

# Adolescent Sleep and Community Impacts

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4/3/2018

## Teens are sleeping less – but there’s a surprisingly easy fix

October 18, 2017 9:51am EDT

## In Texas, Your Child’s Sleep Depends On Your School District

Do you know what time your bell tolls?

08/12/2017 12:10 pm ET | Updated Aug 14, 2017

Teen-agers need more sleep. That takes good policy as well as good parenting.

Wendy Troxel, Opinion contributor Published 6:00 a.m. ET Jan. 26, 2018 | Updated 7:31 a.m. ET Jan. 26, 2018

## The Science of Adolescent Sleep

### The Checkup

By PERRI KLASS, M.D. MAY 22, 2017



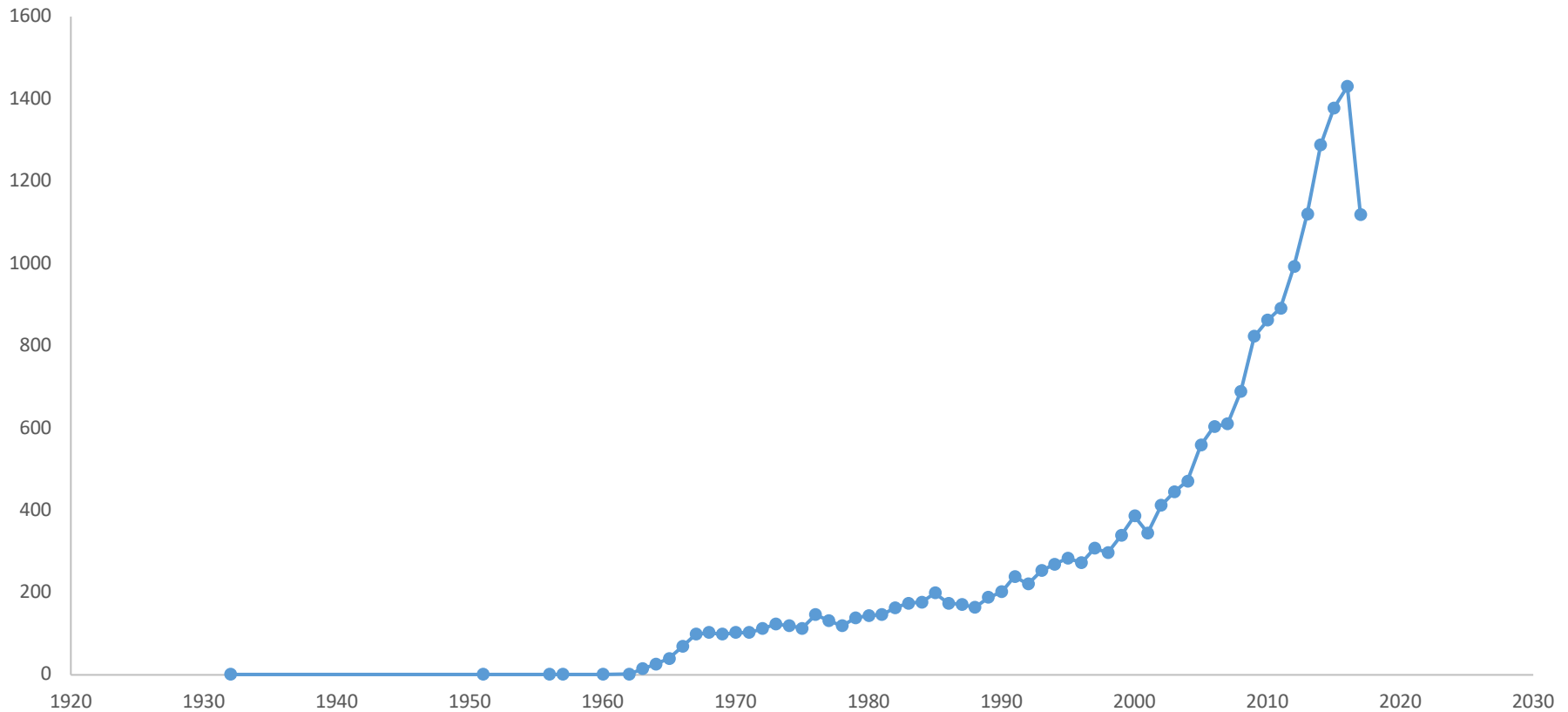
Getty Images

 Claremont Graduate University

Adolescent  
sleep has  
attracted  
international  
press

# The scientific literature surged in adolescent sleep studies

Publications on PubMed Retrieved with the Search Term: "Adolescent sleep"

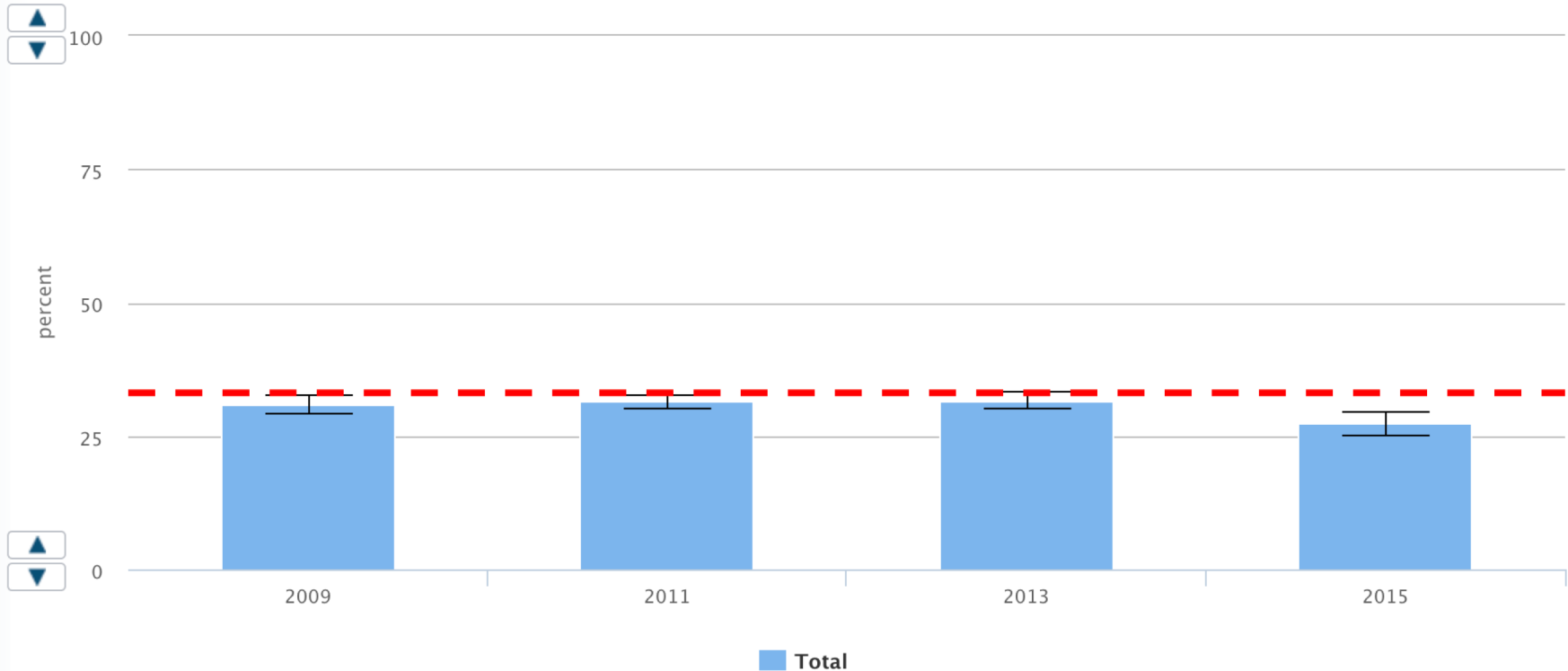


# Sleep Health objectives of Healthy People 2020

## Students getting sufficient sleep on school nights (percent, grades 9–12) By Total

2020 Baseline (year): 30.9 (2009)    --- 2020 Target: 33.1    Desired Direction: ↑ Increase desired

Auto Scale



**Data Source:** Youth Risk Behavior Surveillance System (YRBSS); Centers for Disease Control and Prevention, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention (CDC/NCHHSTP)

**Error Bar (I)** represents the 95% confidence interval

Additional footnotes may apply to these data. Please refer to footnotes below the data table for further information.



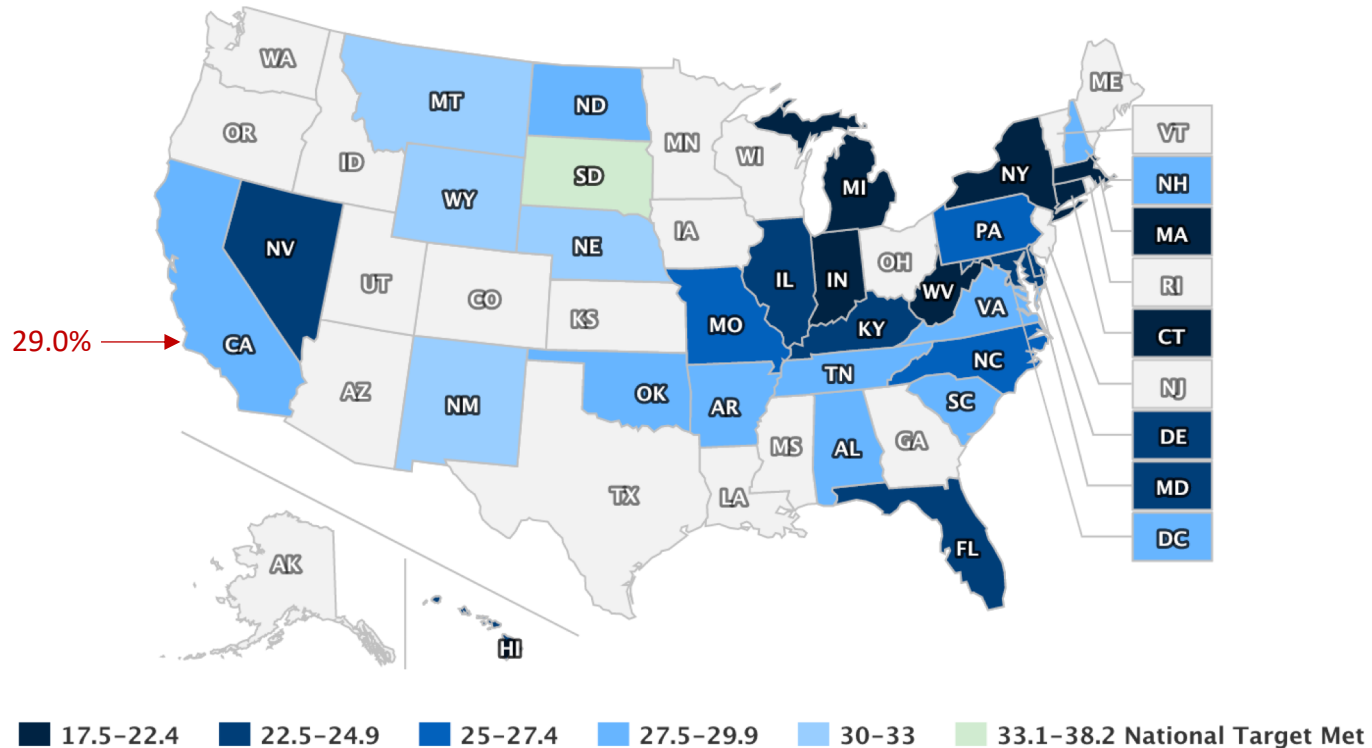
# Sleep Health objectives of Healthy People 2020



## State-level Data

Students getting sufficient sleep on school nights (percent, grades 9–12)

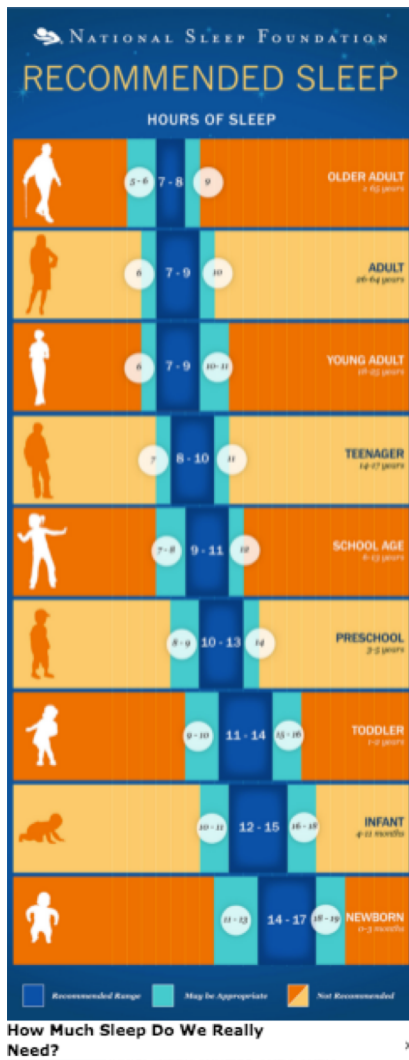
2015



Data Source: Youth Risk Behavior Surveillance System (YRBSS); Centers for Disease Control and Prevention, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention (CDC/NCHHSTP)

# How much sleep do humans need?

## *Policy and research*



In 2014, the American Academy of Pediatrics issued a policy statement recommending high school start times at 8:30 am or later

## Natural Sleep and Its Seasonal Variations in Three Pre-industrial Societies

Gandhi Yetish,<sup>1</sup> Hillard Kaplan,<sup>1</sup> Michael Gurven,<sup>2</sup> Brian Wood,<sup>3</sup> Herman Pontzer,<sup>4</sup> Paul R. Manger,<sup>5</sup> Charles Wilson,<sup>6</sup> Ronald McGregor,<sup>7</sup> and Jerome M. Siegel<sup>7,8,9,\*</sup>

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<sup>2</sup>Department of Anthropology, University of California, Santa Barbara, 1210 Cheadle Hall, Santa Barbara, CA 93106, USA

<sup>3</sup>Department of Anthropology, Yale University, 10 Sachem Street, New Haven, CT 06511, USA

<sup>4</sup>Department of Anthropology, Hunter College, 695 Park Avenue, New York, NY 10065, USA

<sup>5</sup>School of Anatomical Sciences, University of the Witwatersrand, 7 York Road, Parktown, Johannesburg 2193, South Africa

<sup>6</sup>Department of Neurology and Brain Research Institute, University of California, Los Angeles, 10833 Le Conte Avenue, Los Angeles, CA 90095, USA

<sup>7</sup>Department of Psychiatry and Biobehavioral Sciences, University of California, Los Angeles, Los Angeles, CA 90095, USA

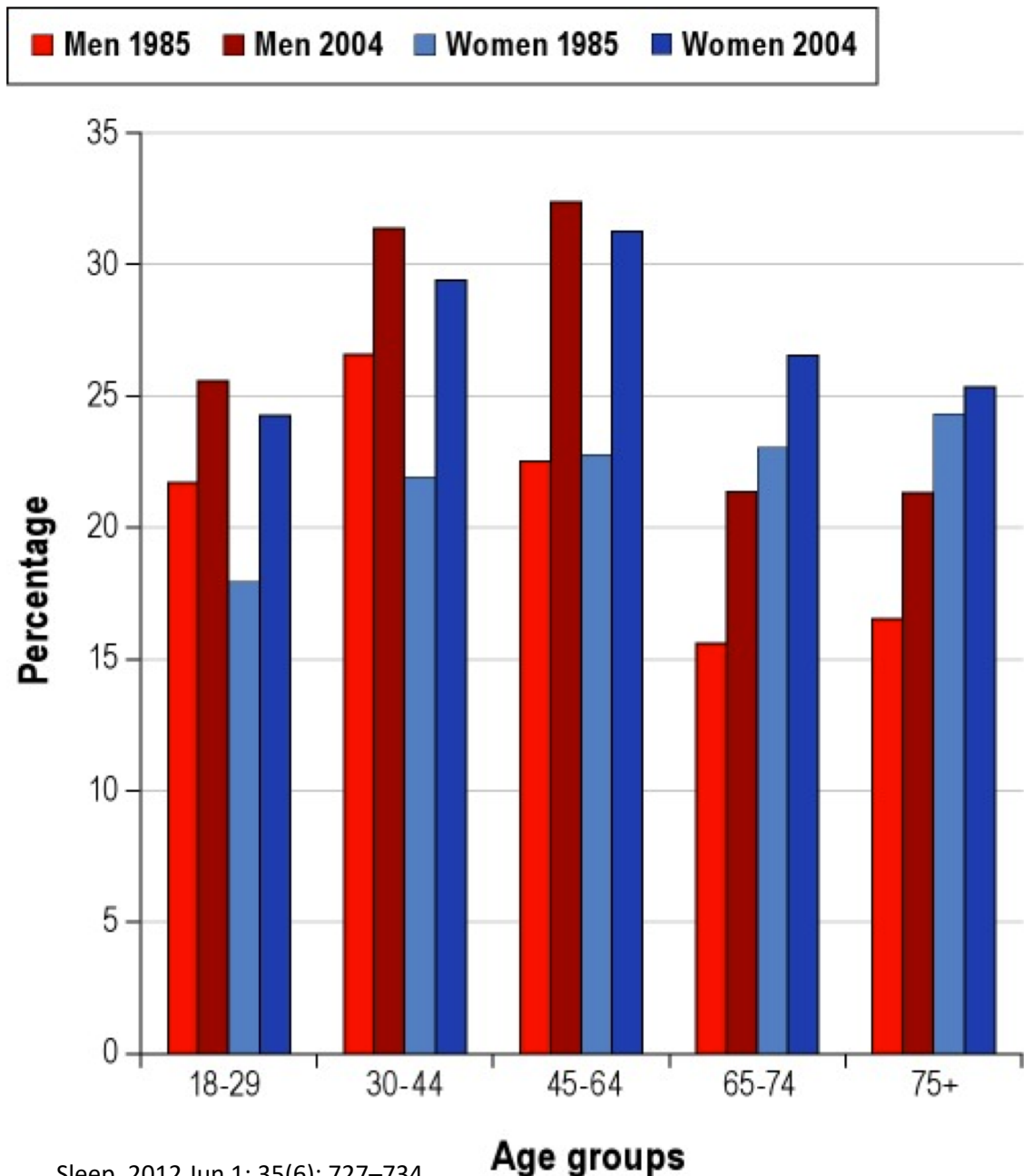
<sup>8</sup>VA Greater Los Angeles Healthcare System, 16111 Plummer Street, Los Angeles, CA 91343 USA

<sup>9</sup>Brain Research Institute, University of California, Los Angeles, Los Angeles, CA 90095, USA

\*Correspondence: [jsiegel@ucla.edu](mailto:jsiegel@ucla.edu)

<http://dx.doi.org/10.1016/j.cub.2015.09.046>

Adults are getting less sleep than they used to



Sleep. 2012 Jun 1; 35(6): 727-734.

# What are the detrimental effects of sleep deprivation?

**Fatigue**

**Mental Health Effects (Depression)**

**Decision-making Impairment**

**Reaction Time Slowing**

**Attention Deficits**

**Metabolic Health (Obesity, Metabolic Syndromes)**

**Neurodegenerative Diseases**

**Exacerbate Other Health Conditions**

**Irritability**

**Cancer?**

**Motor Vehicle Accidents**

## Impact of Chronic Sleep Loss in Adolescents

Physical health and safety
Increased obesity risk
Metabolic dysfunction (hypercholesterolemia, type 2 diabetes mellitus)
Increased cardiovascular morbidity (hypertension, increased risk of stroke)
Increased rates of motor vehicle crashes ("drowsy driving")
Higher rates of caffeine consumption; increased risk of toxicity/overdose
Nonmedical use of stimulant medications; diversion
Lower levels of physical activity
Mental health and behavior
Increased risk for anxiety, depression, suicidal ideation
Poor impulse control and self-regulation; increased risk-taking behaviors
Emotional dysregulation; decreased positive affect
Impaired interpretation of social/emotional cues in self and others
Decreased motivation
Increased vulnerability to stress
Academics and school performance
Cognitive deficits, especially with more complex tasks
Impairments in executive function (working memory, organization, time management, sustained effort)
Impairments in attention and memory
Deficits in abstract thinking, verbal creativity
Decreased performance efficiency and output
Lower academic achievement
Poor school attendance
Increased dropout rates

[Pediatrics](#)  
[September 2014, VOLUME 134 / ISSUE 3](#)

# What are the detrimental effects of sleep deprivation?

Fatigue

Mental Health Effects  
(Depression)

Decision-making  
Impairment

Reaction Time Slowing

Attention Deficits

Metabolic Health (Obesity,  
Metabolic Syndromes)

Neurodegenerative  
Diseases

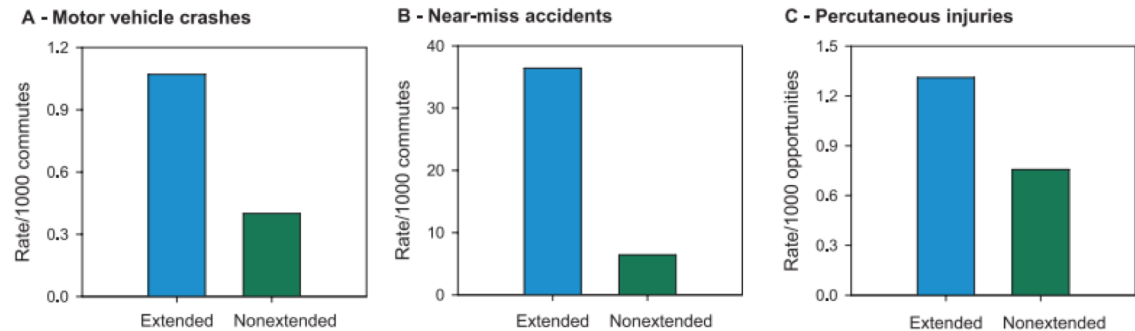
Exacerbate Other Health  
Conditions

Irritability

Cancer?

**Motor Vehicle Accidents**

## Residents' Motor Vehicle Crashes, Near-Miss Motor Vehicle Accidents, and Percutaneous Injuries Reported Relative to the Duration of Work Shifts



**Figure 3.** This figure shows the rate of (A) motor vehicle crashes, (B) near-miss motor vehicle accidents and (C) percutaneous injuries reported by postgraduate year (PGY)-1 residents nationwide ( $n = 2,737$ ) in 17,007 monthly reports between June 2002 and May 2003 relative to the duration of work shifts. Residents reported a significantly higher rate of motor vehicle crashes and near misses on the commute following an extended-duration work shift ( $> 24$  hours; Figures A and B, ■) as compared with the same residents' commute following a nonextended shift ( $< 24$  hours, ■). The Mantel-Haenszel odds ratios ( $OR \pm 95\%$  confidence interval) for having an accident or near miss on the commute home were 2.3 (1.6–3.3) and 5.9 (5.4–6.3), respectively (see text). Residents also reported a significantly higher rate of percutaneous injuries when on duty during the day after being on-call overnight (6:30-17:30; Figure C, ■) as compared with the day before on-call (■;  $OR$  1.61, 1.46–1.78).

Figures A and B: Data replotted from Barger L.K., et al.: Extended work shifts and the risk of motor vehicle crashes among interns. *N Engl J Med* 352:125–134, Jan. 13, 2005.

Figure C: Data replotted with permission from Ayas N.T., et al.: Extended work duration and the risk of self-reported percutaneous injuries in interns. *JAMA* 296:1055–1062, Sep. 6, 2006. Copyright ©2006 American Medical Association.

# The Zeitgeist of “Early to bed, early to rise...”

LIFESTYLE / SLEEP

## 7 Ways Science Proves Early to Bed and Early to Rise Really Works

Tired entrepreneurs should listen to science and go to bed.

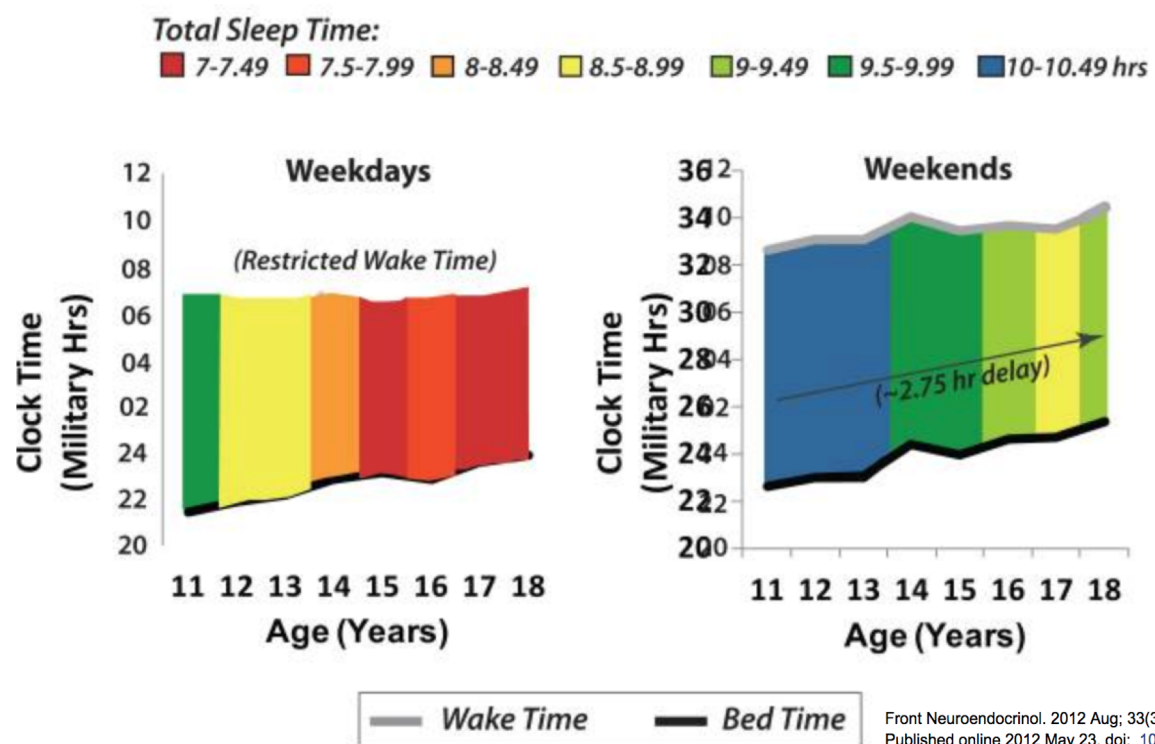
4.9k shares



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NEXT ARTICLE

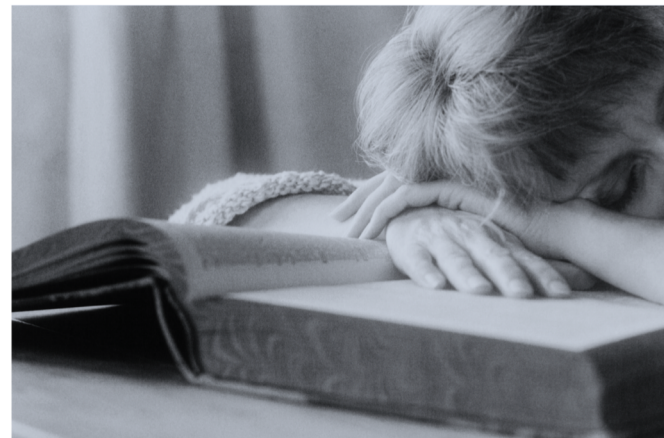
Are teens just bad at making healthy decisions for themselves?



# What are the factors affecting 'unhealthy' adolescent sleep behaviors?

- **Biological**
  - 2 Process Model
  - Environmental Light
  - Puberty and Hormones
- **Social**
  - Autonomy, social activities, weekend warriors, caffeine consumption
  - ***School Start Times***

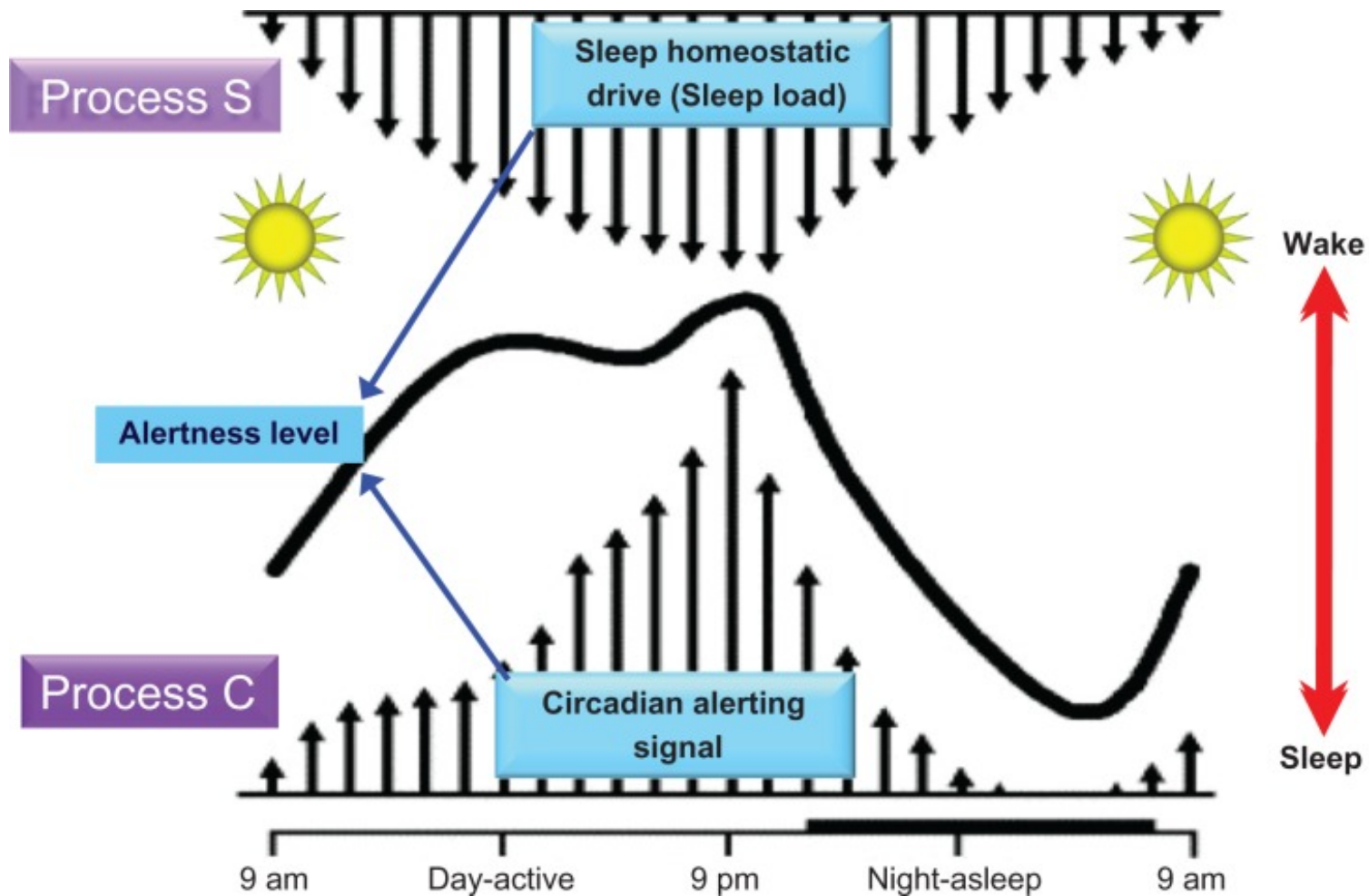
## ADOLESCENT *Research Report* SLEEP NEEDS *and Resource Guide* AND PATTERNS



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# Modeling the biological control of sleep: The two-process model



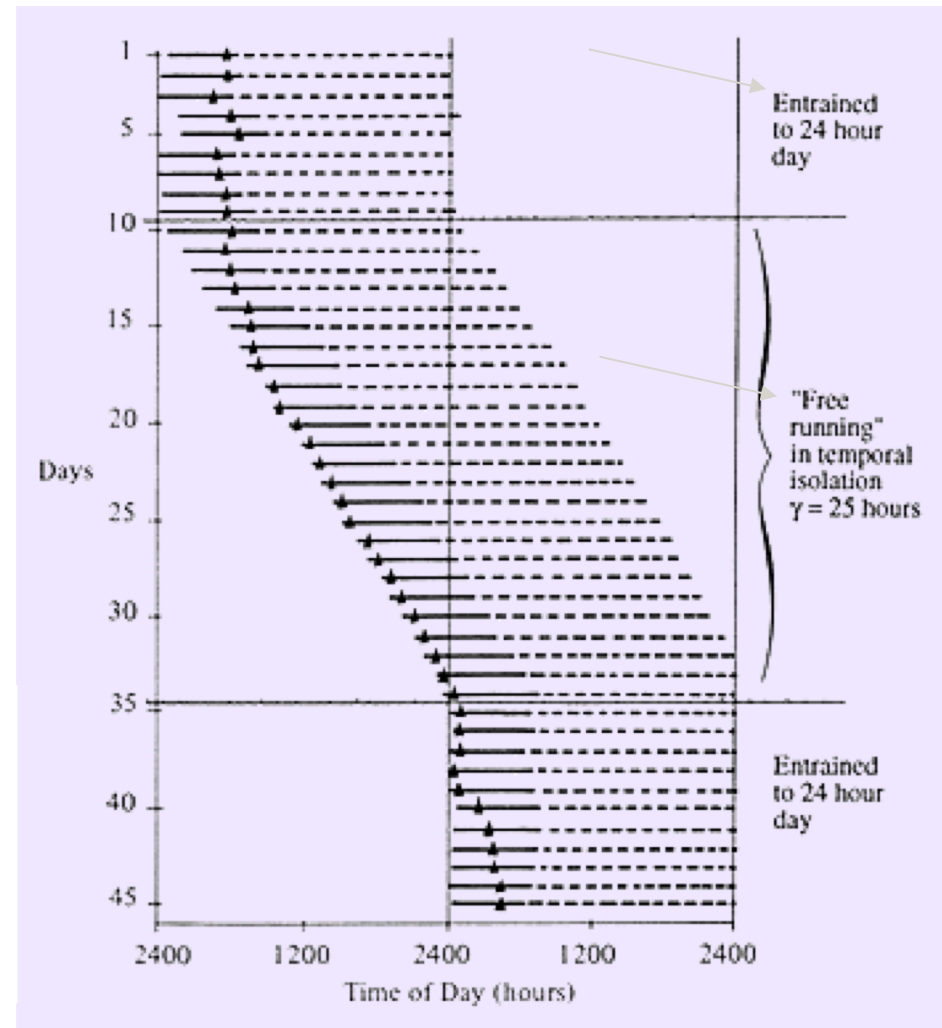
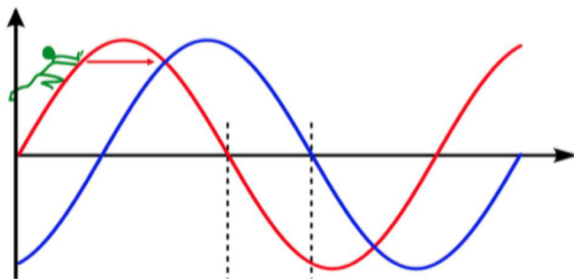
[Nat Sci Sleep. 2010; 2: 187-198.](#)  
Published online 2010 Aug 19. doi: [10.2147/NSS.S6683](#)



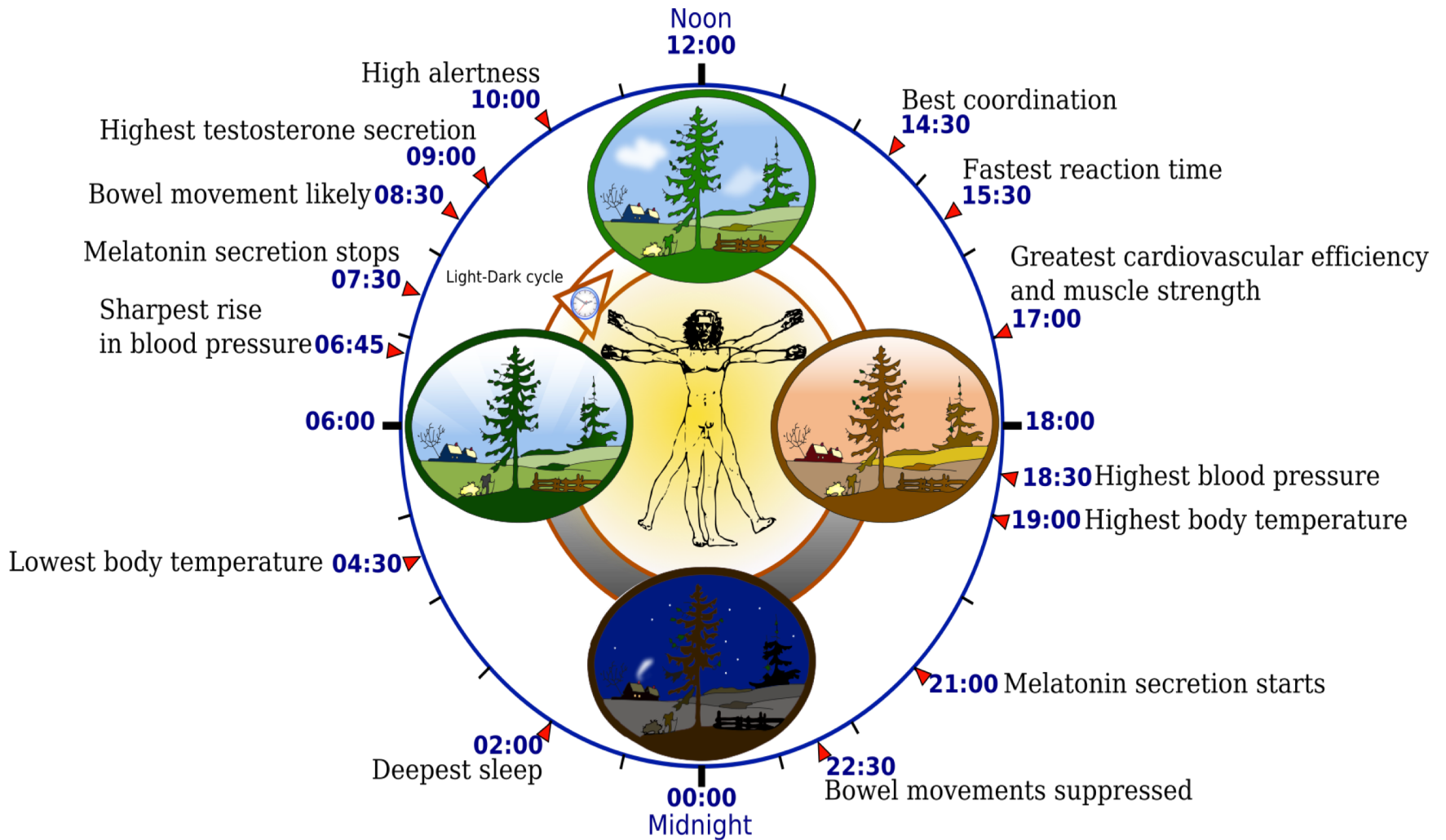
Circa + dia

# Sample Actigraph showing human rhythms

- Two types of rhythms
- Entrained v. Free running



<http://www.sleepsources.org/uploads/sleepsyllabus/g.html>



[https://en.wikipedia.org/wiki/Circadian\\_rhythm](https://en.wikipedia.org/wiki/Circadian_rhythm)

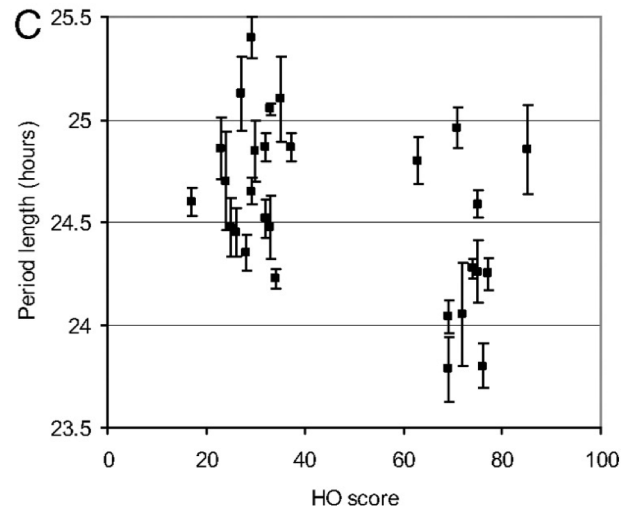
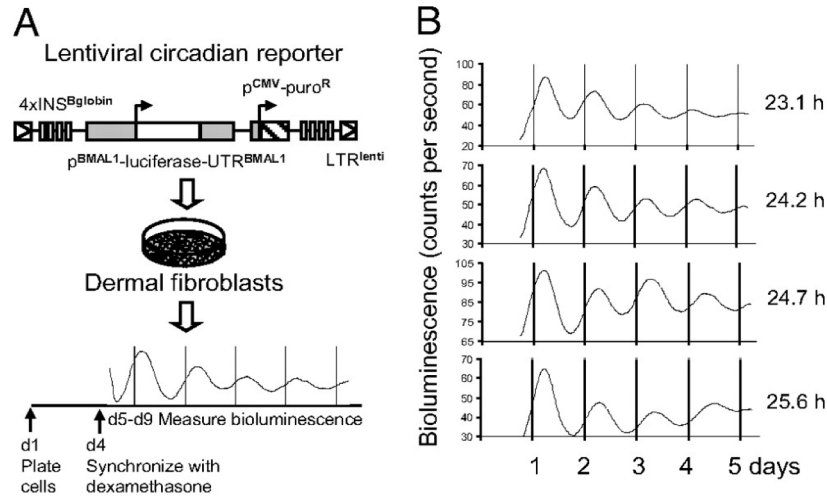
# What's your chronotype?

- Each of us is genetically predisposed to be somewhere on the spectrum of larks and owls.
- Larks and Owls each have their own personality traits
- You can take the isolated skin cells of a lark or owl and be able to tell what that person's sleep habits are



<https://cdnrr.resperate.com/wp-content/uploads/2016/06/bigstock-Owls-and-larks-107660930.jpg>

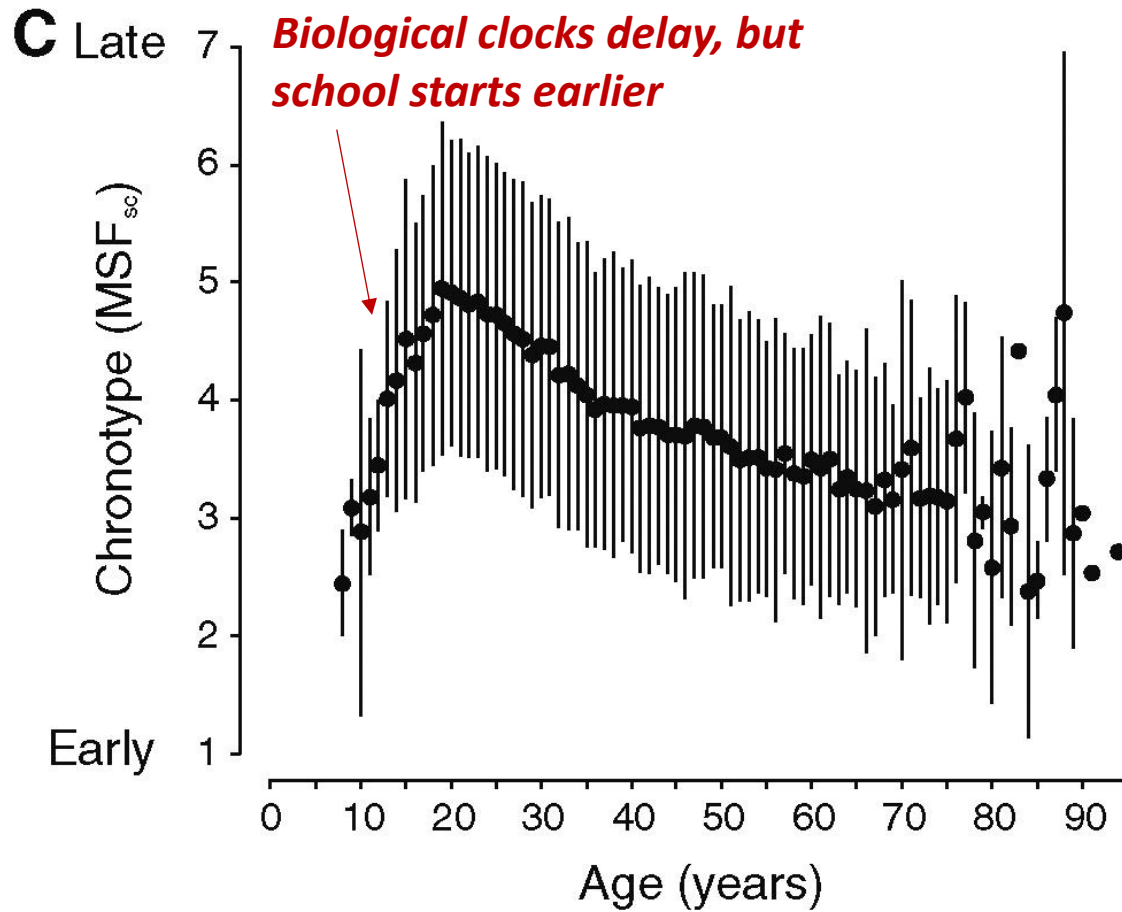
# Comparison of subject chronotype with fibroblast period length



Steven A. Brown et al. PNAS 2008;105:1602-1607

PNAS

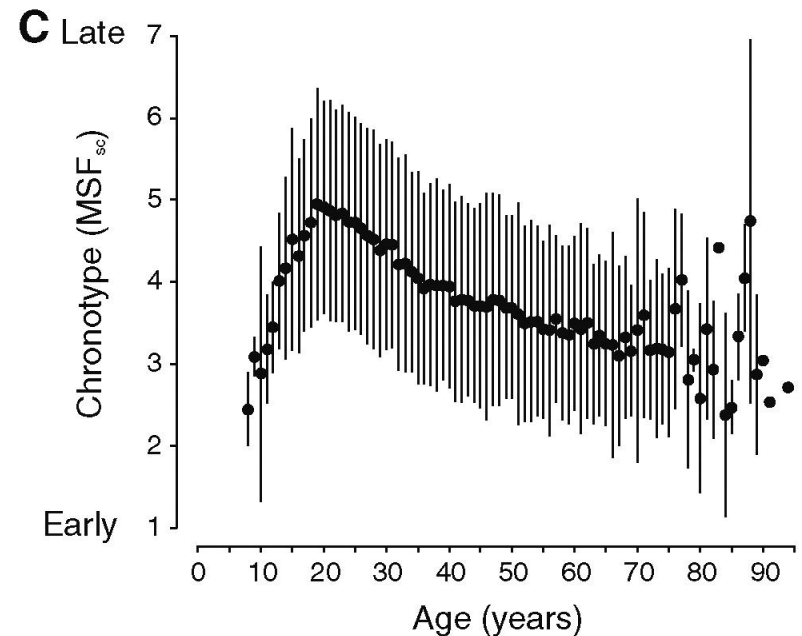
# Chronotype changes across the lifespan: A delay during adolescent years



Roenneberg, Till et al.  
Current Biology, Volume 14, Issue 24, R1038 - R1039

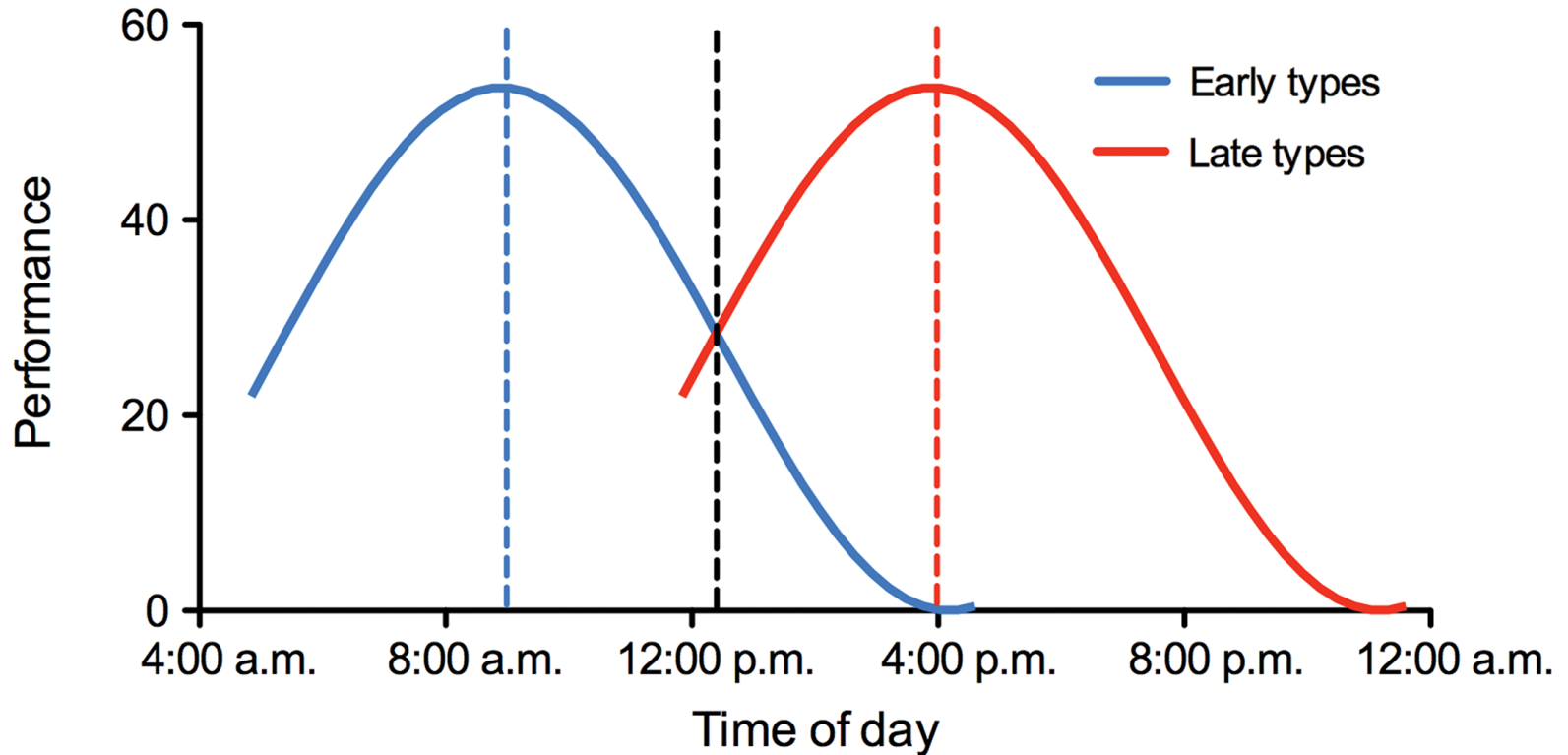
# Why does the school start time remain misaligned with adolescent chronotypes?

Allow earlier commutes  
Transportation limitations  
Time for homework  
Time for extra-curricular activities  
Childcare needs  
Part-time work



Roenneberg, Till et al.  
Current Biology, Volume 14, Issue 24, R1038 - R1039

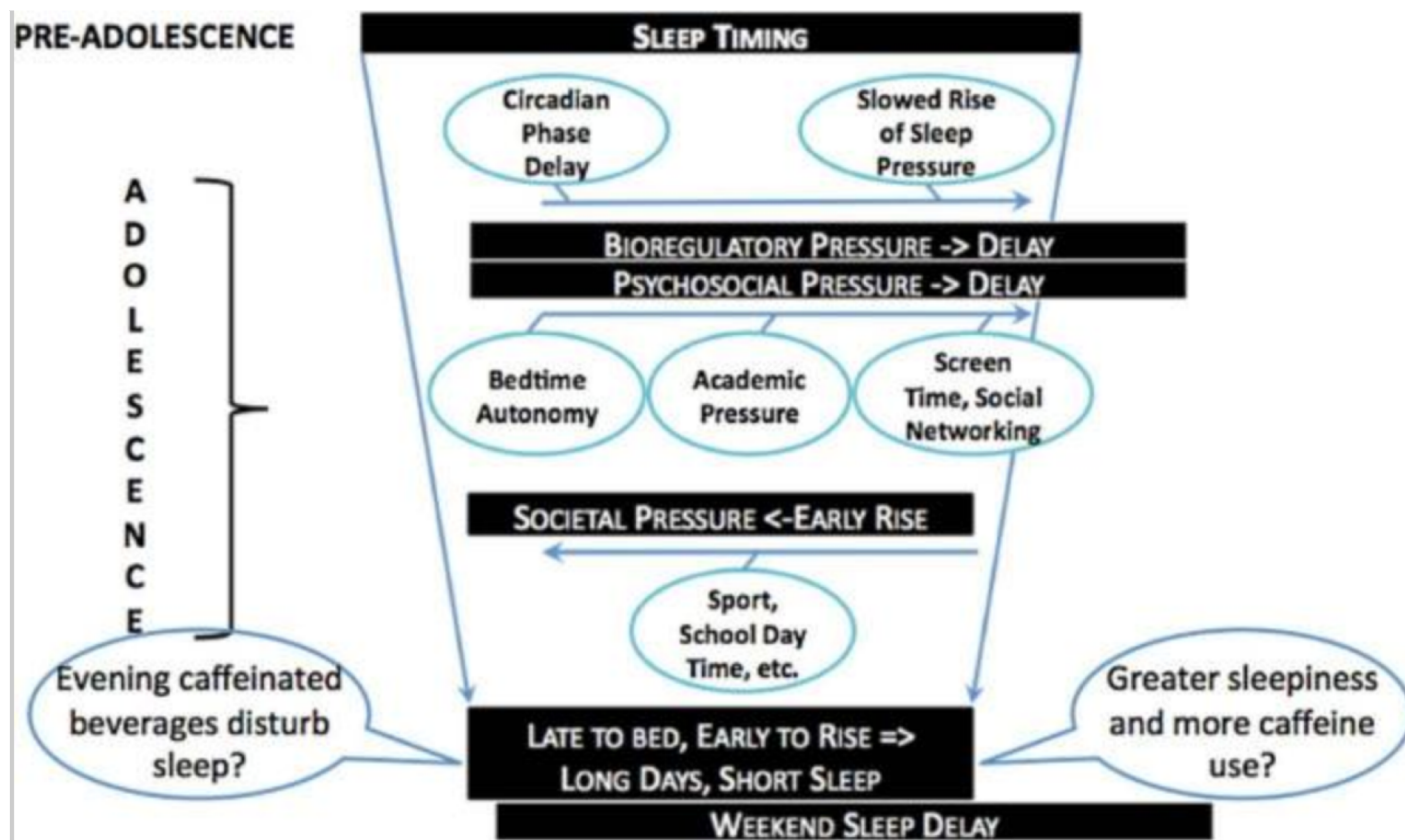
# How does chronotype misalignment affect performance?



Time to learn: How chronotype impacts education, Volume: 6, Issue: 4, Pages: 263-276, First published: 10 October 2017, DOI: (10.1002/pchj.178)

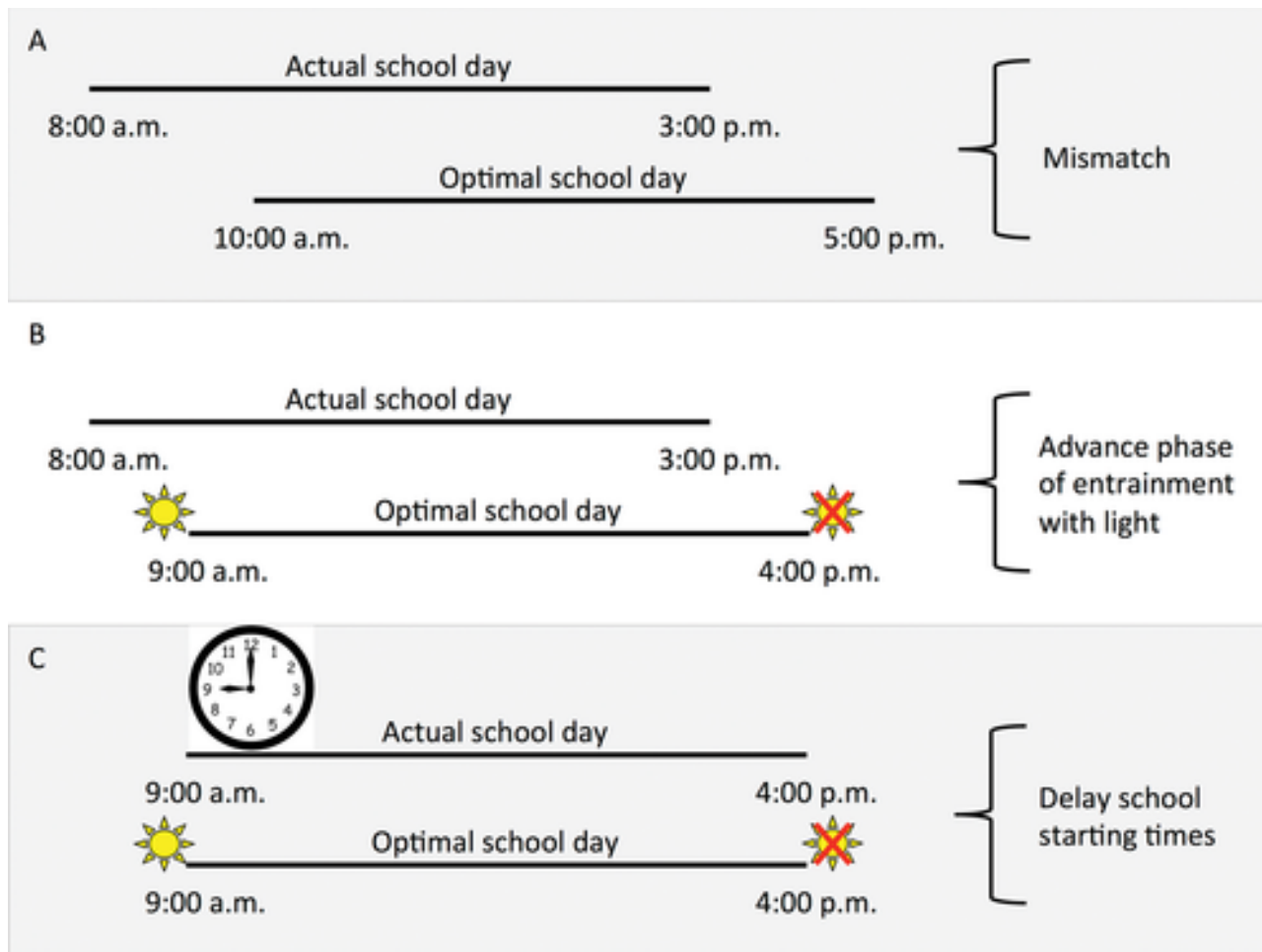


# Many biological and social factors exacerbate this misalignment and sleep deprivation



[Nutr Rev. 2014 Oct 1; 72\(Suppl 1\): 60-64.](#)  
Published online 2014 Oct 15. doi: [10.1111/nure.12147](https://doi.org/10.1111/nure.12147)

# Strategies to address this misalignment...



Time to learn: How chronotype impacts education, Volume: 6, Issue: 4, Pages: 263-276, First published: 10 October 2017, DOI: (10.1002/pchj.178)

# Scientific Evidence and Delaying School Start Times

Most evidence to date is in the form of expert opinion and observational studies

*These data largely support that delaying school start times is related to improvement in weekday sleep, daytime sleepiness, attendance, mood and performance at school*

But there is very little evidence in the form of systematic reviews, longitudinal studies, experimental data

# Scientific Evidence and Delaying School Start Times

JCSM  
Journal of Clinical  
Sleep Medicine

## REVIEW ARTICLES

### High School Start Times and the Impact on High School Students: What We Know, and What We Hope to Learn

Timothy I. Morgenthaler, MD, FAASM<sup>1</sup>; Sarah Hashmi, MSc, MPH, MBBS<sup>2</sup>; Janet B. Croft, PhD<sup>3</sup>; Leslie Dort, MSc, DDS<sup>4</sup>; Jonathan L. Heald, MA<sup>5</sup>; Janet Mullington, PhD<sup>6</sup>

<sup>1</sup>Center for Sleep Medicine, Mayo Clinic, Rochester, MN; <sup>2</sup>American Academy of Sleep Medicine, Darien, IL; <sup>3</sup>Centers for Disease Control and Prevention, Atlanta, GA; <sup>4</sup>University of Calgary, Calgary, Alberta, Canada; <sup>5</sup>Beth Israel Deaconess Medical Center, Boston, MA

**Study Objectives:** Several organizations have provided recommendations to ensure high school starts no sooner than 08:30. However, although there are plausible biological reasons to support such recommendations, published recommendations have been based largely on expert opinion and a few observational studies. We sought to perform a critical review of published evidence regarding the effect of high school start times on sleep and other relevant outcomes.

**Methods:** We performed a broad literature search to identify 287 candidate publications for inclusion in our review, which focused on studies offering direct comparison of sleep time, academic or physical performance, behavioral health measures, or motor vehicular accidents in high school students. Where possible, outcomes were combined for meta-analysis.

**Results:** After application of study criteria, only 18 studies were suitable for review. Eight studies were amenable to meta-analysis for some outcomes. We found that later school start times, particularly when compared with start times more than 60 min earlier, are associated with longer weekday sleep durations, lower weekday-weekend sleep duration differences, reduced vehicular accident rates, and reduced subjective daytime sleepiness. Improvement in academic performance and behavioral issues is less established.

**Conclusions:** The literature regarding effect of school start time delays on important aspects of high school life suggests some salutary effects, but often the evidence is indirect, imprecise, or derived from cohorts of convenience, making the overall quality of evidence weak or very weak. This review highlights a need for higher-quality data upon which to base important and complex public health decisions.

**Keywords:** high school, sleep start time, timing

**Citation:** Morgenthaler TI, Hashmi S, Croft JB, Dort L, Heald JL, Mullington J. High school start times and the impact on high school students: what we know, and what we hope to learn. *J Clin Sleep Med* 2016;12(12):1681–1689.

## CLINICAL REVIEW

### Delayed school start times and adolescent sleep: A systematic review of the experimental evidence



Karl E. Minges<sup>\*</sup>, Nancy S. Redeker

Yale University, USA

## ARTICLE INFO

**Article history:**  
Received 15 May 2015  
Received in revised form  
19 June 2015  
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**Keywords:**  
Schools  
Education  
Sleep  
Sleep deprivation  
Sleep restriction  
Circadian rhythm  
Eveningness  
Start time

## SUMMARY

Many schools have instituted later morning start times to improve sleep, academic, and other outcomes in response to the mismatch between youth circadian rhythms and early morning start times. However, there has been no systematic synthesis of the evidence on the effects of this practice. To examine the impact of delayed school start time on students' sleep, health, and academic outcomes, electronic databases were systematically searched and data were extracted using the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines. Six studies satisfied selection criteria and used pre-post, no control (n = 3), randomized controlled trial (n = 2), and quasi-experimental (n = 1) designs. School start times were delayed 25–60 min, and correspondingly, total sleep time increased from 25 to 77 min per weeknight. Some studies revealed reduced daytime sleepiness, depression, caffeine use, tardiness to class, and trouble staying awake. Overall, the evidence supports recent non-experimental study findings and calls for policy that advocates for delayed school start time to improve sleep. This presents a potential long-term solution to chronic sleep restriction during adolescence. However, there is a need for rigorous randomized study designs and reporting of consistent outcomes, including objective sleep measures and consistent measures of health and academic performance.

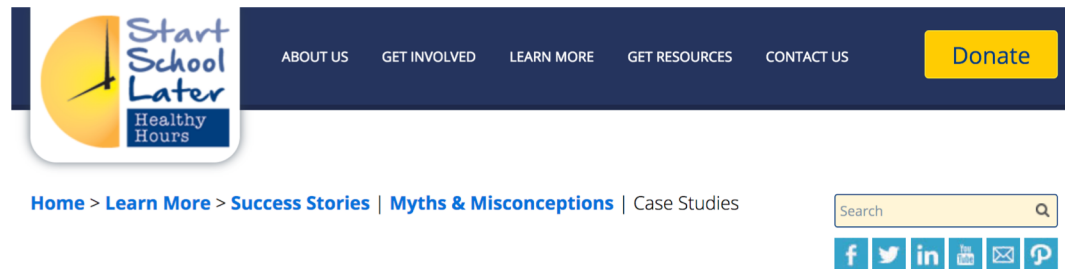
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*Data supports that delaying school start times improved weekday sleep and reduced daytime sleepiness. Some studies also support decreases in depression and caffeine use. Some studies support large decreases in vehicular accident rates.*

*\*For some parameters, effect size is small*

# Resource for case studies on school start times

<http://www.startschoollater.net/case-studies.html>



## Reports and Case Studies



*How have schools managed to delay bell times? Many ways!*

*Find out more from these reports and case studies of districts that have moved to later, healthier, safer schedules.*

# Why not just delay start times?

Allow earlier commutes

Transportation limitations

Time for homework

Time for extra-curricular activities

Childcare needs

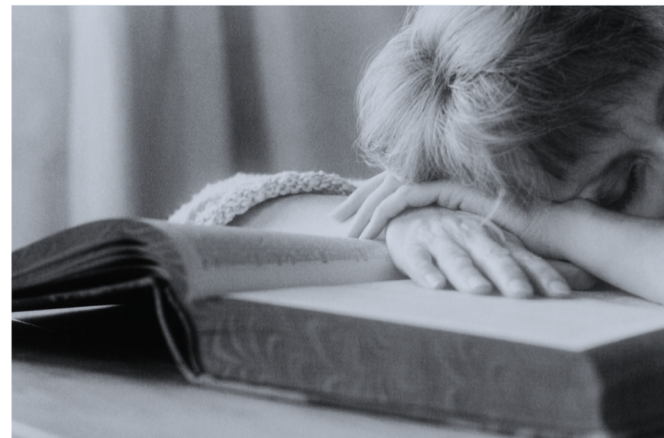
Part-time work

# But delaying start times as the only means to address this is limiting

- **Biological**
  - 2 Process Model
  - Environmental Light
  - Puberty and Hormones
- **Social**
  - Autonomy, social activities, weekend warriors, caffeine consumption
  - School Start Times

Change practices at home, include sleep hygiene education in health class, change high stakes testing times at schools

## ADOLESCENT *Research Report* SLEEP NEEDS *and Resource Guide* AND PATTERNS



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# Take away messages:

- 1) Increased interest and attention around adolescent sleep health is part of a trend as we learn more about the importance of sleep, although there is still much we don't know
- 2) Adolescents are not getting enough sleep according to national guidelines. Chronic sleep deprivation has many detrimental effects
- 3) There are both biological and social reasons why adolescents go to bed and wake up later
- 4) Misaligning chronotype to environment creates cognitive, mood and behavioral challenges
- 5) The data that we do have, albeit limited, supports delaying school start times for better sleep (still not clear on performance), safety
- 6) But there are important considerations if delaying start times. This is a luxury for many.



# Adolescent Sleep and Community Impacts

*Thank You!*