

# Letters

## RESEARCH LETTER

### Dose-Dependent Associations Between Sleep Duration and Unsafe Behaviors Among US High School Students

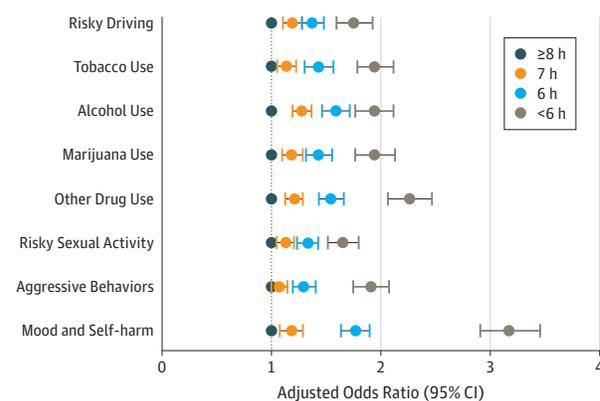
Youths in America are sleeping less than ever before. More than 70% of high school students average less than 8 hours of sleep,<sup>1</sup> falling short of the 8 to 10 hours that adolescents need for optimal health.<sup>2</sup> Insufficient sleep negatively affects learning and development and acutely alters judgment, particularly among youths.<sup>3</sup> We estimated associations between sleep duration and personal safety risk-taking behaviors in US high school students.

**Methods** | We used data from high school students who responded to the Youth Risk Behavior Survey between February 2007 and May 2015.<sup>4</sup> The Youth Risk Behavior Survey is administered biannually to a nationally representative sample of students of all ages enrolled in grades 9 to 12 at public and private schools. Sleep duration on an “average” school night was categorized as 8 hours or more, 7 hours, 6 hours, or less than 6 hours. Personal safety risk-taking behaviors were examined individually and as composite categories. We weighted all analyses to account for the complex survey design and controlled for age, sex, race/ethnicity, and year of survey in weighted logistic regression models to test the association between sleep duration and each outcome of interest. The study was exempt from institutional review board review, as this analysis used publicly available data without identifiable information and these activities are not considered human participants research. Data were originally collected with parental permission. Student participation was anonymous and voluntary.

**Results** | The data set included 67 615 surveys. Most participants (67 147 [99.3%]) were age 14 years or older. Approximately half were female (33 000 [48.8%]), most identified as white (39 457 [58.4%]), 12 349 (18.3%) identified as Hispanic or Latino, 9069 (13.4%) identified as black or African American, and 5520 (8.2%) identified as other race or ethnicity. Grade of school was approximately balanced: 9th grade students had the highest representation (18 396 [27.2%]) and 12th grade students had the lowest representation (15 291 [22.6%]). Each survey year contributed a similar amount of data (minimum, 12 039 [17.8%] and maximum, 14 992 [22.2%]).

Only 20 538 students (30.4%) reported 8 hours or more of sleep on an average school night. The proportion of students that reported less than 8 hours of sleep on an average school night increased from 68.9% (8370 of 12 154) in 2007 to 71.9% (10 448 of 14 534) in 2015. Shorter sleep duration was associated with increased odds of risk-taking behaviors in a dose-dependent manner (Figure), with fewer hours of sleep on an average school night associated with increased odds of all selected unsafe behaviors (Table). Compared with 8 hours or more of sleep,

Figure. Adjusted Association Between Sleep Duration and Risk-Taking Behaviors



Estimated odds ratios are from weighted logistic regression models adjusted for age, sex, race/ethnicity, and year of survey.

insufficient sleep increased the odds of risk-taking while driving (7 hours: odds ratio [OR], 1.19; 95% CI, 1.12-1.26; 6 hours: OR, 1.37; 95% CI, 1.29-1.46; and <6 hours: OR, 1.75; 95% CI, 1.61-1.91); use of alcohol (7 hours: OR, 1.28; 95% CI, 1.21-1.35; 6 hours: OR, 1.61; 95% CI, 1.50-1.74; and <6 hours: OR, 2.01; 95% CI, 1.84-2.19), tobacco (7 hours: OR, 1.13; 95% CI, 1.06-1.21; 6 hours: OR, 1.43; 95% CI, 1.32-1.55; and <6 hours: OR, 1.94; 95% CI, 1.80-2.10), and other drugs (7 hours: OR, 1.17; 95% CI, 1.10-1.25; 6 hours: OR, 1.51; 95% CI, 1.41-1.62; and <6 hours: OR, 2.34; 95% CI, 2.16-2.52); risky sexual activity (7 hours: OR, 1.12; 95% CI, 1.06-1.19; 6 hours: OR, 1.33; 95% CI, 1.25-1.41; and <6 hours: OR, 1.65; 95% CI, 1.53-1.78); and aggressive behaviors (7 hours: OR, 1.06; 95% CI, 1.00-1.13; 6 hours: OR, 1.29; 95% CI, 1.21-1.39; and <6 hours: OR, 1.91; 95% CI, 1.76-2.06). The strongest associations were with mood and self-harm (7 hours: OR, 1.18; 95% CI, 1.09-1.27; 6 hours: OR, 1.77; 95% CI, 1.65-1.88; and <6 hours: OR, 3.17; 95% CI, 2.92-3.44). Those who slept less than 6 hours were more than 3 times as likely as those who slept 8 hours or more to report considering suicide (OR, 3.12; 95% CI, 2.85-3.41), make a plan to attempt suicide (OR, 3.17; 95% CI, 2.87-3.51), or attempt suicide (OR, 3.39; 95% CI, 3.00-3.82) and more than 4 times as likely to report an attempted suicide that resulted in treatment (OR, 4.24; 95% CI, 3.53-5.10).

**Discussion** | We found significantly increased odds of reported unsafe behaviors among youths who reported insufficient sleep. These behaviors are common precursors to accidents and suicides, which are the leading causes of death among teens.<sup>5</sup> Insufficient sleep has pervasive consequences that may underlie adolescent public health concerns, including mental health, substance abuse, and motor vehicle crashes. Prior reports have documented that high school students who slept

Table. Prevalence of Each Risk-Taking Behavior in the Past 30 Days and Its Adjusted Association With Sleep Duration

| Risk-Taking Behavior                                       | Prevalence,<br>% (No./Total No.)<br>(N = 67 615) | Odds Ratio (95% CI)                      |  |   |
|--|--|--|--|---|
|  |  | 7 Hours<br>(20 266 [30.0%]) <sup>a</sup> | 6 Hours<br>(14 900 [22.0%]) <sup>a</sup> | <6 Hours<br>(11 912 [17.6%]) <sup>a</sup> |
| Risky driving  | 35.5 (24 001/67 550)                             | 1.19 (1.12-1.26)                         | 1.37 (1.29-1.46)                         | 1.75 (1.61-1.91) <sup>b</sup>             |
| Rarely or never wore a seat belt                           | 8.2 (5469/67 061)                                | 1.04 (0.93-1.18)                         | 1.56 (1.39-1.75)                         | 2.98 (2.65-3.34) <sup>b</sup>             |
| Texted or emailed while driving (among drivers)            | 41.7 (6756/16 220)                               | 1.30 (1.14-1.49)                         | 1.32 (1.17-1.49)                         | 1.29 (1.12-1.50) <sup>b</sup>             |
| Rode with a driver who had been drinking alcohol           | 24.6 (16 601/67 401)                             | 1.19 (1.12-1.26)                         | 1.41 (1.31-1.51)                         | 1.79 (1.66-1.93) <sup>b</sup>             |
| Drove after drinking alcohol (among drivers)               | 8.8 (1409/15 987)                                | 1.04 (0.84-1.30)                         | 1.27 (1.03-1.56)                         | 1.98 (1.62-2.42) <sup>b</sup>             |
| Tobacco use  | 26.6 (17 953/67 463)                             | 1.13 (1.06-1.21)                         | 1.43 (1.32-1.55)                         | 1.94 (1.80-2.10) <sup>b</sup>             |
| Alcohol use  | 38.9 (24 261/62 291)                             | 1.28 (1.21-1.35)                         | 1.61 (1.50-1.74)                         | 2.01 (1.84-2.19) <sup>b</sup>             |
| Marijuana use  | 21.9 (14 571/66 610)                             | 1.18 (1.11-1.27)                         | 1.43 (1.33-1.54)                         | 1.94 (1.78-2.11) <sup>b</sup>             |
| Other drug use <sup>c</sup>                                | 24.9 (16 420/65 977)                             | 1.17 (1.10-1.25)                         | 1.51 (1.41-1.62)                         | 2.34 (2.16-2.52) <sup>b</sup>             |
| Risky sexual activity                                      | 37.0 (23 805/64 309)                             | 1.12 (1.06-1.19)                         | 1.33 (1.25-1.41)                         | 1.65 (1.53-1.78) <sup>b</sup>             |
| Currently sexually active                                  | 33.4 (21 452/64 170)                             | 1.11 (1.05-1.19)                         | 1.30 (1.23-1.38)                         | 1.59 (1.48-1.71) <sup>b</sup>             |
| Sexually active, have used alcohol or drugs before sex     | 21.9 (4672/21 369)                               | 1.04 (0.92-1.18)                         | 1.17 (1.04-1.32)                         | 1.91 (1.69-2.17) <sup>b</sup>             |
| Sexually active, withdrawal method of birth control        | 5.1 (3191/63 029)                                | 1.15 (1.00-1.33)                         | 1.63 (1.44-1.85)                         | 1.85 (1.61-2.14) <sup>b</sup>             |
| Sexually active, no method of birth control                | 5.8 (3644/63 029)                                | 1.04 (0.91-1.19)                         | 1.31 (1.15-1.49)                         | 1.94 (1.72-2.19) <sup>b</sup>             |
| History of sexual intercourse with ≥4 persons <sup>d</sup> | 13.9 (8930/64 083)                               | 1.03 (0.95-1.11)                         | 1.32 (1.21-1.45)                         | 1.99 (1.81-2.20) <sup>b</sup>             |
| Aggressive behaviors                                       | 36.1 (24 367/67 561)                             | 1.06 (1.00-1.13)                         | 1.29 (1.21-1.39)                         | 1.91 (1.76-2.06) <sup>b</sup>             |
| Carried a weapon   | 17.3 (11 370/65 909)                             | 0.96 (0.89-1.04)                         | 1.16 (1.06-1.26)                         | 1.95 (1.77-2.14) <sup>b</sup>             |
| Carried a gun  | 5.3 (3493/65 506)                                | 0.79 (0.68-0.92)                         | 1.03 (0.89-1.18)                         | 1.73 (1.54-1.96) <sup>b</sup>             |
| In physical fight  | 29.1 (19 220/66 158)                             | 1.09 (1.03-1.16)                         | 1.37 (1.28-1.46)                         | 1.97 (1.81-2.15) <sup>b</sup>             |
| Mood and self-harm   | 34.3 (23 106/67 419)                             | 1.18 (1.09-1.27)                         | 1.77 (1.65-1.88)                         | 3.17 (2.92-3.44) <sup>b</sup>             |
| Felt sad or hopeless                                       | 28.5 (19 150/67 274)                             | 1.16 (1.07-1.25)                         | 1.74 (1.62-1.86)                         | 3.11 (2.87-3.37) <sup>b</sup>             |
| Seriously considered suicide                               | 15.9 (10 670/67 235)                             | 1.15 (1.05-1.26)                         | 1.73 (1.58-1.89)                         | 3.12 (2.85-3.41) <sup>b</sup>             |
| Made plan about how to attempt suicide                     | 12.6 (8459/66 942)                               | 1.10 (1.01-1.21)                         | 1.63 (1.50-1.77)                         | 3.17 (2.87-3.51) <sup>b</sup>             |
| Attempted suicide  | 7.4 (4524/61 435)                                | 0.98 (0.87-1.10)                         | 1.48 (1.31-1.68)                         | 3.39 (3.00-3.82) <sup>b</sup>             |
| Attempted suicide and required treatment                   | 2.3 (1367/60 462)                                | 1.05 (0.85-1.30)                         | 1.29 (1.05-1.58)                         | 4.24 (3.53-5.10) <sup>b</sup>             |

<sup>a</sup> Participants reporting 8 hours or more of sleep (n = 20 538 [30.4%]) are the referent category for all comparisons.

<sup>b</sup> P < .001.

<sup>c</sup> Reported ever using cocaine, inhalants, heroin, methamphetamines, ecstasy,

synthetic marijuana, steroids without a prescription, prescription drugs without a prescription, or injecting an illegal drug.

<sup>d</sup> Lifetime history.

less than 8 hours were at increased risk of adverse health behaviors.<sup>6</sup> Our study adds to this literature by using a larger, updated data set collected during an 8-year interval; by incorporating more granular sleep information; and by examining a wider array of risk-taking behaviors. The data were collected via self-report and may be subject to social desirability and recall bias. The cross-sectional design precludes examination of a bidirectional association, which may exist for some behaviors. We controlled for multiple potential confounders, but residual confounding may persist owing to imprecise or unmeasured confounders.

These data have important implications for the health and safety of high school students nationally. We observed a significant burden of insufficient sleep and a consistent dose-dependent association between sleep duration and unsafe behaviors. Future efforts should seek to promote healthy sleep habits and remove barriers to sufficient sleep in this vulnerable population.

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## Association Between Unintentional Child Injury in the Home and Parental Implementation of Modifications for Safety

Medical attention for an injury can increase parents' perception of their child's susceptibility to injury.<sup>1</sup> Understanding subsequent parental actions to avert future injuries can inform prevention efforts. In this study, we describe the injured body part and parents' reports of (1) the cause of the injury, (2) what could have prevented it, and (3) changes made afterward.

**Methods |** We reviewed medical records of pediatric emergency department patients who sought care for an unintentional home injury between January 1 and December 31, 2012, and contacted the parents for a home interview. The medical record review provided details about the injury and the child's age and sex. The parental interview, which was audiorecorded and transcribed, provided parents' responses to the following: (1) Please describe how your child got injured. (2) Do you think there is anything that could have prevented the injury? If so, what? (3) Have you done anything to change the area of the home where the child was injured? If so, what?

Home interviews were conducted on average 27 days (range, 5-57 days) after the pediatric emergency department visit. A codebook of parental responses was generated and

**Table 1. Body Part and Injury Mechanism for 123 Injuries in 104 Children Injured in Their Homes**

| Injury Mechanism          | Body Part               |              |                   |               | Total, No. (%) (N = 123) <sup>a</sup> |
|---------------------------|-------------------------|--------------|-------------------|---------------|---------------------------------------|
|                           | Head/Neck/Face (n = 76) | Leg (n = 17) | Arm/Hand (n = 23) | Other (n = 7) |                                       |
| Fall                      | 44                      | 3            | 8                 | 2             | 57 (46.3)                             |
| Cut/pierce                | 13                      | 6            | 7                 | 0             | 26 (21.1)                             |
| Burn                      | 6                       | 5            | 6                 | 3             | 20 (16.3)                             |
| Struck by/against         | 13                      | 3            | 2                 | 0             | 18 (14.6)                             |
| Carbon monoxide poisoning | 0                       | 0            | 0                 | 2             | 2 (1.6)                               |

<sup>a</sup> Missing 3 participants, who contributed 5 injury mechanisms (3 falls and 2 cut/pierce).

analyzed to yield the following groups of codes: (1) body part injured (head/neck/face, leg, arm/hand, or other), (2) injury mechanism (fall, cut/pierce, burn, struck by/against, or carbon monoxide poisoning), (3) item(s) involved (toys, furnishings, house features, food/beverage, or other), (4) parents' perception of preventability (child behavior, adult supervision, or safer environment), and (5) changes made (increased supervision, got rid of/replaced item, or safer environment (restricted access to dangerous item)).

We tallied the code groups and arranged cross-tabulations of injury mechanisms and body parts. At recruitment, we obtained written parental informed consent per approval by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board.

**Results |** One hundred four children (42 female and 62 male) aged 6 months to 7 years (mean [SD] age, 2.9 [1.8] years) who were predominantly of black race/ethnicity (84 [80.8%]) experienced 123 injuries. One injury mechanism was associated with 109 of 123 injuries (88.6%), while 2 injury mechanisms were associated with 14 of 123 injuries (11.3%). The most common injury mechanism was a fall (57 of 123 [46.3%]), and the most common body part injured was the head/neck/face (76 of 123 [61.8%]) (Table 1). Most children (99 of 104 [95.2%]) had 1 injured body part, whereas 5 of 104 children (4.8%) had 2 injured body parts.

In all but 2 cases, an item was identified as contributing to the injury: 42 of 120 (35.0%) involved house features, 40 of 120 (33.3%) involved furnishings, 13 of 120 (10.8%) involved food/beverage, and 10 of 120 (8.3%) involved toys (Table 2). Parents, who were mostly female (96 of 104 [92.3%]) and high school graduates (78 of 104 [78.8%]), identified at least 1 prevention strategy (86 of 104 [82.7%]). Of the 110 suggestions, 44 (40.0%) were to create a safer environment (eg, store hazardous products), 34 (3.9%) were to modify child behavior (eg, implement new rules), and 32 (29.1%) were to provide increased adult supervision. Fifty-nine of 104 parents (56.7%) reported making changes: 53 of 104 (50.9%) modified the environment, 22 of 104 (21.2%) got rid of/replaced items, and 8 of 104 (7.7%) increased supervision.

**Discussion |** This study explored how parents changed their homes after a medically attended unintentional injury to prevent reoccurrence. Most parents identified a prevention