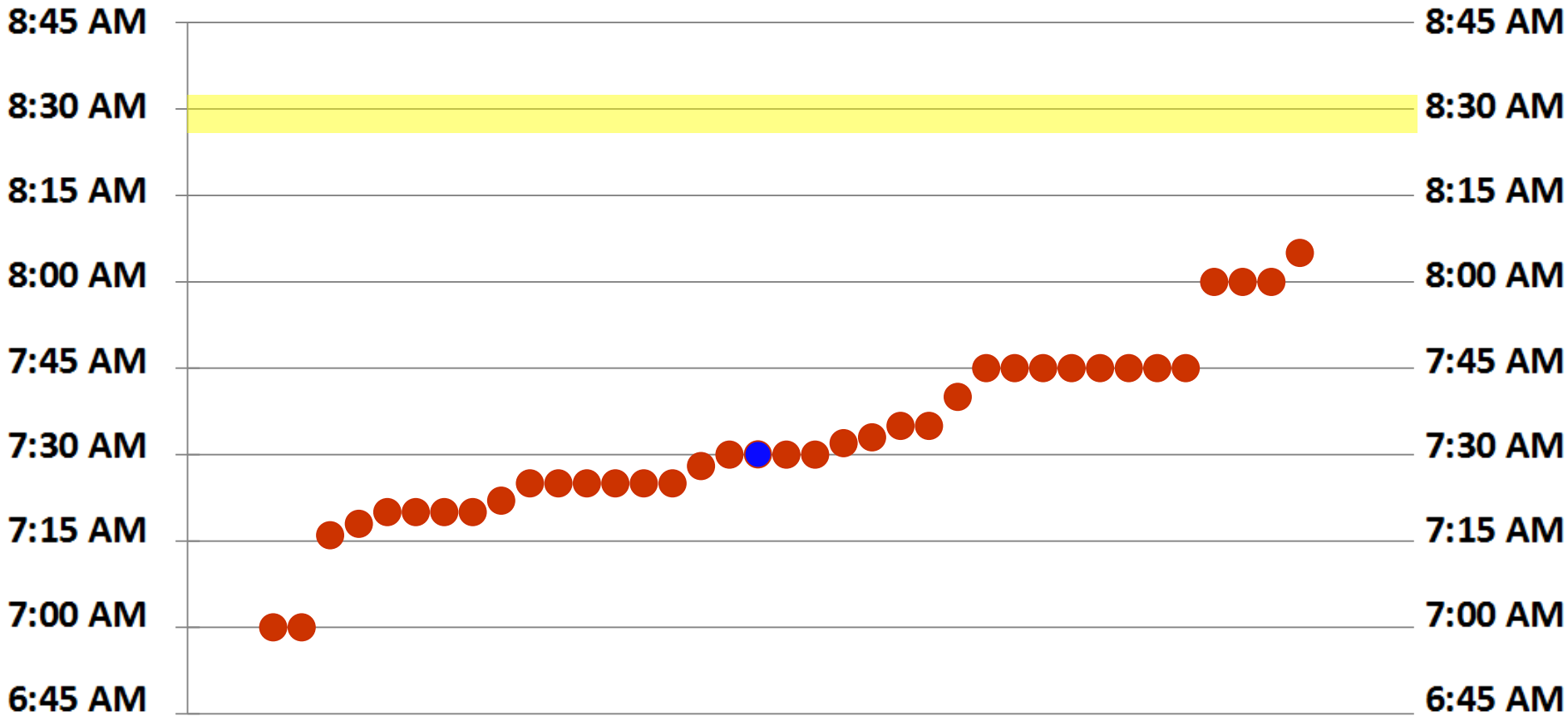
A growing list of organizations recommend starting middle/high school at 8:30am or later

- American Academy of Pediatrics (AAP): August 2014
- Centers for Disease Control (CDC): August 2015
- American Medical Association (AMA): June 2016
- The Sleep Research Society (SRS)
- American Academy of Sleep Medicine (AASM): April 2017
- The National Association of School Nurses
- 2017: Society for Behavioral Sleep Medicine (SBSM)
- The National Education Association (NEA)
- National Parent Teacher Association (PTS)
- And others….

Let Them Sleep: AAP Recommends Delaying Start Times of Middle and High Schools to Combat Teen Sleep Deprivation

8/25/2014

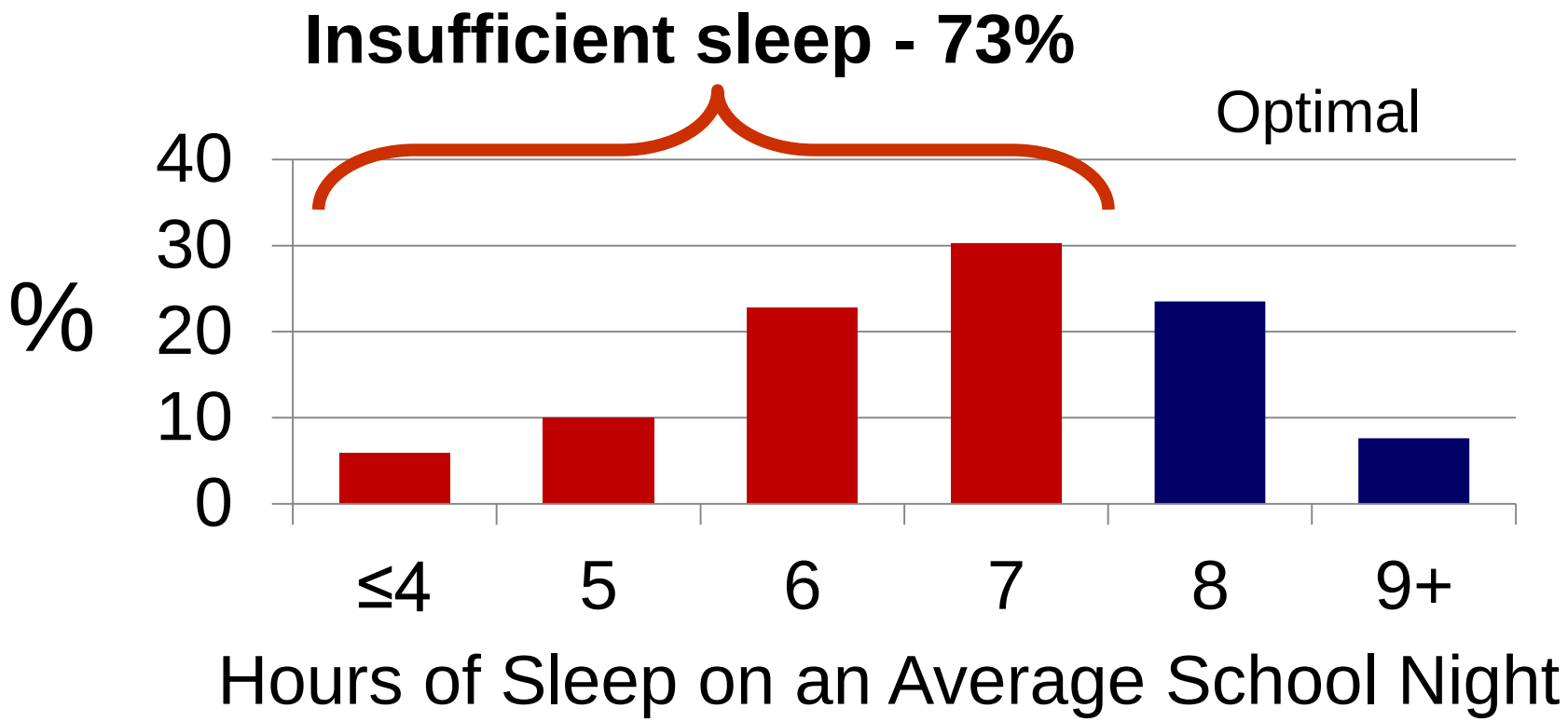
High School Start Times in Allegheny County



Epidemic of sleep deprivation in teens

- CDC - Youth Risk Behavior Survey (YRBS), 4 waves: 2007, 2009, 2011, 2013

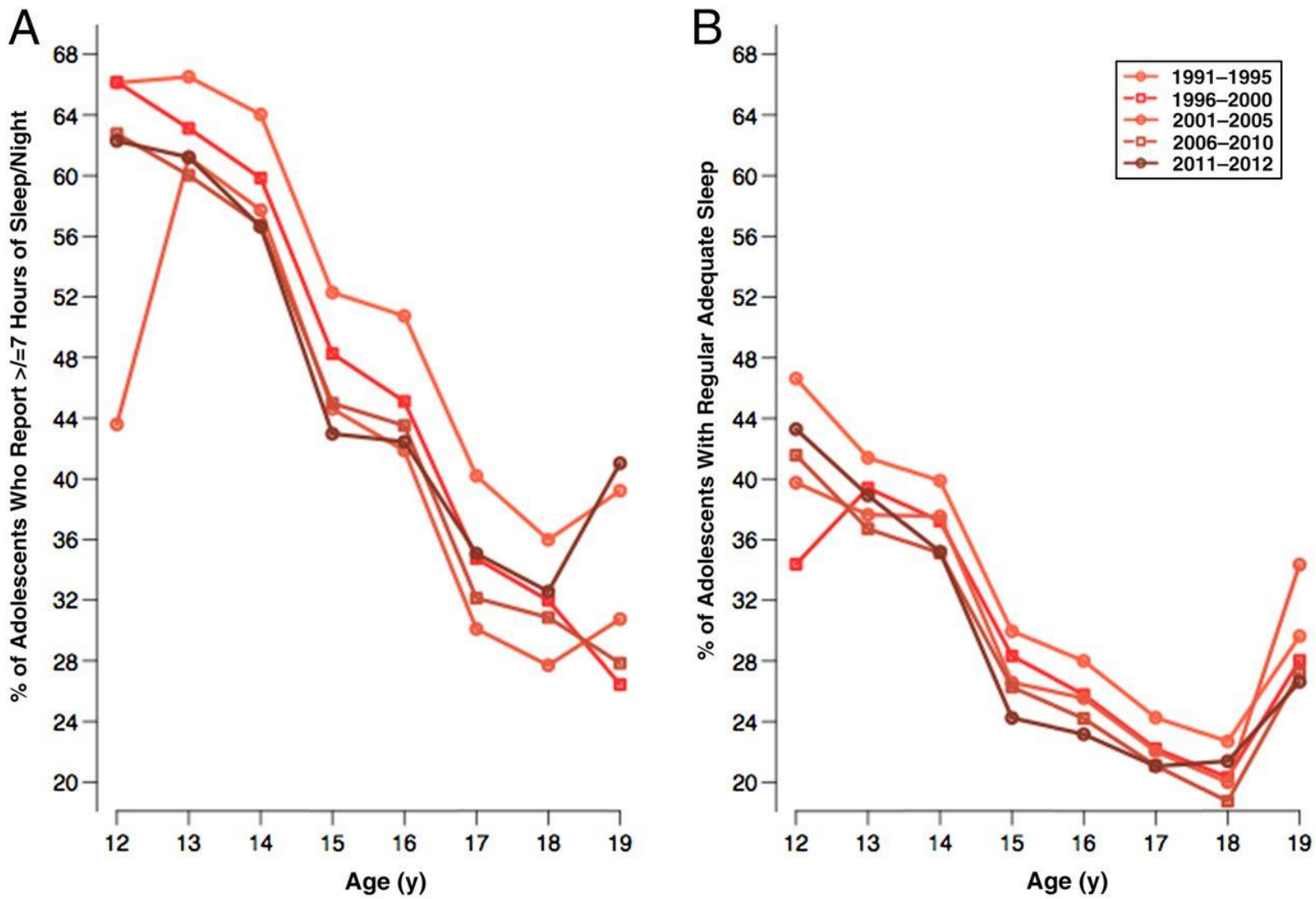
  n = 52,718 US high school students



Basch, et al. (2014). *Prev Chronic Dis*

N = 272,077

% with ≥ 7 hours sleep **% with adequate sleep**



Keyes et. al (2015). *Pediatrics.*

Q: Why is short sleep so common in teens?

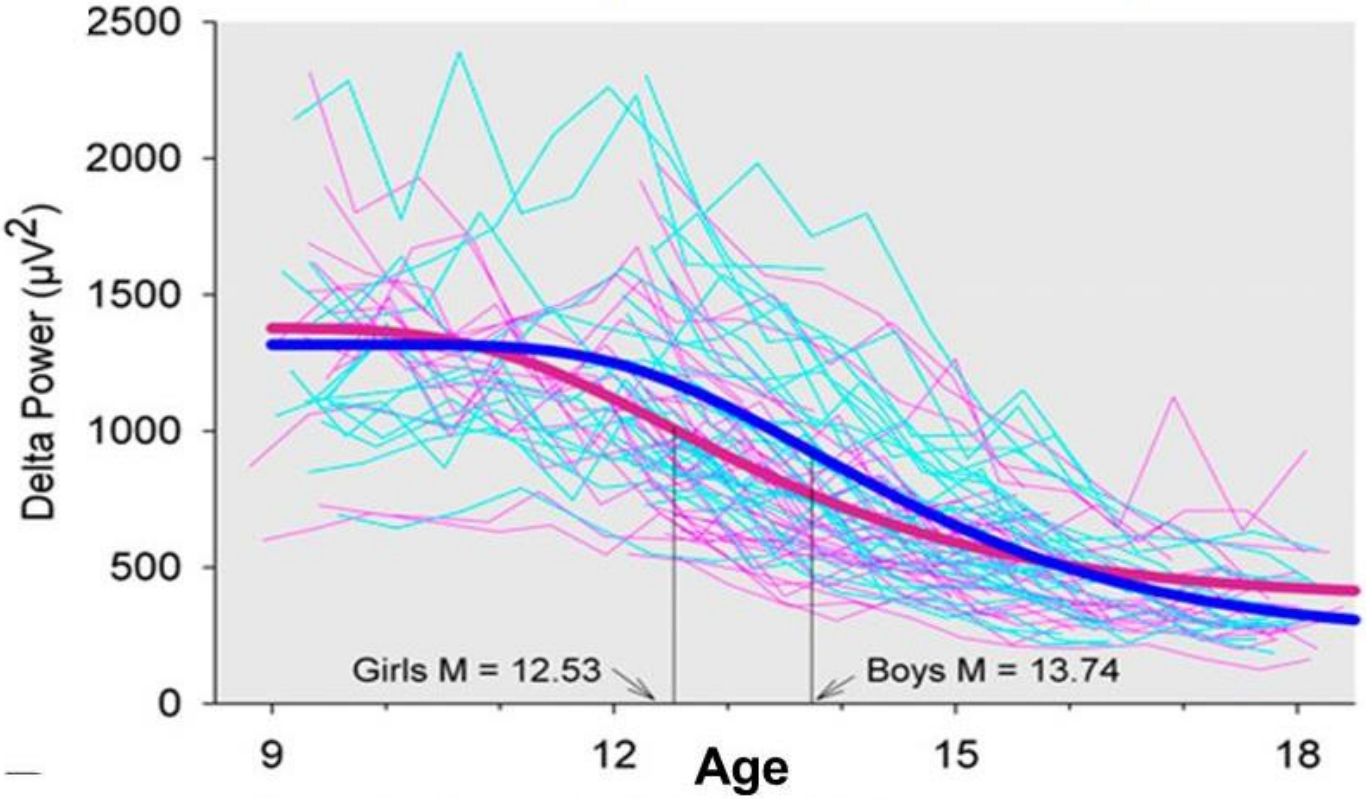
A: School / sleep squeeze

Result of unique **biological** and **social/environmental** influences during adolescence.

Biological changes begin post-puberty

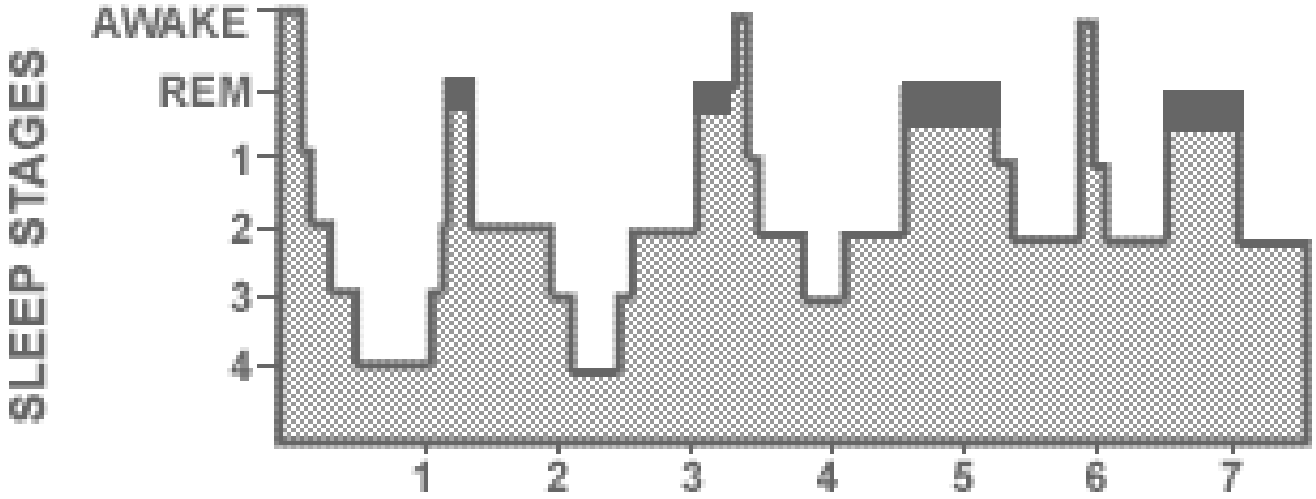
Adolescent sleep becomes lighter

Slow wave sleep declines by 40%



Campbell, et al., 2012, PNAS.

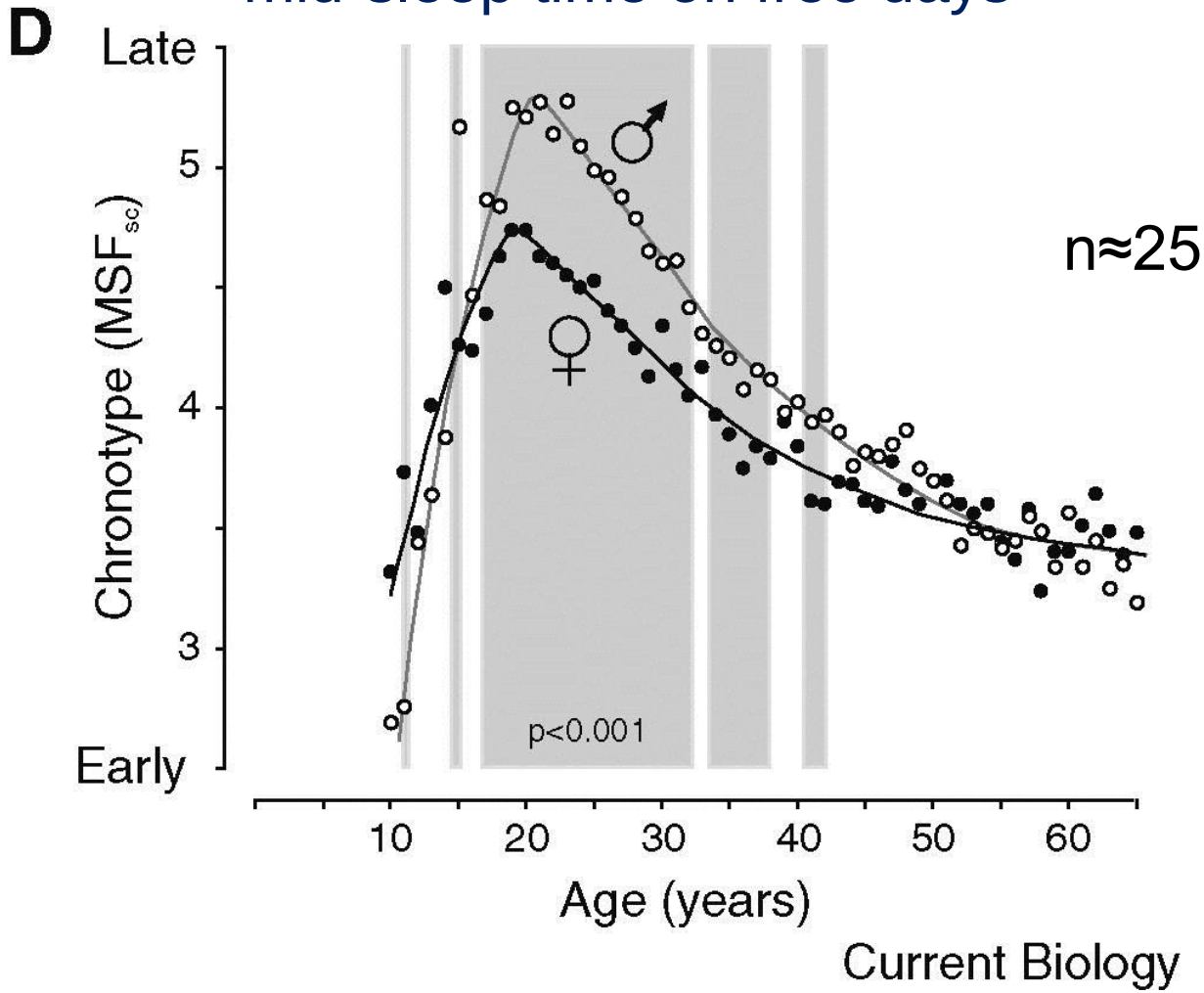
Rapid Eye Movement: REM Sleep



- Waking too early chops off morning REM sleep
- REM sleep is implicated in certain types of learning and memory, as well as creativity, and how we respond to emotional information

Sleep phase preference delays across adolescence

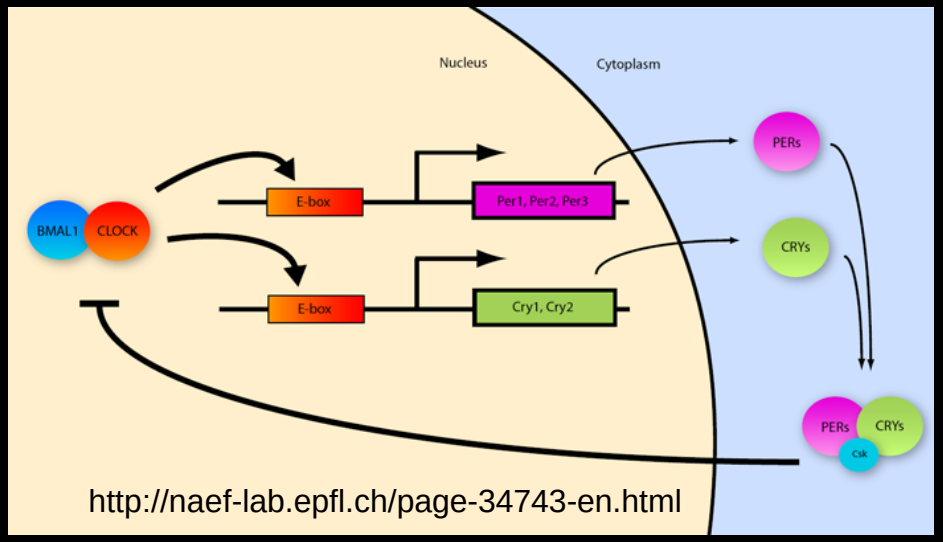
mid-sleep time on free days



n≈25,000

Roenneberg, et al., 2004

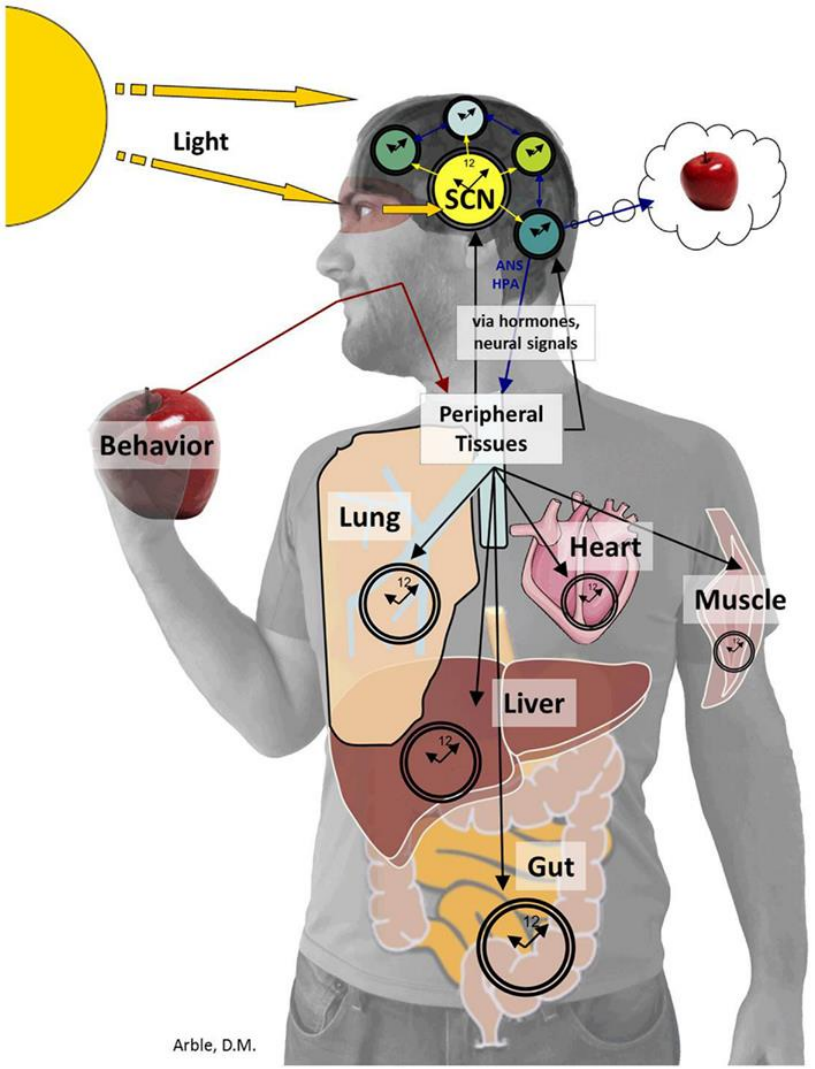
Circadian Rhythms: Clocks everywhere



http://naef-lab.epfl.ch/page-34743-en.html

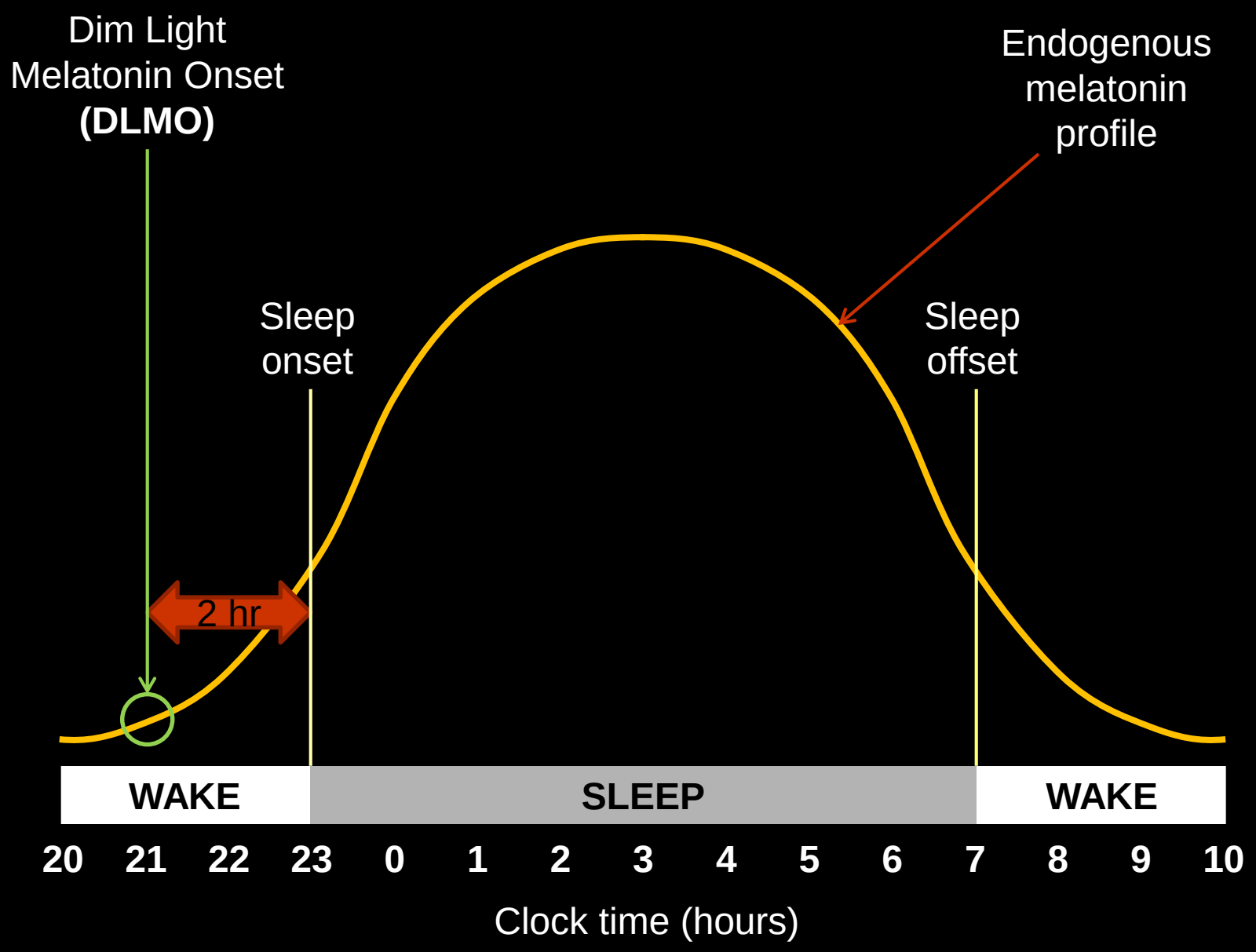
Timing is everything: U.S. trio earns Nobel for work on the body's biological clock

Science AAAS



Arble & Sandoval (2013) *Front. Neurosci*

Measuring the clock with melatonin



Why is short sleep so common in teens?

- School / sleep squeeze: Result of unique **biological** and **social/environmental** influences during adolescence.
- Biological changes in sleep at puberty:
  - Sleep becomes lighter (less homeostatic sleep drive)

    Marked decrease in Slow Wave Sleep and delta power

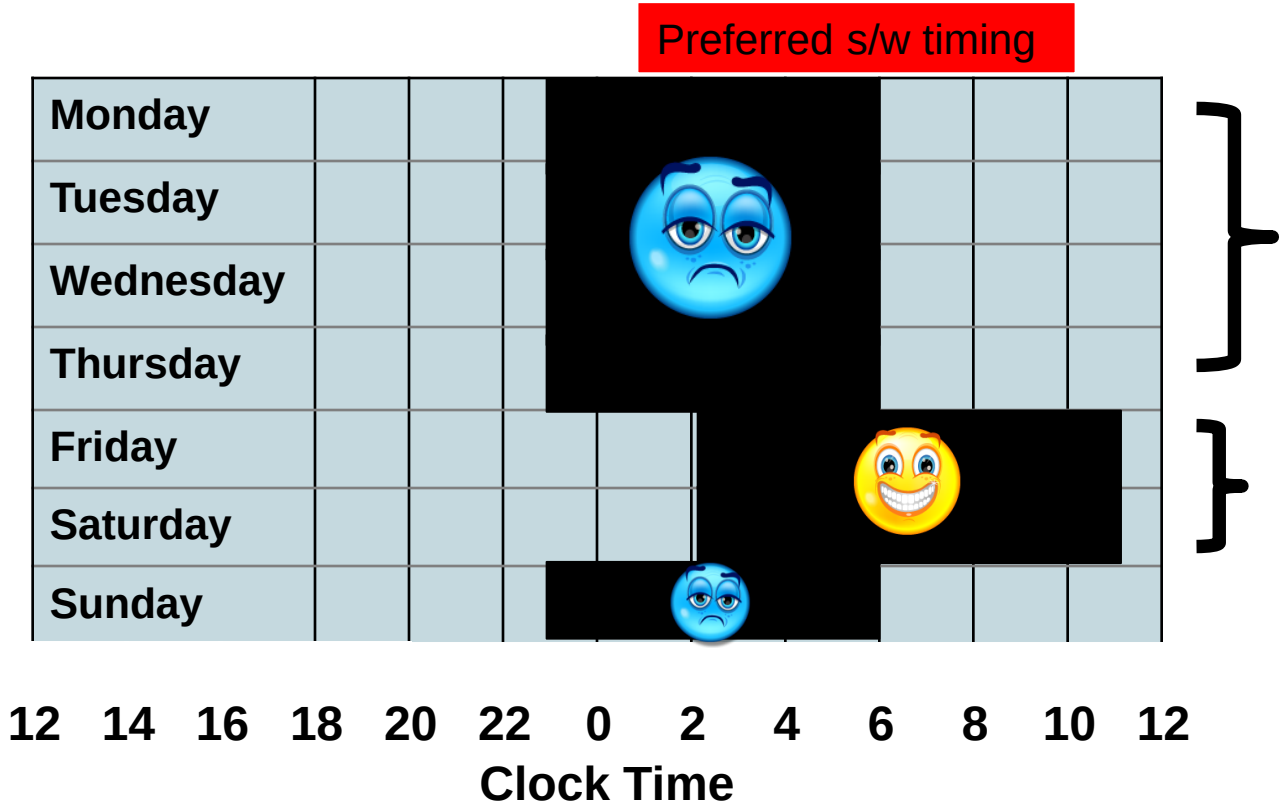
    (Jenni, Achermann, & Carskadon, 2005).
  - Sleepiness increases
  - Circadian rhythms delay
    - Delayed melatonin onset (by ~ 2 h), leading to a tendency to prefer and have later bed and wake times
      - DLMO: Preschool ~ 7:30 PM
      - DLMO: Prepubertal ~8:30 PM
      - DLMO: Mature adolescents ~9:30 PM

Circadian misalignment, defined

A mismatch between the timing of the behavioral sleep-wake schedule and that of the internal circadian clock

Delayed circadian timing during adolescence leads to chronic circadian misalignment

- Circadian and preferred sleep timing shift later (delay) during adolescence
- Mismatch with early school start times



Circadian misalignment; sleep loss

Better alignment; make up sleep

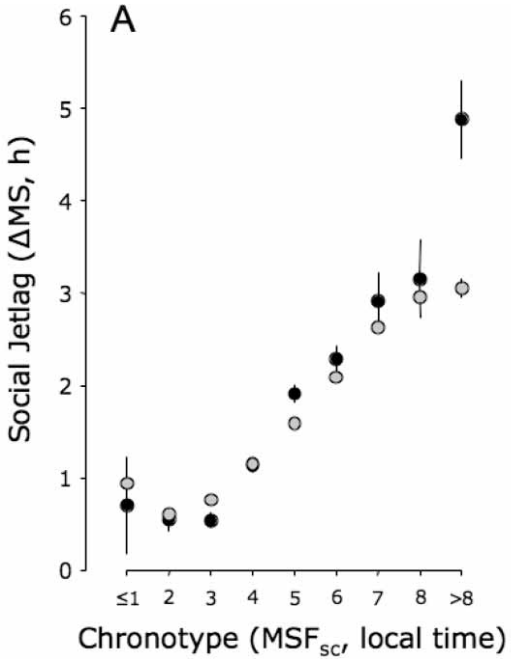
Courtesy of Brant Hasler, PhD

Social Jet Lag

- SJL = difference in sleep timing on school/work days and free days*

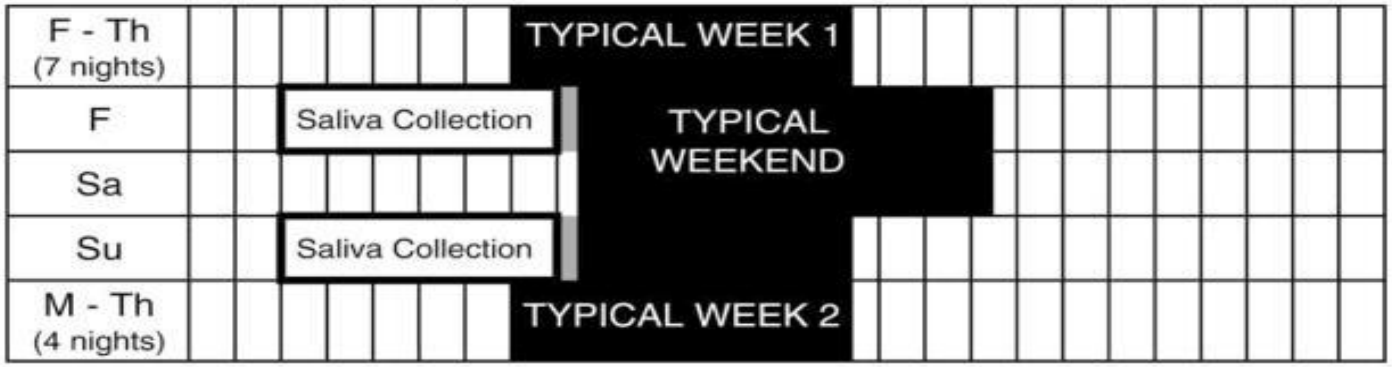
- Very common pattern in adolescents
  - In 1,456 youth ages 11-17 from the NSF 2006 Sleep in America poll:
  - Weekend bed times were ~90 min later, ~75 min longer sleep than school days
  - At age 17, weekend bed times were 137 min later, with 93 minutes more sleep

- Tends to be worse for evening types/late chronotypes
  - ~1 hour weekend oversleep in morning larks
  - ~1.5 – 2 hours for intermediate types
  - ~3 hours weekend oversleep in night owls

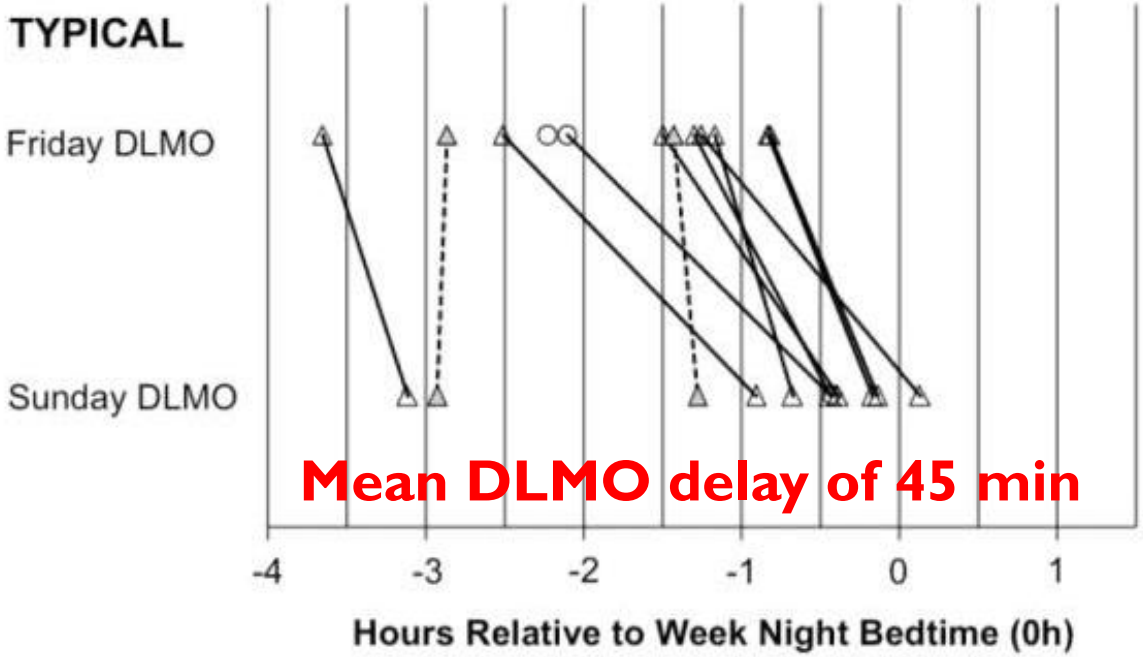


Social Jet Lag

- Melatonin onset (DLMO) in 12 teens ages 15–17 (Crowley & Carskadon, 2010)



Bedtimes: 1.5 h later
Waketime: 3 h later



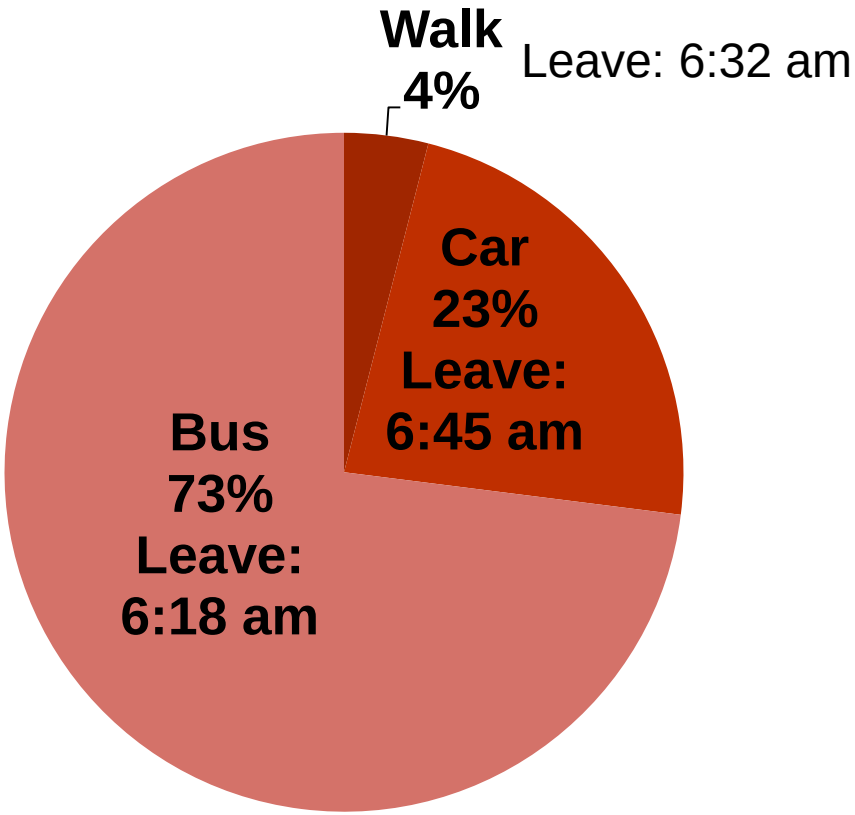
Why is short sleep so common in teens?

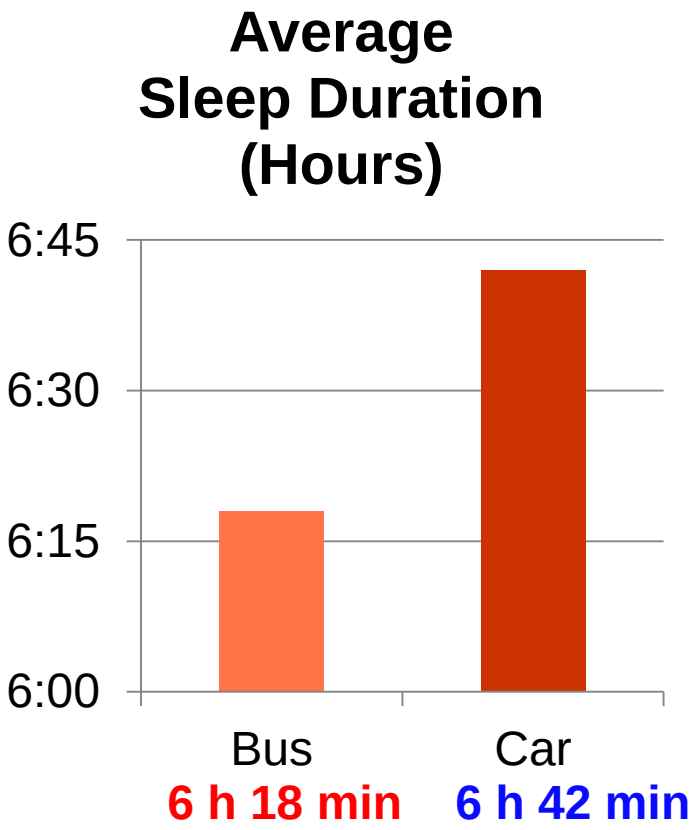
- School / sleep squeeze: Result of unique **biological** and **social/environmental** influences during adolescence.
- Biological changes in sleep at puberty:
  - Sleep becomes lighter (less slow wave sleep)
  - Sleepiness increases
  - Circadian rhythms shift later (delayed melatonin onset)
- Social / Environmental influences
  - Decrease in parental control
  - Increase sensitivity to peers
  - Use of social media (texts, IMs, etc.) & exposure to light
  - Homework, after school work / activities
  - **Early school start times / transportation to school**

Transportation matters: What time do you leave for school?

- Average: 6:25 AM

How do you travel to school?



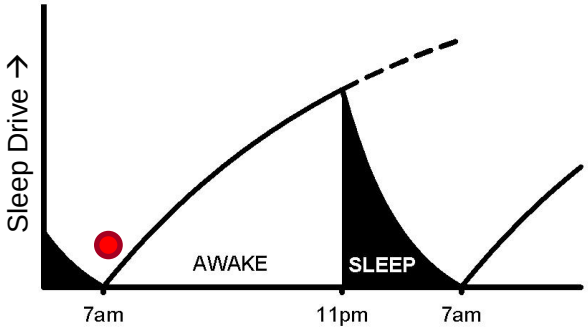


What controls sleep? The hourglass, the clock, and the alarm

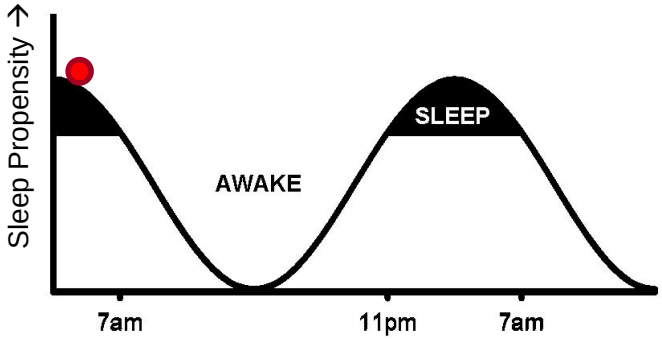
How long you've been awake

Time of day

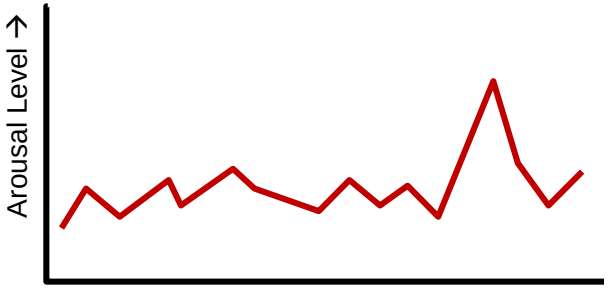
Level of arousal



Sleep drive



Circadian sleep-wake rhythm



Moment-to-moment arousal

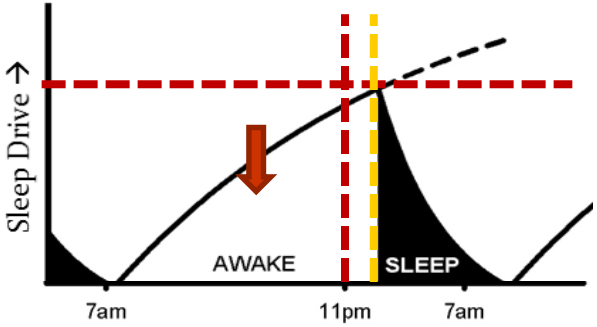
Courtesy of Daniel Buysse, MD

What happens in adolescence?

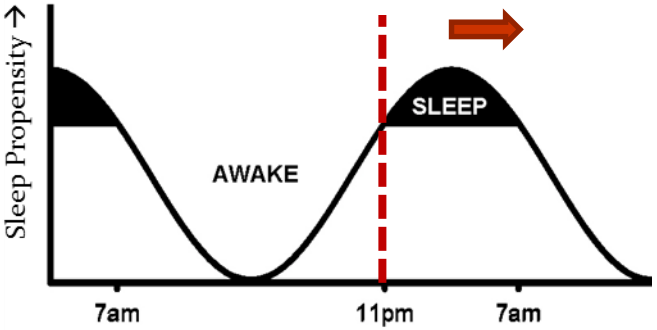
How long you've been awake

Time of day

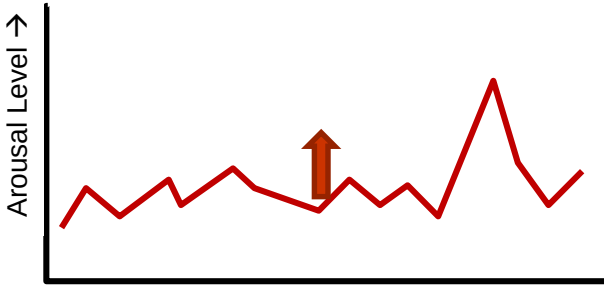
Level of arousal



Sleep drive: Takes longer to build up



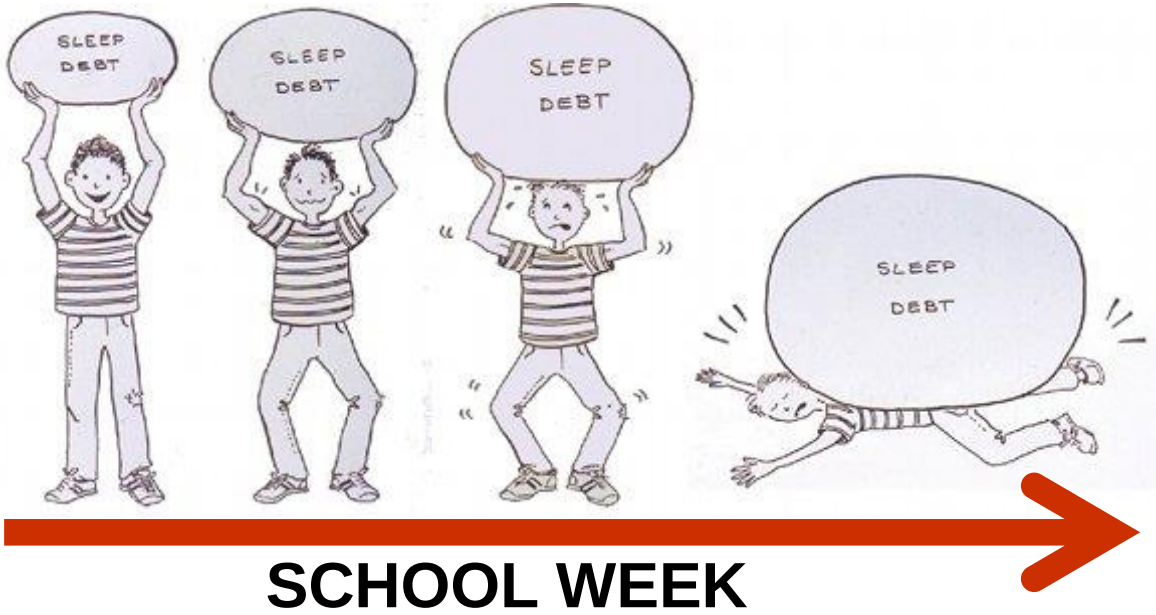
Circadian sleep-wake rhythm: Later timing

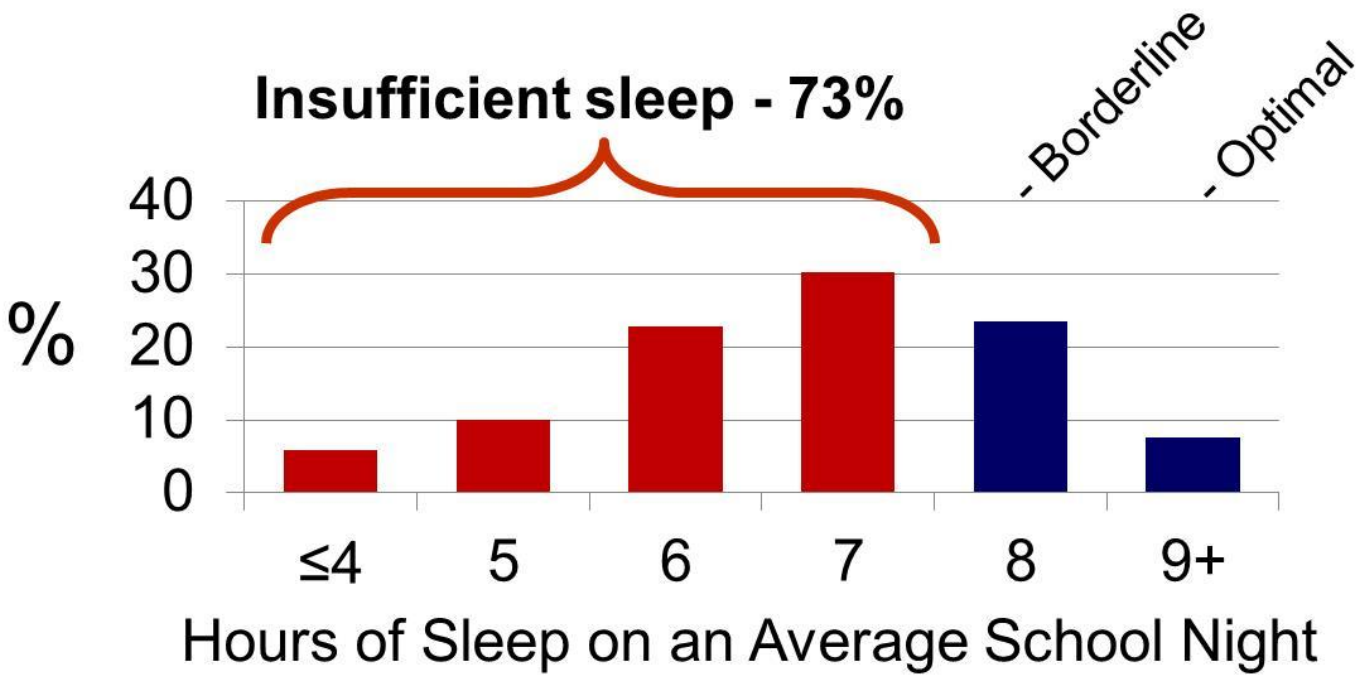


Moment-to-moment arousal: Increases

Courtesy of Daniel Buysse, MD

Consequences of Insufficient Sleep:





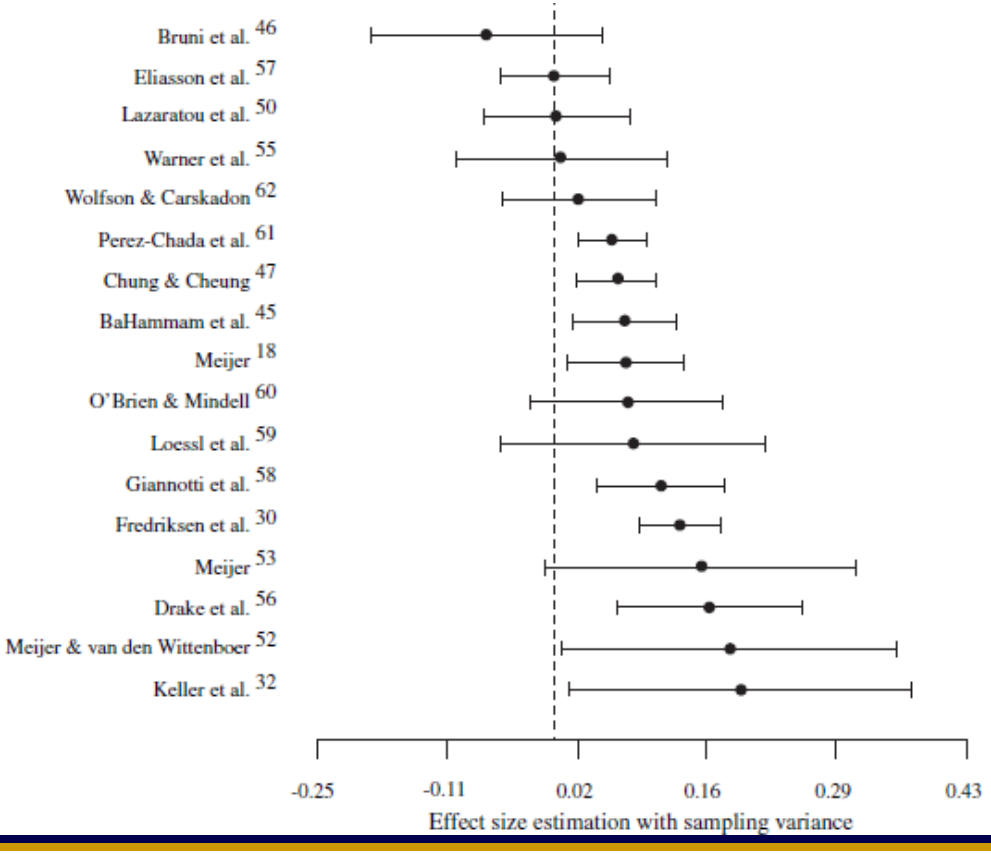
Consequences of Insufficient Sleep:

- Lower grades & achievement test scores
- Falling asleep in school
- More days tardy or absent
- Car crashes
- Depression
- Suicide
- Substance use
- Violence and risk taking
- Weight gain / obesity
- Sports injuries

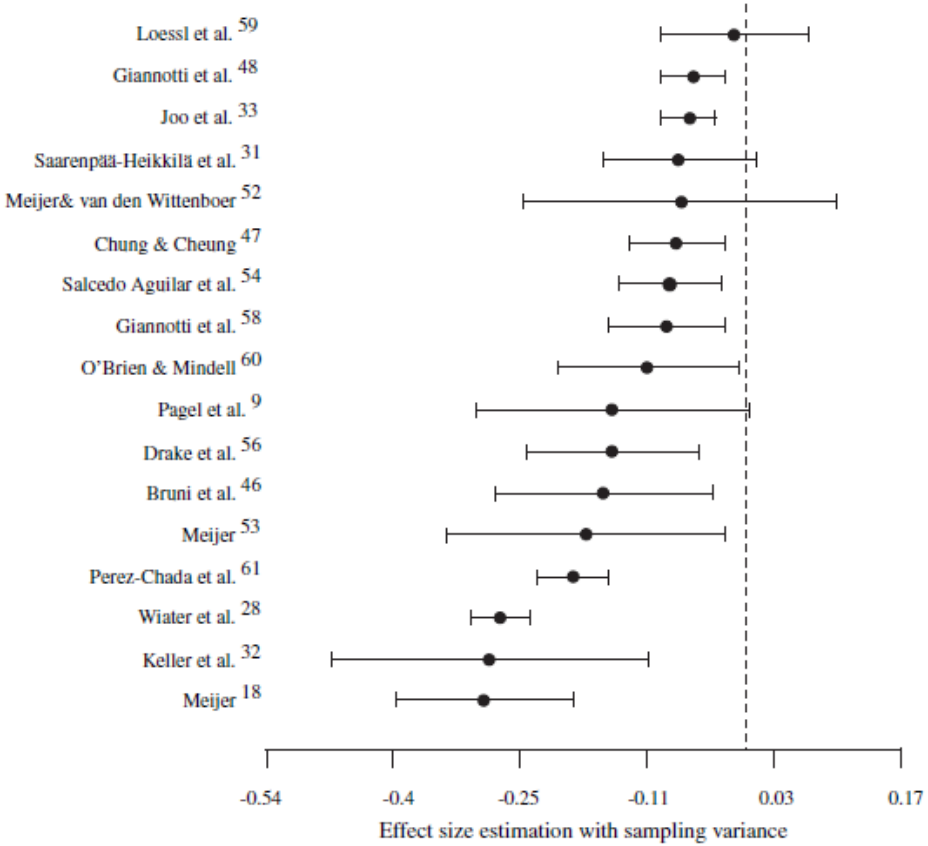
Consequences of insufficient sleep in adolescents

- Academic Performance
  - 3 meta-analyses of 16 studies (Dewald, et al., 2010)
  - Sleep quality also examined

Sleep Duration



Sleepiness



Consequences of short sleep: Physical health

- Overweight/obesity
  - Link between short sleep and overweight, obesity in middle school, high school
- High blood pressure and diabetes linked to short sleep duration
- Impairs immune function, and thus, healing and recovery
- Short sleep duration in adolescence in girls predicted increased risk of high cholesterol as a young adult (Gangwisch, et al., 2010, *SLEEP*)

Shochat et al., 2014, *Sleep Med Reviews*

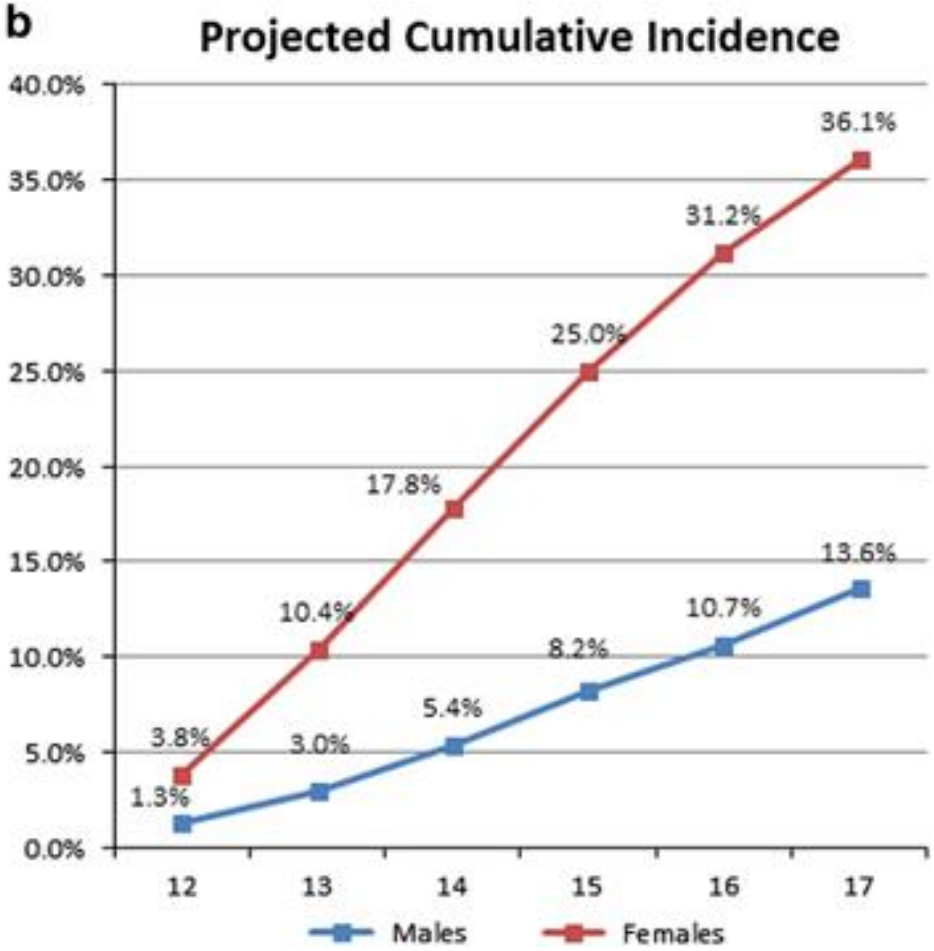
Consequences of insufficient sleep in adolescents

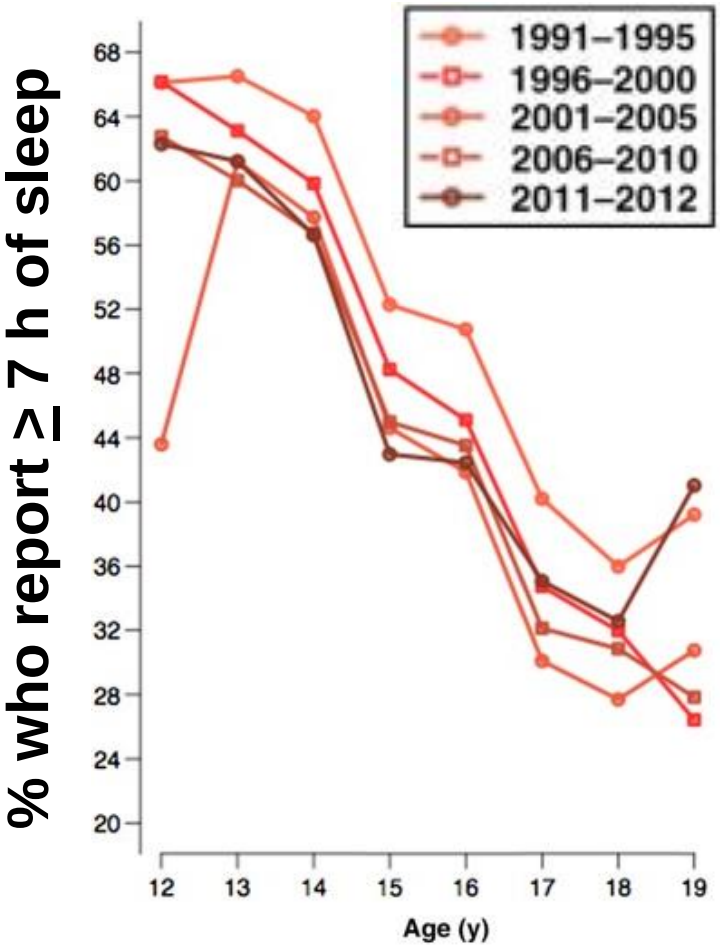
- Increased sports-related injuries
  - 7th-12th graders in California school (Milewski, et al., 2012 abstract)
  - Those who slept 8+ hours were 68% less likely to be injured
  - Risk also increased for higher grade level
    - Independent of gender, amount of sports participation per year, # of sports, strength training

Consequences of insufficient sleep in adolescents

- Motor Vehicle Accidents
  - Leading cause of death in teenagers (CDC, 2012)
    - In 2010, 22% of drivers ages 15–20 had been drinking
  - Teen drivers ages 16–19 are 3x more likely to be in a fatal crash vs. drivers 20+
  - Teen drivers are at the **highest risk** of car accidents due to falling asleep, accounting for 50% of all crashes
  - NSF poll (2006): 68% of HS seniors reported driving while drowsy; 15% at least a week

Sleep loss and depression are both extremely prevalent during adolescence





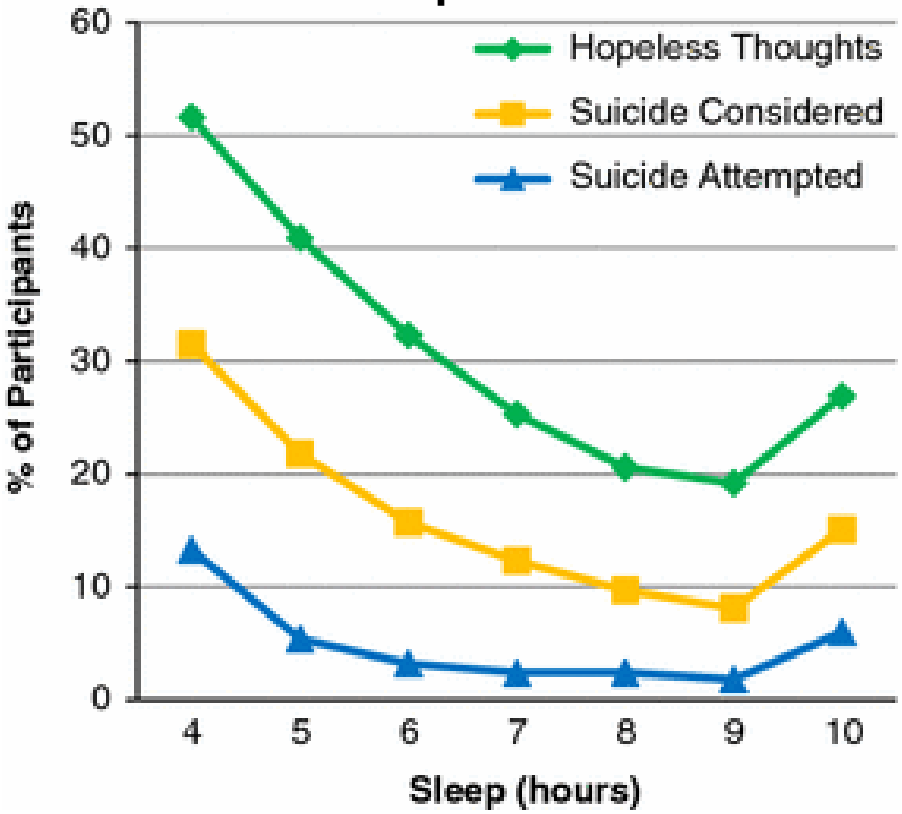
Breslau et al., 2017, *Translational Psychiatry*

Keyes et al., 2015, *Pediatrics*

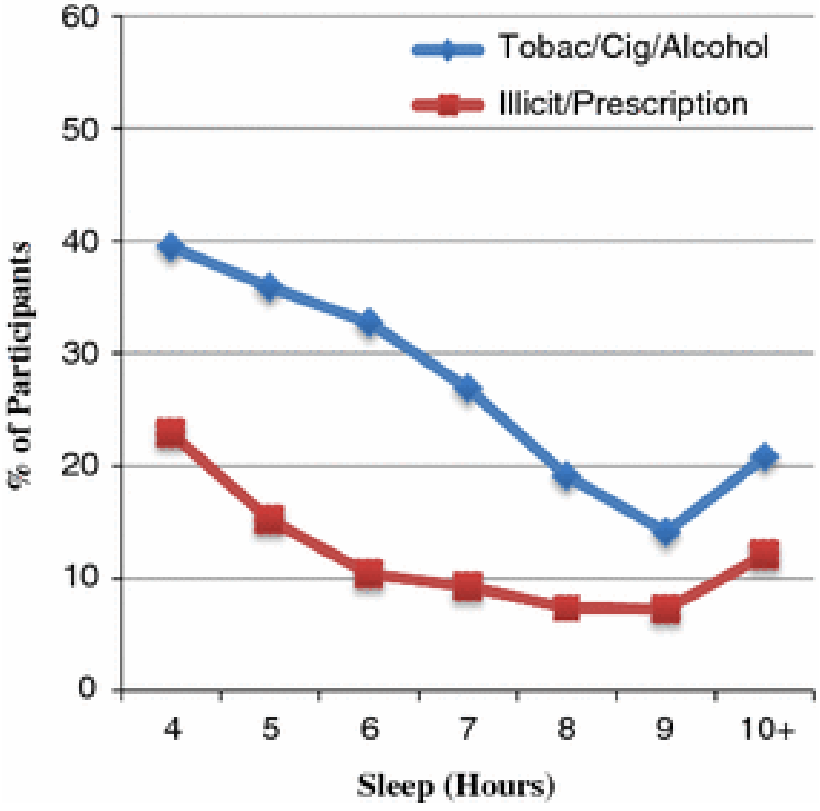
The "dose" of sleep loss increases negative consequences: Fairfax County VA (n=27,939)

Winsler, et al. 2015, *J Youth Adolesc*

Hopelessness and suicide by hours of sleep.



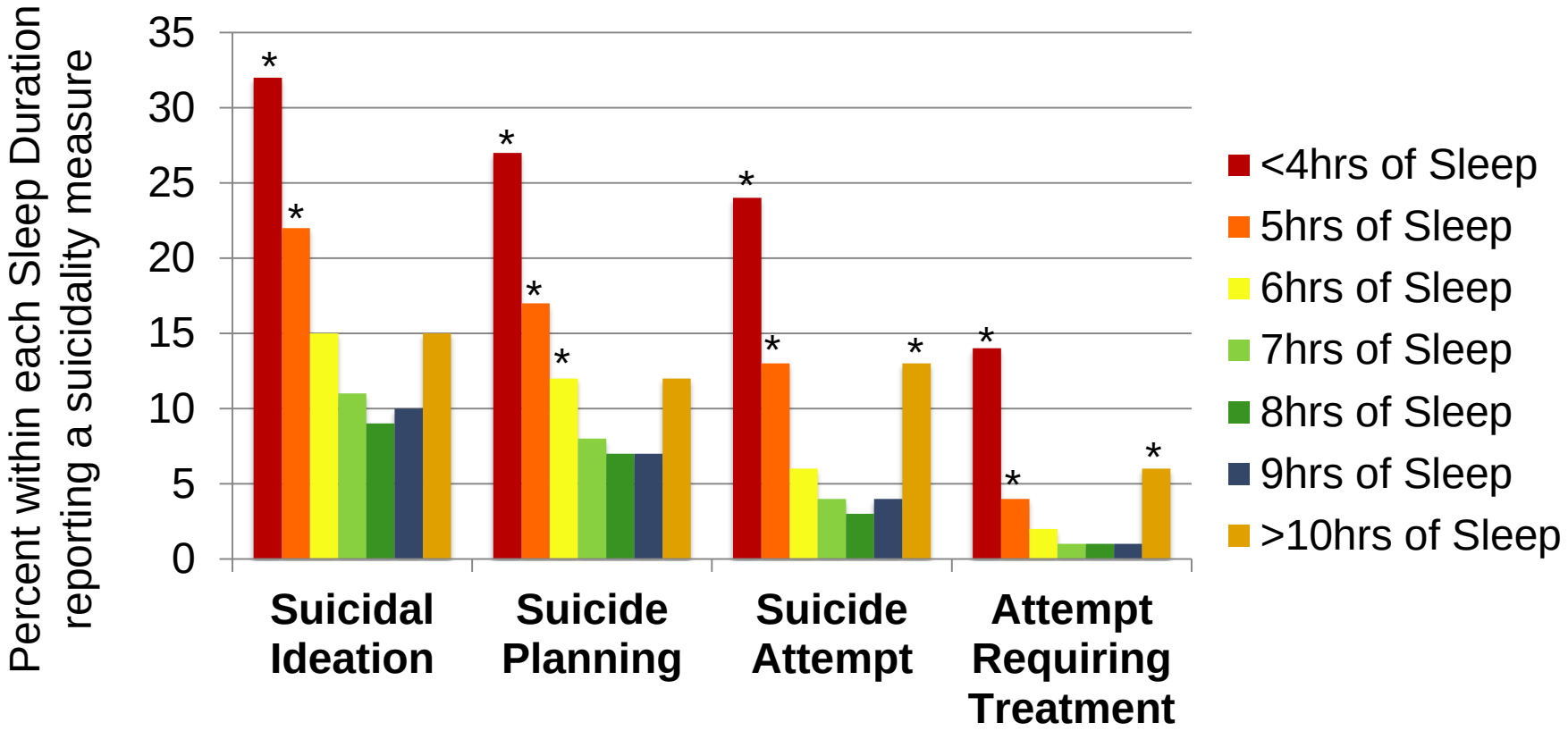
Substance use by hours of sleep.



Note: Each hour less of sleep is associated with a significant increase in odds of the outcome, *p*'s < .001

Winsler, et al. 2015. Journal of Youth and Adolescence

Consequences of insufficient sleep: suicidality Youth Risk Behavior Survey 2009



Nationally representative sample of 16,410 9th-12th grade American Students. *Odds ratio 95% CI excludes 1.0

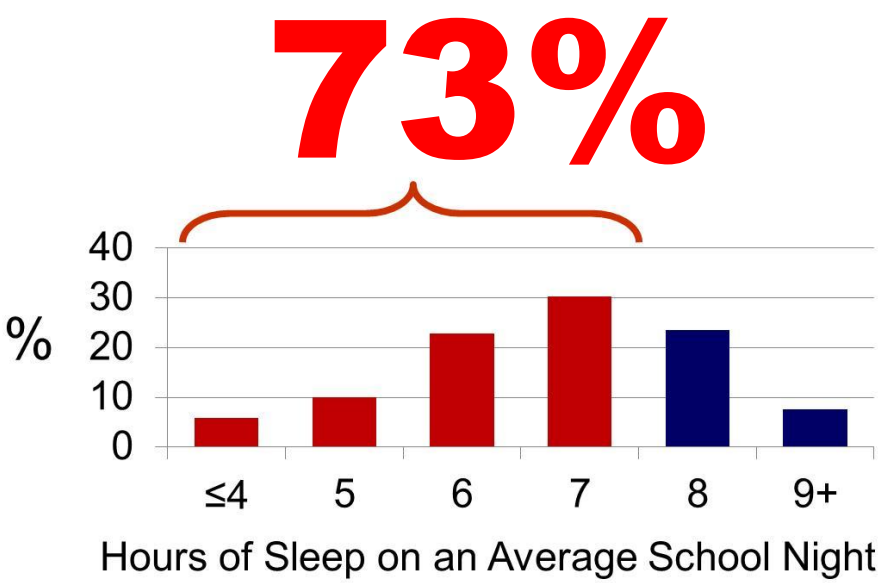
Fitzgerald, *J Clin Sleep Med* 2011

Consequences of insufficient sleep in adolescents

- Depression
  - n > 3,000 followed for 1 year from Teen Health 2000 (Roberts & Duong, *Sleep*, 2014)
  - ≤ 6 h sleep on weeknights
    - ~20% at wave 1
    - ~25% at wave 2
- Sleep and depression associated at baseline
- Short sleep at baseline increased risk at follow up:
  - Depressive symptoms: increased 25-38%
  - Depression: by a factor of > 3

    (Odds ratio: 3.12, 95% CI: 1.6–6.3)

- Adolescent (and adult) sleep deprivation is a widespread, chronic health problem
- …and is associated with negative outcomes.
- So, what can be done to improve sleep health, and perhaps prevent such outcomes?



Group-Based School Sleep Education Programs

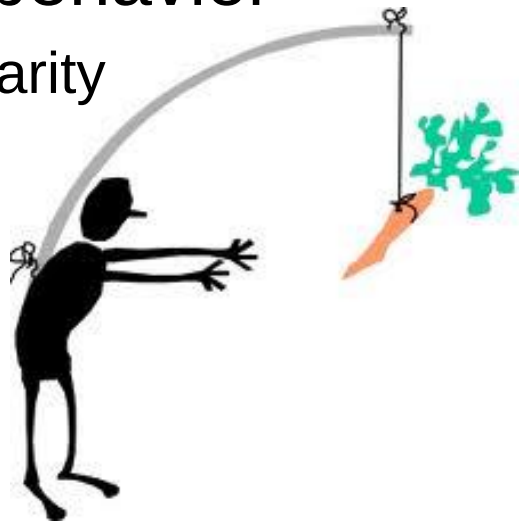
- Informational pamphlet (Bakotic 2008)
- One 2-hour sleep education course (Cortesi 2004)
- Five daily 50-minute sessions (de Sousa 2007)
- Four weekly 50-minute sessions (Moseley 2009)
- Four weekly 50-minute sessions + Motivational Interviewing (Cain 2011)

Group-Based School Sleep Education Programs: Results

- Great at changing sleep-related knowledge; *not great* at effecting change in sleep behavior

  *some improvement in sleep quality, sleep regularity

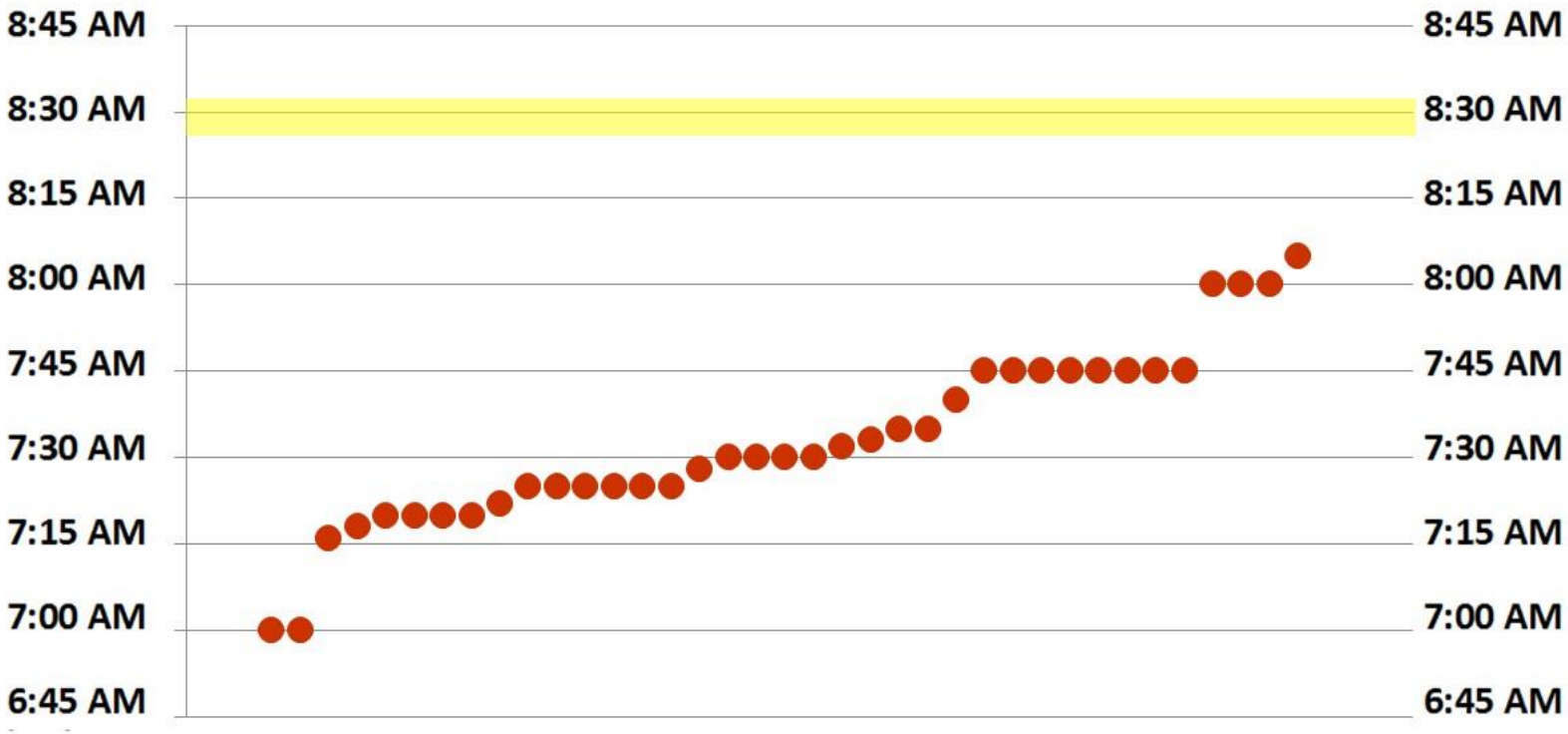
- Improvement in motivation with MI



Adolescent Sleep Loss is a Public Health Crisis

Changing too-early school start times is the single most effective action

To do nothing is to do harm



"The European custom of beginning school at 7 to 8 o'clock in the morning works great hardship…. The American practice of beginning [school] at 9 o'clock is far wiser, and should never be changed unless for very special reasons."

Terman LM, Hocking A: The sleep of school children, its distribution according to age, and its relation to physical and mental efficiency: Part III: The conditions of children's sleep. ***Journal of Educational Psychology 1913, 4:269-282.***

If school start time is delayed, won't youth just stay up later?

- Minnesota:
  - Average bedtimes remained constant 10:40 pm
  - Result was ~1 hour more sleep / night; 5 hours / week

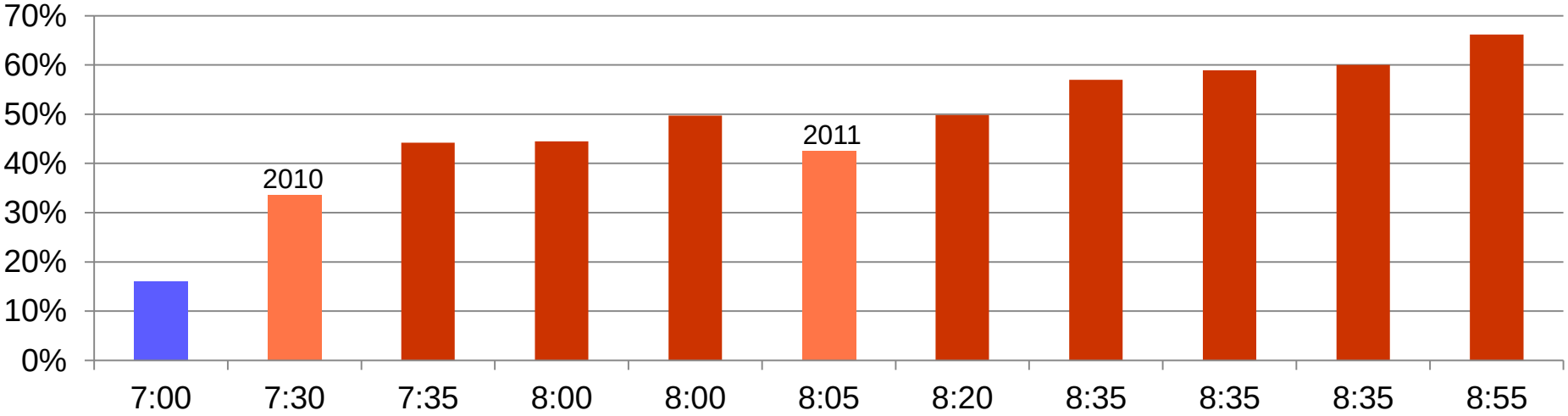
- Systematic review of 6 research studies

  (Minges & Redeker, 2016, *Sleep Med Rev*)
  - School start times delayed from 25 – 60 minutes
  - Sleep time increased from 25 – 77 minutes on weekdays

The case for later school start times

- Wahlstrom (2014): 3-year CDC-funded study
  - n=9,089 students in 8 public high schools in three states, most of which had already shifted school start times later by 30 to 60 minutes.

% sleeping ≥ 8 hours on a school night



Local data

- **Teens who got < 8 h of sleep**
  - Higher depression symptoms
  - Fall asleep in class
  - Greater caffeine
  - More substance use
- **Teens with school starts later than 8:30 AM**
  - Higher grades in core subject areas
  - Higher state and national achievement tests
  - Higher attendance rates
  - Reduced tardiness

The case for later school start times: Narrowing the achievement gap

- A recent review (Wheaton, Chapman, Croft, 2016) of 38 studies found that later start times are associated with:
  - Higher attendance
  - Reduced tardiness
  - Reduced drop-out rates
  - Improvements in standardized test scores
  - Better grades
  - Involvement in extra-curricular activities remains the same or increases
- Disadvantaged students and highest achieving both benefit.
  - In one study, SAT scores for top 10% of students increased > 200 points with later start times.
  - "Early school start times reduce performance among disadvantaged students by an amount equivalent to having a highly ineffective teacher." Jacob & Rockoff, 2011, Brookings Institute Report

Improved attendance and graduation rates

- N=29 high schools in 8 districts, > 30,000 students
- Rates compared before and 2 years after delaying school start time
- Delays
  - 25 to 75 minutes
  - Pre: 7:30 am to 8:30 am
  - Post: 8:35 am to 9:15 am

	PRE	POST
ATTENDANCE		
Average	90%	94%
Minimum	68%	86%
Maximum	99%	99%
GRADUATION		
Average	79%	88%
Minimum	51%	68%
Maximum	94%	97%

McKeever & Clark (2017). *Sleep Health*

Delaying school start times associated with ~25% reductions in teen car accident rates

- Delaying school start times by 1 hour
  - 7:30 AM to 8:30 AM, in Fayette County, KY (Danner & Phillips, 2008)
  - Teen crash rates dropped 16.5% over prior 2 years
  - In rest of KY, accident rates increased 7.8%, so a comparable decrease by 24.3%.
- Study of two neighboring districts in Virginia, similar in demographics and per-capita income (Verona, 2010)
  - 25% higher weekday crash rates in the district which started 75 minutes later (7:20 AM vs. 8:40 AM)

Later school start times

- "If you knew that in your child's school there was a toxic substance that reduced the capacity to learn, increased chances of a car crash and make it likely that 20 years from now he [she] would be obese and suffer from hypertension, you'd do everything possible to get rid of that substance and not worry about cost. Early start times are toxic."
- Judith Owens, MD, Director, Center for Pediatric Sleep Disorders, Harvard

(Clarkson, Resetting the Clock: High School Start Times; Apr. 1, 2013; *Washington Parent*.)