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Are Americans sleeping less then they used to? Evidence for Adults and Adolescents

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Overview

- The assertion that adults and adolescents sleep 1-2 hours less than they did in early to mid 20th c to is common, but controversial.
 - Why this seems plausible
 - Why it matters
- To the extent this is based on data, what are those data (for the US)?
 - Limitations of self-reported sleep duration (3 studies)
- What other data have been used to examine this?
- Are there better data?
- For adults:
 - May have been a half-hour decline since 1942, trend may be upward in the last 15 years
- High School students:
 - May have declined by 20 minutes relative to 1913
 - No evidence of a decline from 2003 to 2014 -- the social media era



The Trend

“Sleep deprivation is such a rampant problem that last year the Centers for Disease Control and Prevention called insufficient sleep a public health epidemic.”

CNN 2/18/2105

“Between 1960 and 2010, the average night’s sleep for adults in the United States dropped to six and a half hours from more than eight.” NYT A Good Night’s Sleep Isn’t a Luxury; It’s a Necessity

New York Times, 5/30/2011

“According to Charles Czeisler, the chief of the Division of Sleep and Circadian Disorders at Brigham and Women’s Hospital, over the past five decades our average sleep duration on work nights has decreased by an hour and a half, down from eight and a half to just under seven.”

New Yorker 7/7/2015



Plausible?

- Work hours
- Electric lights
- Television
- Electronics (especially adolescents)
- Modernity; fraying fabric
- Failure to prioritize sleep
- Availability of experience that sleep used to be longer (and better)

“Never before have work and play stolen more hours from the sandman. Between a global economy that demands increased productivity and a technology-fueled entertainment machine that provides non-stop diversions, it's a wonder people get any rest at all.”

USA Today 2/27/2006



So what?

- **Cognitive** consequences of sleep deprivation
 - Accidents
 - IOM estimates 20% of all motor vehicle crashes related to sleepiness (2006)
 - Investigators have identified sleep deprivation as a factor in the
 - 1979 nuclear accident at Three Mile Island
 - 1986 nuclear meltdown at Chernobyl
 - 1986 space shuttle Challenger
 - 1989 grounding of the Exxon Valdez oil tanker
 - Memory, processing time and performance on cognitive tasks in experimental studies
 - Learning for adolescents
- **Health:** mortality, **obesity**, diabetes, stroke
- **Mental Health:** Depression, Anxiety, Hyperactivity in Children



And..

- Crisis language has been used to drive both govt and individual spending
- Seems actionable
 - If short sleep duration is a choice

Note: Short sleep could be deleterious whether or not there is secular trend.



Recent History of Assertion

- Dr. William Dement lobbied Congress in the late 1980s to create the National Commission on Sleep Disorders Research, which convened in March 1990.
- New York Times 5/1990,
 - roundtable discussion on "Insomnia: Sleep Deprivation in America" held in conjunction with the American Psychiatric Association annual meeting. (personal communication, Natalie Angier)
- Time cover story 12/1990 "Drowsy America"
 - adults need 8 hours & most Americans sleep less than that and are sleep deprived
 - deleterious consequences
 - problem evolved over the past century due to the introduction of the light bulb.
 - "The sun presumably dictated the habits of the ancient people: when it was up they were awake and when it was down they slept."
- National Commission on Sleep Disorders Research report, "Wake up America: A National Sleep Alert," 1/1993
 - "Over the past century, we have reduced our average nightly total sleep time by more than 20 percent." (no citation)
- From 1993 to 2006, the number physician diagnoses of insomnia increased from < 1 million to > 5 million.

At the same time....



To the extent this is based on data, what are those data?



The Data

“Over the past 50 years, sleep duration in adults and adolescents has decreased by 1.5–2 hours per night, and more than 30% of Americans between the ages of 30 and 64 report sleeping less than 6 hours per night [\[3\]](#)” Eve Van Cauter et al. “Metabolic consequences of sleep and sleep loss” *Sleep Medicine* 2008

[3] National Health Interview Survey. QuickStats: Percentage of Adults Who Reported an Average of <6 Hours of Sleep per 24-Hour Period, by Sex and Age Group – United States, 1985 and 2004. MMWR Morb Mortal Wkly Rep.

“Today, 30% of all employed US adults and 44% of night workers report averaging less than 6 hours sleep per night¹, whereas 50 years ago less than 3% of the US adult population slept so little.” Charles Czeisler, *Nature* 5/23/2013

¹ Luckhaupt, S. E. Morb. Mort. Wkly Rep. 61, 281–285 (2012).

Why 50 years?



American Cancer Society CPS-I

- Cohort Study with baseline 1959-1960 of about 1 million
- Volunteer network recruited friends, relatives and neighbors, to minimize loss to follow-up
- Recruited adults aged 30+ ONLY IF an adult aged 45+ in the household agreed to participate
- Study population differed from population in 1960

| | 1960 Census | ACS CPS-I |
|----------------------------|------------------------|--------------------------|
| Black | 10.5 % | 2 % |
| % of Adults over 45 | 42 % | 81 % |
| College Grads (aged 50-54) | 8 % Men 6.5 % Women | 21 % Men 17.5 % Women |



Challenges Extracting Mean Sleep Duration from CPS I

- The sleep distribution data from the CPS-I has only been published in a 1979 article.¹
 - Which omitted about 200,000 persons with history of high blood pressure, heart disease, stroke (~20% of the cohort)
 - Data reported by age group & sex in one-hour increments, e.g. 7 - 7.9 hours.
- What do we impute as the mean for 7 - 7.9? 7.5 hours?
 - Other studies, the great majority report the even hour
- Age distribution
- Adjusting to the 1960 population age distribution, assuming $\frac{1}{4}$ hour averages, mean = 7.68 hours in 1960
 - Can't fix the SES or health confounding problems

¹ Kripke et al. *Arch Gen Psychiatry*. 1979



| Table 1.—Percent of Men With Each Reported Sleep Duration | | | | | | | | | |
|---|-----------------------------|----------------|-------------|-------------|--------------|--------------|--------------|-------------|-------------|
| Age, yr | Total No. of Subjects | Hours of Sleep | | | | | | | |
| | | < 4 | 4-4.9 | 5-5.9 | 6-6.9 | 7-7.9 | 8-8.9 | 9-9.9 | ≥10 |
| 30-34 | 9,677 | 0.04 | 0.30 | 2.20 | 14.97 | 37.46 | 38.48 | 5.12 | 1.43 |
| 35-39 | 16,591 | 0.07 | 0.31 | 2.14 | 15.16 | 37.68 | 38.91 | 4.60 | 1.13 |
| 40-44 | 28,519 | 0.05 | 0.35 | 1.98 | 13.72 | 37.45 | 40.76 | 4.70 | 1.00 |
| 45-49 | 83,845 | 0.06 | 0.28 | 1.61 | 12.00 | 36.35 | 43.39 | 5.26 | 1.06 |
| 50-54 | 79,627 | 0.05 | 0.31 | 1.56 | 10.82 | 34.52 | 45.68 | 5.78 | 1.28 |
| 55-59 | 58,376 | 0.07 | 0.30 | 1.52 | 9.81 | 32.38 | 47.95 | 6.43 | 1.53 |
| 60-64 | 39,702 | 0.07 | 0.40 | 1.57 | 9.04 | 28.84 | 50.04 | 7.86 | 2.19 |
| 65-69 | 26,011 | 0.10 | 0.46 | 1.80 | 7.62 | 23.64 | 52.27 | 10.85 | 3.26 |
| 70-74 | 14,115 | 0.09 | 0.52 | 2.01 | 7.66 | 20.71 | 51.35 | 12.61 | 5.04 |
| 75-79 | 6,484 | 0.22 | 0.68 | 2.27 | 7.93 | 18.95 | 49.52 | 13.36 | 7.08 |
| 80-84 | 2,440 | 0.20 | 0.74 | 2.62 | 8.20 | 16.76 | 45.16 | 14.59 | 11.72 |
| 85-89 | 831 | 0.2 | 1.3 | 2.5 | 6.7 | 13.4 | 36.9 | 17.9 | 20.9 |
| ≥90 | 275 | 0.0 | 2.9 | 1.8 | 5.1 | 11.6 | 28.7 | 18.2 | 31.6 |
| Total | 366,493 | 0.07 | 0.35 | 1.70 | 10.84 | 32.67 | 45.83 | 6.69 | 1.87 |

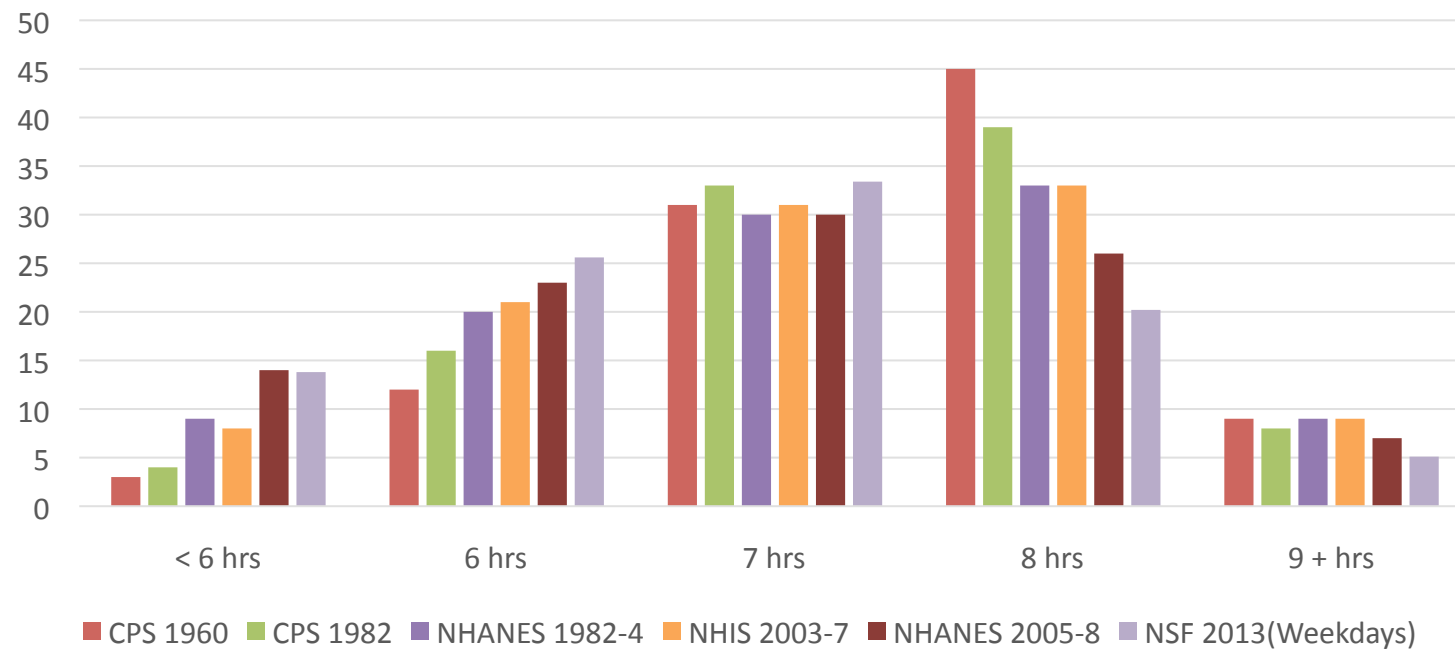
¹ Kripke et al. *Arch Gen Psychiatry*. 1979

“National Surveys” of Adults with Single Questions about Sleep Hours

| Survey | Years | Question | Type & Mode | Ages |
|-------------------|-----------|---|--------------------------------------|---|
| CPS-1 | 1959-1960 | "How many hours of sleep do you usually get at night?" | Volunteer cohort, written survey | Family members 30+, only if household member ≥ 45 participated |
| CPS-2 | 1982 | "On the average, how many hours do you sleep each night? " | Volunteer cohort, written survey | Family members 30+, only if household member ≥ 45 participated |
| NHANES I Followup | 1982-1984 | "How many hours of sleep do you usually get at night (or when you usually sleep)?" | Nationally representative, in-person | > 30 |
| NHIS | 2003-2007 | "On average, how many hours of sleep do you get in a 24-hour period?" | Nationally representative, in-person | 18+ |
| NHANES | 2005-2008 | How much sleep do you usually get at night on weekdays or workdays? | In person | 20+ |
| NSF | 2013 | "On average, <u>worknights or weeknight</u> , how many hours, not including naps, do you usually sleep in one night?" | Web+phone | 23-60 |



Sleep Hour Distributions from “National Surveys” of Adults: 1960-2013



Survey Questions

- No standard question
 - **Cancer Prevention I: “How many hours of sleep do you usually get at night?”**
 - Nurses’ Health Study: “How many hours of actual sleep do you get in a 24-hour period?”
 - NHANES I Epidemiologic Follow-Up: “How many hours of sleep do you usually get at night (or when you usually sleep)?”
 - NHIS: “On average, how many hours of sleep do you get in a 24-hour period?”
 - **National Sleep Foundation Sleep in America Polls (two questions): “On workdays or weekdays, how many hours, not including naps, do you usually sleep during one night?” also for “weekend nights”**



Does it matter what the survey question is?



1. Background: These questions are *hard*
2. Reports are inaccurate and biased relative to objective measures
3. Psychometrics: Question format matters
4. Association between sleep and health differs for different ways of measuring sleep duration



1. Background: These questions are *hard*

- Sleep duration is difficult for individuals to accurately estimate.
 - Sounds like a simple fast question.
 - Must realize it is a arithmetic problem
 - Estimate highly variable bedtime and waketime
 - Mental subtraction, often around midnight



Response Bias Potential

- For those who do not take the calculation route to an answer, where do they get their answer?
 - A plausible answer?
 - A socially desirable answer?



What is the socially desirable answer?

8 hours?

A day and night together lasts 24 hours. It is sufficient that a person sleep one third of that time, which is eight hours.

Maimonides (1135-1204)

2015 sleep recommendations from National Sleep Foundation; American Academy of Sleep Medicine/Sleep Research Society; American Thoracic Society

generally recommend 7-9 hours for adults

As little as possible?

What is it to "redeem the time" from sleep? It is, in general, to take that measure of sleep every night which nature requires, and no more; that measure which is the most conducive to the health and vigour both of the body and mind.

Healthy men, in general, need a little above six hours' sleep, healthy women, a little above seven, in four-and-twenty. I myself want six hours and a half, and I cannot well subsist with less.

John Wesley (1703-1791)



Measuring Sleep

- Survey
 - Single questions (or two, for workdays and weekends) about habitual sleep hours
 - Bedtimes & wake times in general
 - Bedtime & wake time for specific nights
 - Sleep Log
 - Time Diary2020
- Two objective approaches
 - Polysomnography (PSG): the gold standard
 - Define sleep by electrical brain activity
 - Not good for duration
 - Accelerometers (wrist actigraphy)
 - Estimates sleep by arm motion
 - Does not alter behavior



2. Reports are inaccurate and biased relative to objective measures



1. Sleep Heart Health Study, population-based study of older adults, 1night home PSG compared to the next-morning estimate.
 - Correlation = 0.16.
 - Greater divergence was found for those with less education.
2. Rotterdam Study of older adults
 - several nights of actigraphy and morning estimates
 - morning estimates were 23 minutes longer than actigraph sleep
 - one-third had more than an hour difference
 - women reported a quarter hour less sleep than men while their actigraph sleep was a quarter hour longer
 - age and cognitive function had opposite effects on sleep estimate and actigraph sleep
3. Ancillary study to the Women's Health Initiative oversampled women reporting short or long sleep
 - Actigraph sleep averaged 48 minutes shorter than self-report.
 - correlation 0.48
4. Ancillary study to CARDIA compared 3 nights of actigraph sleep with self-report
 - Correlation 0.47, with self-reported sleep averaging 48 minutes longer
 - Persons with mortality risk factors (fair/poor SRH, obesity or more depressive symptoms) systematically reported shorter sleep *at the same level of measured sleep*

Silva et al. J Clin Sleep Med. 2007;3:622-30.

Van Den Berg et al. J Sleep Res. 2008;17(3):295-302.

Kripke et al. Sleep Med. 2011;12:28-33.

Lauderdale et al. Epidemiology. 2008;19:838-45.



3. Psychometrics: Question format matters



Survey experiment about 2 versus 1 questions

- 1600 Knowledge Panel respondents randomized to receive 1 question about usual sleep duration vs. separate questions for workdays and weekends
- Sleep duration differed by question format ($p = .03$)
 - single question mean shorter than the weighted average of two questions (7.03 hr vs. 7.28 hr).

Lauderdale DS (2014) Survey Questions About Sleep Duration: Does Asking Separately About Weekdays and Weekends Matter?, Behavioral Sleep Medicine, 12:2, 158-168



TABLE 4
Predicted Mean Sleep by Race or Ethnicity and Employment Status From Regression Models for
Participants Receiving One Question and Two Questions

| Variable | One Question ^a | | Weighted Average of 2 Questions ^b | | Weekday/Workday Only ^b | |
|------------|------------------------------------|--------------------------------|---|--------------------------------|------------------------------------|--------------------------------|
| | β (Hours) | <i>p</i> Compared to Whites | β (Hours) | <i>p</i> Compared to Whites | β (Hours) | <i>p</i> Compared to Whites |
| White | 6.87 | Referent | 7.01 | Referent | 6.70 | Referent |
| Black | 6.74 | .64 | 6.15 | < .01 | 5.68 | < .01 |
| Hispanic | 6.18 | .02 | 6.95 | .84 | 6.69 | .96 |
| | <i>p</i> Compared to Unemployed | | <i>p</i> Compared to Unemployed | | <i>p</i> Compared to Unemployed | |
| Unemployed | 7.07 | Referent | 7.47 | Referent | 7.30 | Referent |
| Employed | 6.87 | .23 | 7.01 | .003 | 6.70 | < .001 |

Note. Predicted hours for race contrasts are for an employed, 45- to 59-year-old, male, high school graduate, with a household income between \$25,000 and \$50,000. Predicted hours for employment contrasts are for a White, 45- to 59-year-old, male, high school graduate, with a household income between \$25,000 and \$50,000.

^a*n* = 521, ^b*n* = 519.



4. Association between sleep and health differs for different ways of measuring sleep duration



NSHAP Sleep Study

- Nationally-representative probability sample age 57-85
- Second Wave 2010
 - 1/3 respondents (+ partners) invited to sleep study
 - Accelerometer and sleep booklet to collect information about the respondent's sleep over 72 hours
 - 727 with actigraphy data and in age eligible range

Lauderdale, Schumm, Kurina, McClintock, Thisted, Chen, Waite. Assessment of sleep in the national social life, health, and aging project. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences*. 2014 Nov;69 Suppl 2:S125-33



Sleep Duration Measures

1. SURVEY SLEEP HOURS: “How many hours do you usually sleep at night?”
2. SURVEY CALCULATED SLEEP TIME: “What time do you usually go to bed and start trying to fall asleep?” and “What time do you usually wake up?”
3. SLEEP LOG TIME (3 night average)
4. ACTIGRAPH SLEEP INTERVAL: duration from falling asleep to final waking up from actigraphy (3 night average)
5. ACTIGRAPH TOTAL SLEEP TIME (3 night average)



Hypothesis

U shape between sleep hours & mortality, especially the long sleep effect, is an artifact of how sleep is measured.

Do the proportions reporting fair/poor health for different sleep durations vary by how sleep is measured?

“Would you say your health is -- excellent, very good, good, fair, or poor?”

Dichotomized fair/poor versus excellent/very good/good



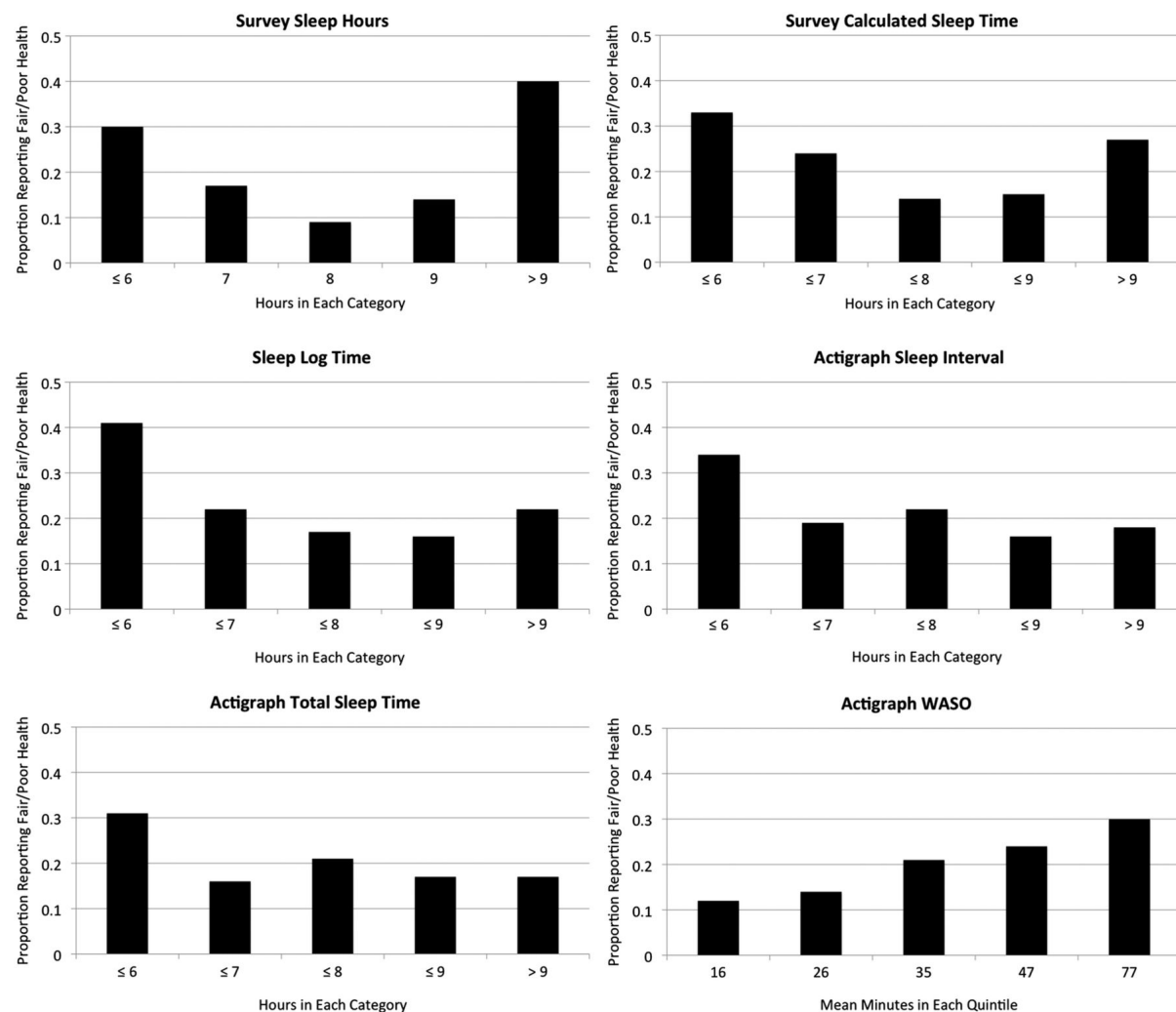
Pairwise Pearson correlations between survey-based and actigraph-estimated sleep duration measures

| | A | B | C | D | E |
|---------------------------------|----------------|----------------|----------------|----------------|---|
| A. Survey sleep hours | 1 | | | | |
| B. Survey calculated sleep time | 0.39 (<0.0001) | 1 | | | |
| C. Sleep log time | 0.46 (<0.0001) | 0.56 (<0.0001) | 1 | | |
| D. Actigraph sleep interval | 0.25 (<0.0001) | 0.39 (<0.0001) | 0.56 (<0.0001) | 1 | |
| E. Actigraph total sleep time | 0.29 (<0.0001) | 0.38 (<0.0001) | 0.52 (<0.0001) | 0.95 (<0.0001) | 1 |

Data are from the National Social Life Health and Aging Project (NSHAP) Sleep Substudy, 2010–2011 (N=727), estimated using survey weights. The statistical significance of each correlation is in parentheses.



The prevalence of fair/poor health by sleep hours measured five different ways, and by wake after sleep onset (WASO) quintiles.



Summary

- Should not combine different types of data sources
 - i.e., single question and time diary
- Self reported duration is not a good way to measure sleep
 - Biases may change over time
- Better would be 1+ time points with the SAME method & nationally representative sample
 - Objective measures
 - Sleep logs or time diaries
 - Usual bedtimes and waking times



What has been done to examine sleep trend with objective data?

Has adult sleep declined over the last 50+ years?
Shawn Youngstedt et al. Sleep Medicine Reviews
2016;28:65-81

168 studies of adults with PSG or actigraphy from
1965-2013., (n=6052, most < 20 people)

Explicitly labelled “normal” sleepers

No temporal trend

However:

- little PSG data < 1980

- little acti data < 1995

- no reason to think study populations are
representative of the general population

What does this add?

- no evidence of trend since 1980, but selection
issues are insurmountable

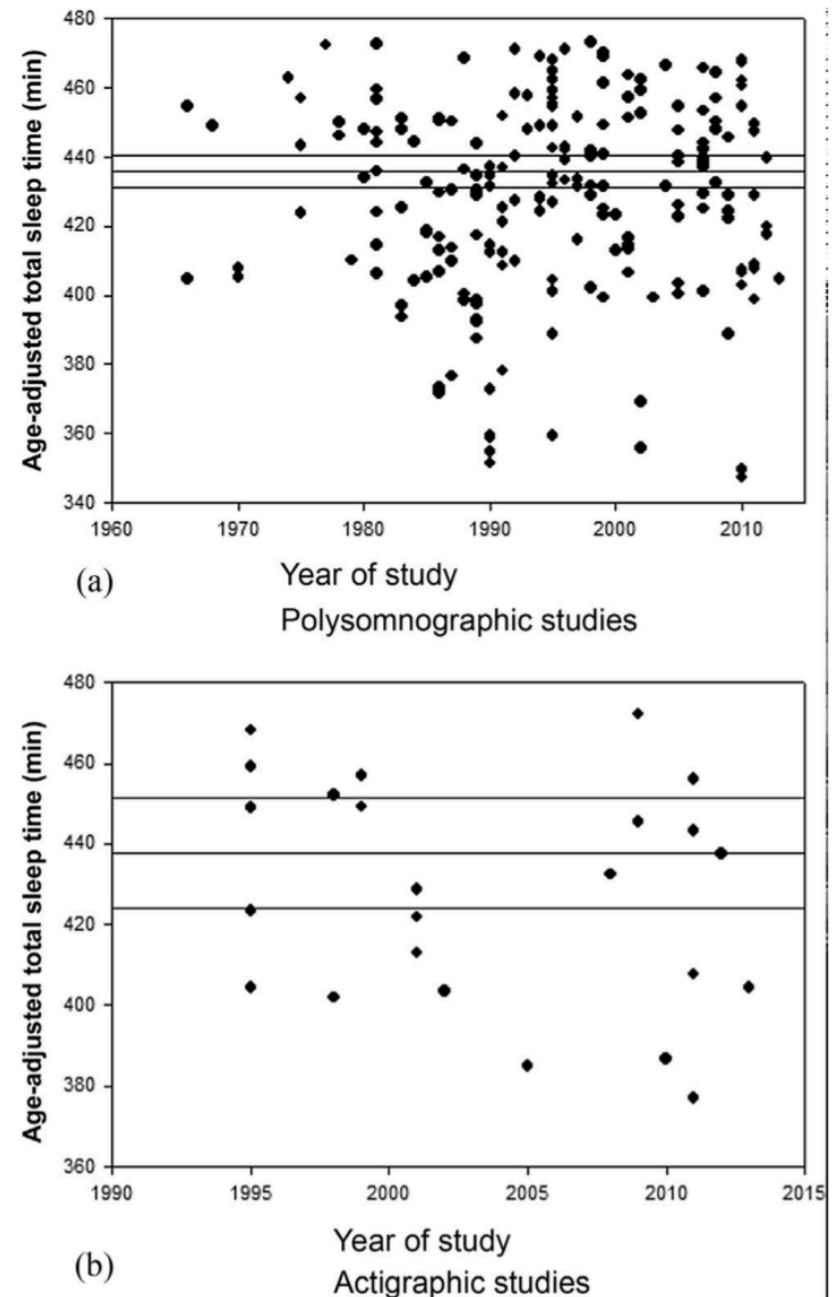


Fig. 4. Association of year of study with age-adjusted total sleep time (min) for polysomnographic data (a) and actigraphic data (b). The regression line and 95% confidence intervals are displayed.



What about time diaries?

US: Sporadic investigator-initiated studies before 2003, then annual ATUS

Trends in the prevalence of short sleepers in the USA: 1975-2006. Knutson, Van Cauter, Rathouz, DeLeire, Lauderdale.
Sleep 2010

Americans' Use of Time Series (1975, 1985, and 1998-99), the Environmental Protection Agency Time Use Study (1992-94), and the American Time Use Survey (2003, 2004, 2005, 2006).

Sleeping at the Limits: The Changing prevalence of short and long sleep durations in 10 countries. Bin, Marshall, Glozier.
American Journal of Epidemiology 2013

Multinational Time Use Survey database: national statistics organizations, for the US: 1985-2007

No trend in mean sleep in 1975 is the base, slight increase if 1985 is the base:

| | 1975 | 1985 | 1992-94 | 1989-90 | 2003 | 2004 | 2005 | 2006 |
|-------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Sleep | 509 ± 134 | 484 ± 123 | 496 ± 123 | 484 ± 125 | 509 ± 132 | 507 ± 133 | 510 ± 134 | 510 ± 135 |

No overall trend to short sleep (<6 hrs) , although there was an increase among the fulltime employed.

Increase in long sleep (>9 hrs)

Possibly sample differences between ATUS and other surveys.



Usual Bedtimes and Wake Times?

Several surveys that claim to be nationally representative have asked this:

Gallup 1942

Gallup 1990

National Sleep Foundation Sleep in America Polls (2013)

Gallup 1942

What time do you usually get up in the morning on weekdays?

About what time do you usually go to bed at night?

As a usual thing, how many hours sleep do you get at night?

Gallup 1990

As a usual thing, how many hours sleep do you get at night?

What time do you usually go to bed on weekday nights?

What time do you usually get up on a weekday morning?

NSF 2013

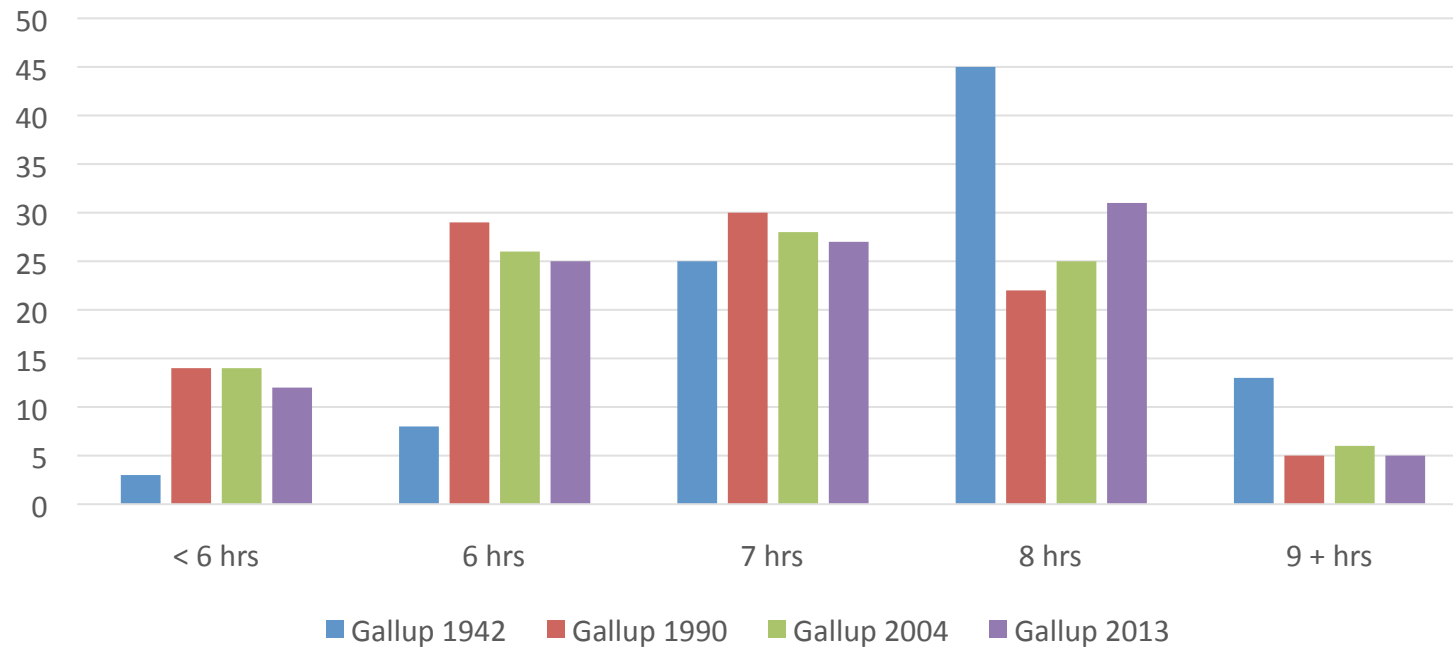
Please think about your sleep schedule in the last two weeks. At what time do you usually go to bed on nights before a workday or weekdays? This is not necessarily the time you turn off the lights and begin trying to sleep.

Thinking about the last two weeks, at what time do you usually get up and out of bed for good on workdays or weekdays?

On average, worknights or weeknights, how many hours, not including naps, do you usually sleep during one night?

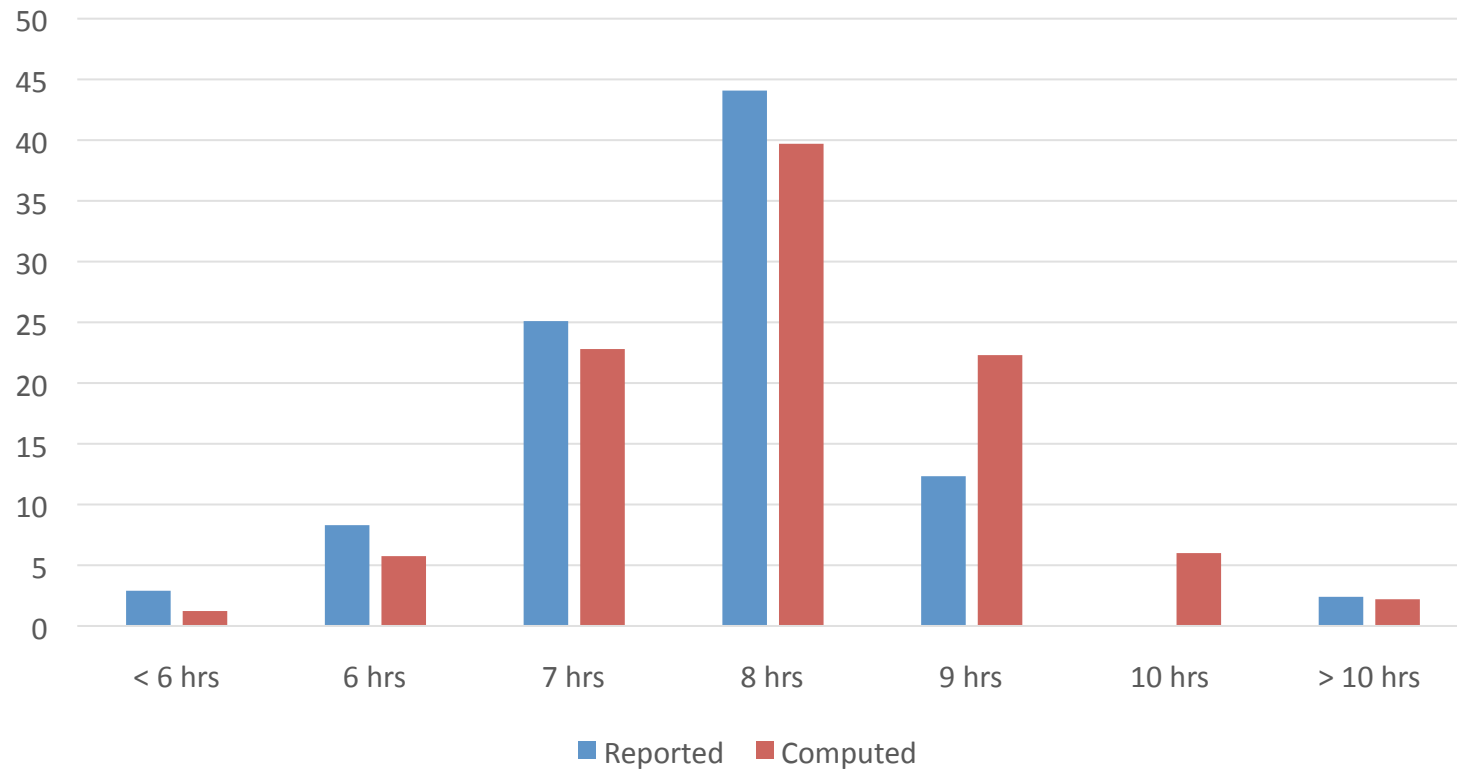


Sleep Hour Distributions from Gallup Surveys of Adults: 1942-2013
"As a usual thing, how many hours sleep do you get at night?"



Reported and Computed Sleep Hours from Gallup 1942

mean computed = 8.2 hours
mean reported = 7.7 hours



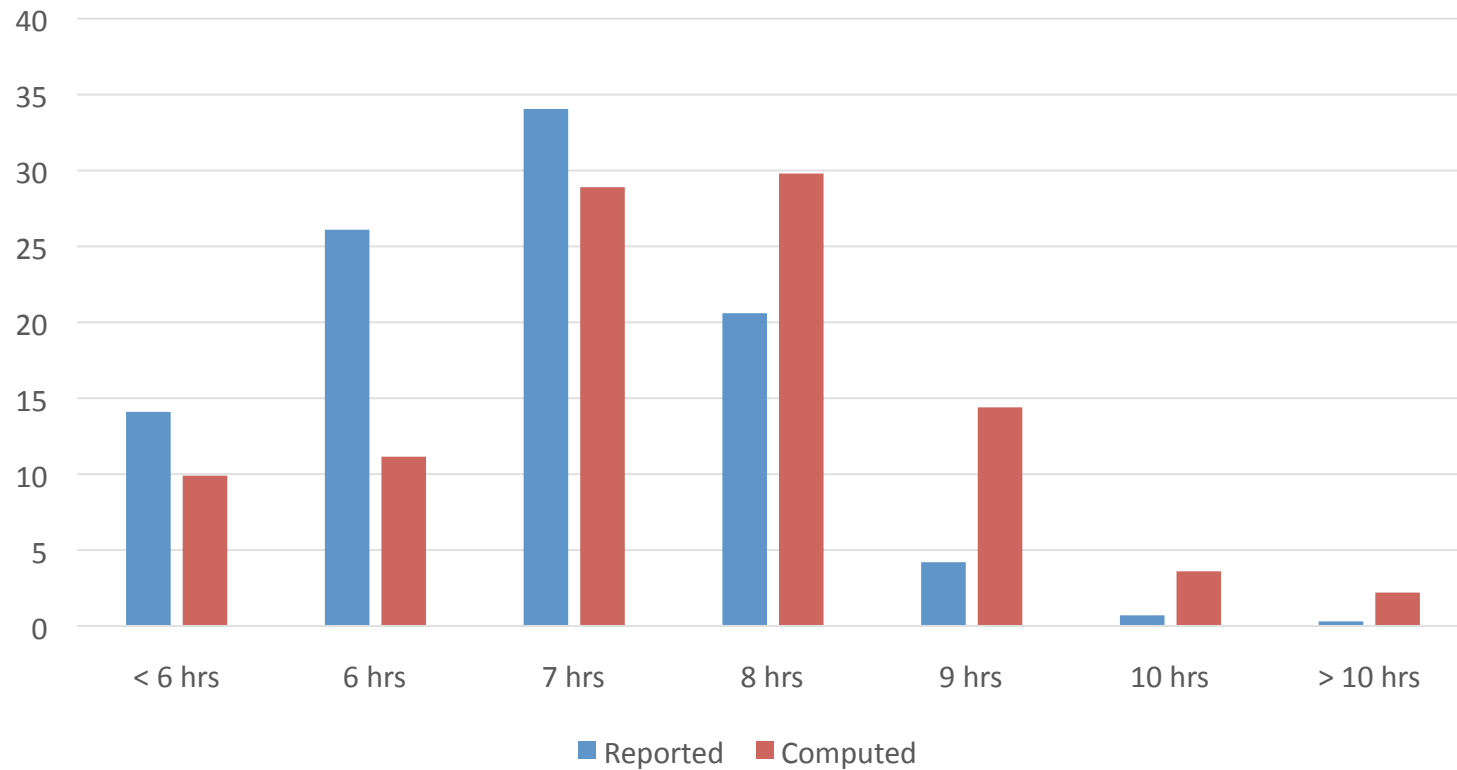
Correlation = 0.54



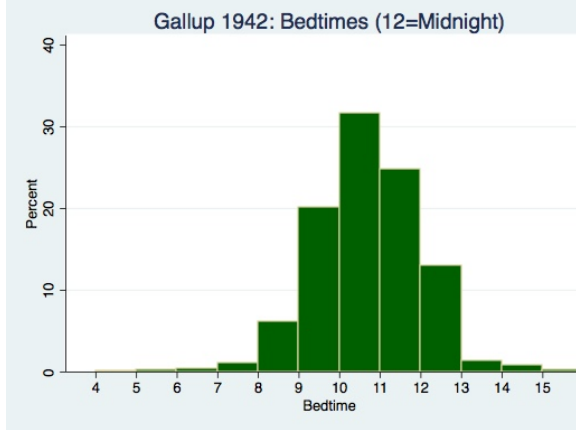
Reported and Computed Sleep Hours from Weekday NSF 2013

mean computed = 7.7 hours

mean reported = 6.8 hours



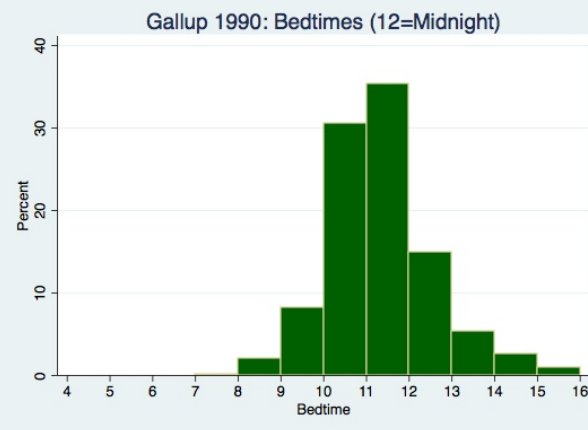
1942



Means

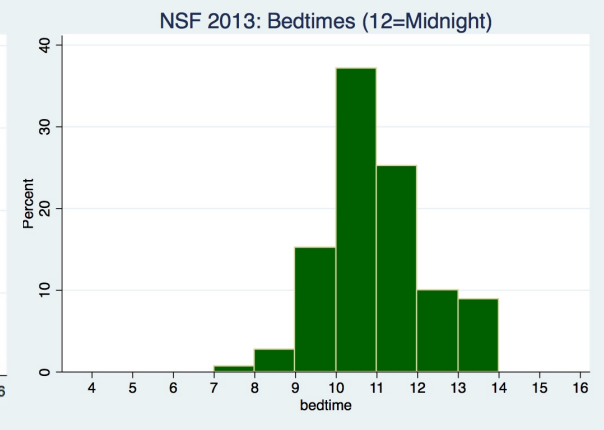
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1990

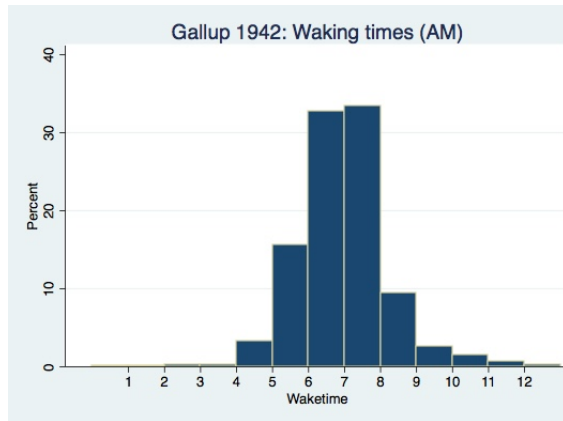


11:00

2013

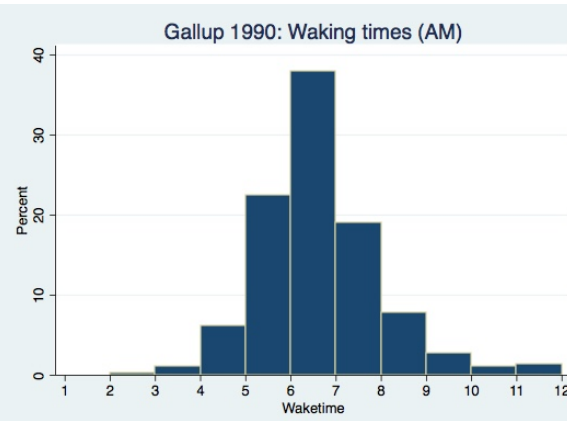


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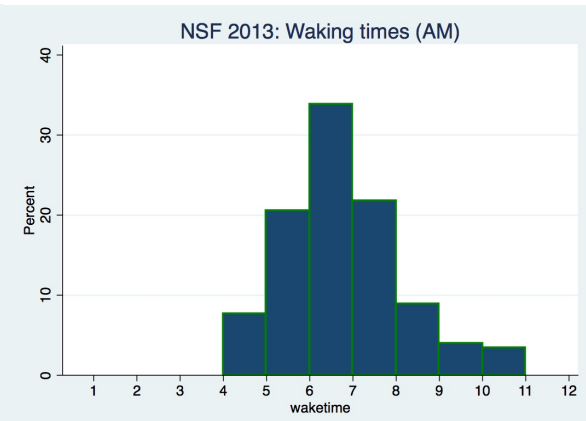


Means

6:40



6:20



6:30

Difference

8.2 hours

7.3 hours

7.7 hours



Adult Summary

- Since 1975, time diaries show no evidence of shorter mean sleep or more “short sleepers?”
- Surveys from 1942 to 2013 with questions about usual bedtime and wake time suggest a half hour decline in mean sleep, due to both later bedtime and earlier wake time.
- No evidence for the 1.5 hour decline since 1960 widely cited.



Adolescents

Principles and Practice of Sleep Medicine (Kryger, Roth, Dement) various editions:

“Unfortunately with each new wave of technological development, the priority society places on obtaining adequate sleep seems to lessen...For example, in 1913, 8- to 12- year-old schoolchildren slept an average of 10.5 h per night; by 1964, the average dropped to 9.2 h per night.”

Worldwide, children are sleeping about 1.2 hours less on school nights than a century ago².” Charles Czeisler, *Nature* 5/23/2013

² Matricciani, L., Olds, T. & Petkov, J. *Sleep Med. Rev.* 16, 203–211 (2012)



What are those studies?

Terman LM, Hocking A. The sleep of schoolchildren: its distribution according to age and its relation to physical and mental efficiency. J Educ Psychol 1913;4:138-147.

2693 students aged 6 to 20

6 small cities in California, Oregon and Arizona

The relevant averages : (9-10yrs) 10:13; (10-11 yrs) 9:56; (11-12 yrs) 10:00.

Thus the average for 9-12 year olds ~ 10 hours

The teachers were instructed: “On the day before the sleep records are to be collected say to the children, just before dismissal of school in the afternoon, that you would like to know how many hours they sleep. Tell them to look at the clock “tonight” just as they go to bed and to write down on a piece of paper the exact time. (Make it clear that they are to make the record just as soon as they look at the clock.) Tell them also to look at the clock again as soon as they wake up next morning ... This piece of paper they are to bring to school next day.”



1964 source

O'Connor AL. Questionnaire responses about sleep [master's thesis]. Gainesville, FL: University of Florida, 1964.

- “one elementary school, one high school, two men’s civic organizations, three women’s civic organizations and an old age home...”
- “The sample of this study was not chosen to be representative of any specified population.”
- Children were asked “How many hours do you usually sleep at night?” The average sleep is reported in age groups. For the youngest age group, 9-12 year olds (n=113), the average sleep was 9.3 hours.

Contrast is 10 to 9.3 hours (~40 minutes), not 10.5 to 9.2 hours (~80 minutes), but the question formats are a problem.



Self Report vs Time Diary

2002 wave of the Child Development Supplement of the PSID

24-hour time diaries collected from about 2000 children aged 10 to 19 for a randomly selected weeknight and weekend night.

Asked: “How many hours of sleep do you usually get at night?”

Time diary sleep averaged 8.8 hours weekday & 10.3 hours weekend, weighted average 9.2 hours

Single question averaged 8.0 hours

Correlation between the weighted average of the time diary days and self-reported sleep was 0.27

Knutson KL, Lauderdale DS. Sleep duration and overweight in adolescents: self-reported sleep hours versus time diaries. *Pediatrics*. 2007 May;119(5):e1056-62.



What can we compare: Terman (1913) & ATUS (2003-2014)

15-18 yr old HS students

TERMAN:

The amount of sleep for these 2692 persons is shown in hours and minutes in the following table:⁴

| Age. | No. of records. | Av. No. hours of sleep. | Age. | No. of records. | Av. No. of hours of sleep. | |
|------------|-----------------|-------------------------|---------------------|-----------------|----------------------------|-------------------------|
| 6-7 | 37 | 11:14 | 13-14..... | 250 | 9:31 | 15 year olds: 9.0 hours |
| 7-8 | 147 | 10:41 | 14-15..... | 244 | 9:06 | 16 year olds: 8.7 hours |
| 8-9 | 218 | 10:42 | 15-16..... | 201 | 8:54 | 17 year olds: 8.6 hours |
| 9-10..... | 291 | 10:13 | 16-17..... | 167 | 8:30 | 18 year olds: 8.8 hours |
| 10-11..... | 307 | 9:56 | 17-18..... | 117 | 8:46 | |
| 11-12..... | 282 | 10:00 | 18-19..... | 43 | 8:46 | |
| 12-13..... | 312 | 9:36 | University students | 51 | 7:47 | |



What can we compare: Terman (1913) & ATUS (2003-2014)

15-18 yr old HS students

TERMAN:

15 year olds: 9.0 hours

16 year olds: 8.7 hours

17 year olds: 8.6 hours

18 year olds: 8.8 hours

ATUS HS students the night before a school day

15 year olds: 8.6 hours

16 year olds: 8.5 hours

17 year olds: 8.3 hours

18 year olds: 8.4 hours

DIFFERENCES: 12-24 minutes

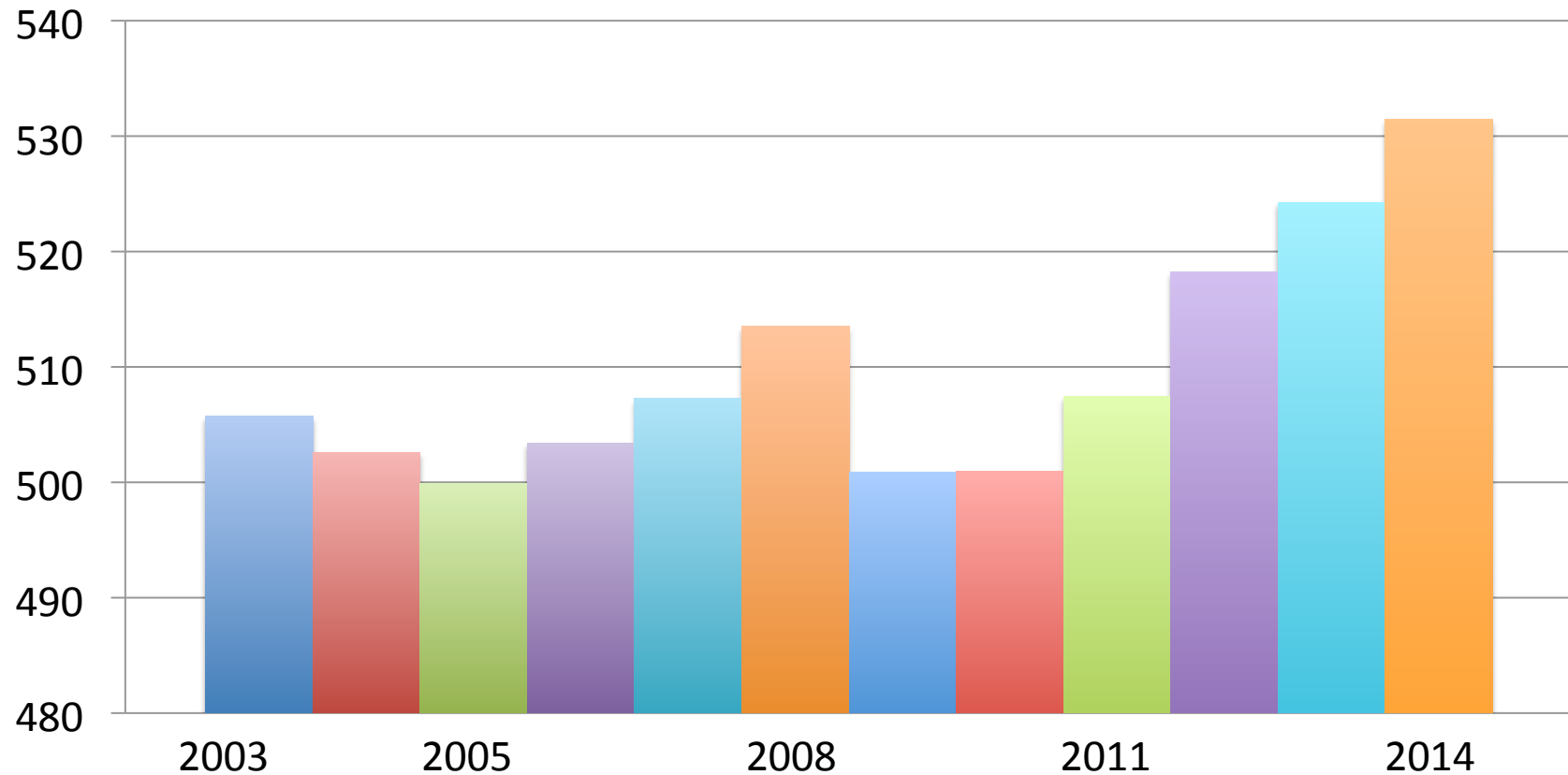


ATUS high school students with a school night time diary

| | | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | Total by gender, within age | Total by age, across all years |
|-----|---------------|------|------|------|------|------|------|------|------|------|------|------|------|--------------------------------|-----------------------------------|
| AGE | | | | | | | | | | | | | | | |
| | girls | 138 | 64 | 79 | 96 | 69 | 68 | 58 | 56 | 53 | 60 | 45 | 34 | 820 | 1673 |
| | 15 boys | 112 | 116 | 72 | 80 | 62 | 81 | 53 | 69 | 55 | 60 | 46 | 47 | 853 | |
| | girls | 159 | 107 | 78 | 113 | 93 | 85 | 94 | 93 | 88 | 61 | 68 | 60 | 1099 | 2239 |
| | 16 boys | 163 | 99 | 81 | 112 | 107 | 93 | 88 | 79 | 88 | 86 | 72 | 72 | 1140 | |
| | girls | 137 | 97 | 84 | 95 | 81 | 88 | 68 | 85 | 56 | 58 | 59 | 53 | 961 | 2026 |
| | 17 boys | 152 | 114 | 87 | 98 | 88 | 94 | 76 | 94 | 68 | 65 | 65 | 64 | 1065 | |
| | girls | 48 | 35 | 29 | 28 | 21 | 21 | 16 | 24 | 18 | 24 | 24 | 22 | 310 | 669 |
| | 18 boys | 62 | 25 | 32 | 24 | 28 | 26 | 33 | 30 | 29 | 27 | 20 | 23 | 359 | |
| | Total by year | 971 | 657 | 542 | 646 | 549 | 556 | 486 | 530 | 455 | 441 | 399 | 375 | Grand Total: | 6607 |



ATUS time trend mean sleep for 15-18 HS students on weeknights



High School Age Summary

- Over the past CENTURY, there may have been a 12-24 minute decrease in time in bed
 - Cannot adjust for differences in who is in high school
- From 2003 to 2014, the social media era, there is the suggestion of increased hours in bed.
 - Quality of sleep may have changed



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