Overview of epidemiology of sleep and obesity risk

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What is sleep?

- A natural, recurring state of inactivity associated with diminished responsiveness to the external environment that is rapidly reversible.

- Periods of sleep occur in all multicellular animals – even microscopic worms (nematodes).

 Credits to Bob Goldstein, UNC Chapel Hill
Why sleep?

- There is a homeostatic drive to sleep (if you don’t sleep, you become sleepy). This suggests it is important.

- With complete sleep deprivation, rats die in a few weeks.

- Potential explanations for sleep:
  - Rebuild brain energy stores
  - Memory and learning
  - Clearance of neural waste products
  - Physical restoration
How is sleep regulated?

- **Sleep drive is impacted by two forces:**
  - Homeostatic drive to sleep
    - the longer since last sleep, the sleepier you are
  - Circadian rhythm for alertness
    - Near 24-hour rhythm regulated by the circadian clock

- **The circadian clock keeps body processes and behaviors synchronized including:**
  - sleep
  - feeding
  - body temperature
  - hormone secretion (e.g., cortisol)
Sleep needs over the lifespan

- Newborns
- Infants
- Toddlers
- Preschoolers
- School age children
- Teenagers
- Younger adults
- Adults
- Older adults

Hours of sleep

National Sleep Foundation 2016
Sleep duration in adolescents

Youth Risk Behavior Surveys (sleep on school days)

<table>
<thead>
<tr>
<th>Year</th>
<th>≤ 7 hrs</th>
<th>≤ 4 hrs</th>
<th>5 hrs</th>
<th>6 hrs</th>
<th>7 hrs</th>
<th>8 hrs</th>
<th>≥ 9 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>69.0%</td>
<td>5.8%</td>
<td>10.0%</td>
<td>22.8%</td>
<td>30.4%</td>
<td>23.5%</td>
<td>7.4%</td>
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<tr>
<td>2009</td>
<td>69.1%</td>
<td>5.5%</td>
<td>10.1%</td>
<td>21.9%</td>
<td>31.6%</td>
<td>23.4%</td>
<td>7.5%</td>
</tr>
<tr>
<td>2011</td>
<td>68.6%</td>
<td>6.6%</td>
<td>10.8%</td>
<td>21.7%</td>
<td>29.6%</td>
<td>24.0%</td>
<td>7.4%</td>
</tr>
<tr>
<td>2013</td>
<td>68.4%</td>
<td>7.4%</td>
<td>11.3%</td>
<td>21.2%</td>
<td>28.5%</td>
<td>23.2%</td>
<td>8.4%</td>
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</tbody>
</table>

- **Prevalence of ≤ 7 hours by grade**
- **Prevalence of ≤ 7 hours by race**

MMWR 4/08/2016
# Childhood sleep trends over time

Zurich Longitudinal Study – parental report of sleep times

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Age 1</th>
<th>Age 3</th>
<th>Age 5</th>
<th>Age 10</th>
<th>Age 14</th>
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</thead>
<tbody>
<tr>
<td><strong>Bedtime</strong></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>1974-78</td>
<td>7:08 PM</td>
<td>7:35 PM</td>
<td>7:46 PM</td>
<td>8:45 PM</td>
<td>9:43 PM</td>
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<tr>
<td>1979-85</td>
<td>7:35 PM</td>
<td>7:53 PM</td>
<td>7:56 PM</td>
<td>8:50 PM</td>
<td>9:47 PM</td>
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<tr>
<td>1986-93</td>
<td>7:46 PM</td>
<td>8:07 PM</td>
<td>8:11 PM</td>
<td>8:59 PM</td>
<td>10:02 PM</td>
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<tr>
<td><strong>Wake time</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1974-78</td>
<td>7:16 AM</td>
<td>7:18 AM</td>
<td>7:16 AM</td>
<td>6:56 AM</td>
<td>6:41 AM</td>
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<tr>
<td>1979-85</td>
<td>7:34 AM</td>
<td>7:27 AM</td>
<td>7:17 AM</td>
<td>6:56 AM</td>
<td>6:39 AM</td>
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<tr>
<td>1986-93</td>
<td>7:19 AM</td>
<td>7:35 AM</td>
<td>7:20 AM</td>
<td>6:56 AM</td>
<td>6:30 AM</td>
</tr>
</tbody>
</table>

Iglowstein I et al. Pediatrics 2003
Prevalence of insufficient sleep in adults

- Behavioral Risk Factor Surveillance System (BRFSS) 2009
  - 35.3% adults report < 7 hours on average
- National Health and Nutrition Examination Survey (NHANES) 2005-2008
  - 37.1% adults report < 7 hours on average
Change in sleep duration over time

National Health Interview Survey 1985 and 2004

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
Predictors of short sleep in adults

- Demographics
  - African-American race
  - Male gender
  - Acculturation

- Neighborhood
  - Urban residence
  - Unsafe neighborhood
  - Long commuting time

- Work
  - Employment status
  - Long work hours
  - Adverse work shift

- Personal
  - Screen time
Distribution of poor sleep in US adults

Prevalence of reporting insufficient sleep on 30 of the previous 30 nights.

Behavioral Risk Factor Surveillance System 2008
Distribution of obesity in US adults

Behavioral Risk Factor Surveillance System 2015
Insufficient sleep and obesity

2008 BRFSS (N=384,541)

Means adjusted for race, age, education, smoking, recent physical activity, and frequent mental distress.

Wheaton AG et al. BMC Public Health 2011
Sleep duration and prospective weight gain

Nurses Health Study (N=68,183)

Other sleep domains

Proposed 5-dimension model of sleep health

- Satisfaction (sleep quality)
- Alertness (daytime sleepiness)
- Timing
- Efficiency (% of time in bed spent asleep)
- Duration

- Variability (in timing or duration) – likely reflects and/or impacts strength of circadian rhythms.
Other aspects of sleep associated with obesity

- Delayed timing of sleep
- Highly variable sleep patterns (including weekend catch-up)
- Daytime napping
- Shiftwork
- Poor quality, sleepiness

Obesity can impact sleep

- Sleep Apnea
- Arthritis
- Depression
- GERD
- Diabetes
- Asthma

Sleep Disruption
Obstructive sleep apnea (OSA)

Syndrome characterized by repetitive episodes of upper airway obstruction during sleep, associated with snoring, sleep fragmentation, and intermittent hypoxemia.

Credits to Habib M’henni / Wikimedia Commons
Effect of obesity on OSA

OSA prevalence by BMI quartile (N=5615)

Young T et al, Arch Intern Med 2002
**OSA risk by race**

All analyses adjusted for age, sex, site

Chen X et al, Sleep 2015
Obesity is an independent predictor of sleepiness

Relationship is independent of sleep apnea, depression, and diabetes.

Bixler EO et al, J Clin Endo Metab 2005
Conclusions

- Poor sleep and obesity are closely associated with bi-directional relationships.
- The epidemic in obesity has occurred contemporaneously with a reduction in sleep duration and quality.
- Racial minorities particularly blacks and Asians are at greater risk of poor sleep.
- Other important factors contributing to poor sleep include work/school requirements, place of residence, and screen time.