CALCULATING

the Cost of Poor Sleep ~ Methodology

NSC FATIGUE Cost Calculator

Executive Summary

Sleep deficiency is a hidden cost of our technology-driven, 24/7 society. Approximately 70% of Americans report that they routinely get insufficient sleep.[1] The issue is pervasive in the workforce, with 30% of U.S. workers and 44% of night shift workers reporting less than six hours of sleep on average.[2] In addition, undiagnosed and untreated sleep disorders are common. The Institute of Medicine estimates that 50–70 million people in the U.S. are living with a sleep disorder.[3]

The Brigham and Women's Hospital Sleep Matters Initiative and the National Safety Council have developed an online fatigue cost calculator that estimates the cost of sleep deficiency for individual businesses. The cost calculator asks users to enter their workforce size, industry and location. This information is used to predict the prevalence of sleep deficiency and common sleep disorders among employees. The calculator draws from peer-reviewed scientific literature to further estimate costs associated with these conditions. Costs of sleep health education and sleep disorder screening programs are factored in to estimate the economic impact of improving employees' sleep health.

This tool can be used to communicate the economic costs of sleep deficiency to employers, and to estimate the potential return on investment of implementing an evidence-based program which seeks to improve sleep health and workplace safety, health and performance.

Sleep disorders are common, but they are usually undiagnosed and untreated. Reduced alertness as a result of sleep deficiency or untreated sleep disorders contributes to:

- **Missed days of work**
- **Diminished performance and lower workplace productivity**
- **Increased health care expenditures for illnesses and treatment of multiple associated health conditions**
- **Workplace accidents and occupational injuries**
- **Motor vehicle crashes**

These outcomes can result in substantial costs to employers.

Insomnia is estimated to cost U.S. businesses more than $63 billion in absenteeism and reduced workplace productivity,[4] with accidents and occupational injuries adding up to $31 billion lost annually.[5] Undiagnosed obstructive sleep apnea (OSA) has been estimated to cost $150 billion each year.[6] Collectively, costs attributable to sleep deficiency in the U.S. exceeded $410 billion in 2015, equivalent to 2.28% of gross domestic product.[7]

Why Sleep Matters

Sleep deficiency is a hidden cost of our tech-driven 24/7 society, with 70% of Americans admitting that they routinely get insufficient sleep.[1] The issue deeply affects our workforce, as 30% of U.S. workers and 44% of night shift workers report sleeping less than six hours per night.[2]

Undiagnosed and untreated sleep disorders are associated with poor health outcomes for employees, and they generate substantial costs for employers. An estimated 50–70 million people have a sleep disorder.[3] The Institute of Medicine recognized the health and safety consequences of sleep deficiency and labeled the issue "an unmet public health problem," arguing that 20% of serious crash injuries and hundreds of billions of dollars in medical costs each year can be attributed to sleep deficiency.[3]

Diminished alertness is often caused by sleep deficiency and undiagnosed and untreated sleep disorders. This results in substantial direct and indirect costs due to:

- **Absenteeism** (missed hours of work)
- **Presenteeism** (diminished actual work performance relative to potential performance)
- **Health care expenditures for illness and treatment of associated health conditions**
- **Workplace accidents and occupational injuries**
- **Commute-related motor vehicle crashes**

Economic Impact

Insomnia may be responsible for over $63 billion in absenteeism and presenteeism,[4] and accidents and errors by people suffering from insomnia may result in an additional $31 billion lost annually.[5] A recent report estimates that undiagnosed sleep apnea in the U.S. costs society $150 billion each year.[6] The RAND Corporation has estimated that collectively, costs attributable to sleep deficiency in the U.S. exceeded $410 billion dollars in 2015, equivalent to 2.28% of gross domestic product.[7]

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Calculating Employers' Cost of Sleep Deficiency

The Brigham and Women's Hospital Sleep Matters Initiative and the National Safety Council have produced a fatigue cost calculator that estimates the economic costs of sleep deficiency for employers. Information about the employer's location, workforce size and industry are entered into the calculator to estimate sleep deficiency and likelihood of common sleep disorders among employees.

NSC FATIGUE Cost Calculator

The calculator also shows employers how they can mitigate the costs of fatigue by implementing an effective fatigue risk management program.

BRIGHAM HEALTH

BWH BRIGHAM AND WOMEN'S Sleep Matters Initiative

About the Sleep Matters Initiative

The mission of the Sleep Matters Initiative, led by investigators from Brigham and Women's Hospital and Harvard Medical School, is to foster excellence in the treatment of sleep and circadian disorders in order to improve health, safety, and performance; and to promote widespread change in social norms that will engender a culture of sleep health.

Fatigue Cost Calculator Design Methodology

The calculator uses a complex algorithm based on information and data from peer-reviewed scientific literature. The literature review determined what contributors to fatigue were important enough to include, how to measure them, and how to determine estimated costs associated with these conditions.

How the Inputs are Used to Calculate Fatigue Costs

The cost calculator requires three pieces of information:

1. **workforce size,**
2. **industry or occupation, and**
3. **workforce geographic location.**

Workforce size

Workforce size is converted into an estimated count of employees who are affected by sleep deficiency or sleep disorders. This count is further incorporated in estimates of costs.

Industry description

Industry description is is used to characterize gender, salary, and scheduling practices in the workforce. The Bureau of Labor Statistics (BLS) provides information on the distribution of employed men and women in each industry, and this information is used to calculate the expected prevalence of each common sleep disorder. Industry-specific salary information, also obtained from the BLS, informs the costs attributable to workforce absenteeism and presenteeism. Scheduling practices are also important considerations in the calculation of fatigue-related costs. Information on the proportion of employees that worked night shifts, rotating shifts, or between midnight and 6 a.m. was obtained from the BLS and the American Time Use Survey (ATUS, a survey of U.S. adults that is conducted by the U.S. Census Bureau[8]). See Table 1. The ATUS collects information annually on the type, timing and duration of activities of daily life, including work. The fatigue calculator uses the ATUS Table A-4A, which is a combined average of responses from 2011–2015.[9] The shiftwork characteristics collected through The BLS and the ATUS are used to adjust the prevalence of sleep disorders and sleep deficiency among shift workers.

Geographic location

Geographic location of the workforce links to state-level data from the 2014 Behavioral Risk Factor Surveillance System (BRFSS), a state-based telephone survey of health-related behaviors conducted annually in the U.S.[10] See Table 2. The fatigue calculator uses this data to estimate the prevalence of sleep deficiency across states. If multiple states are selected, national estimates of sleep deficiency are applied.

Prevalence of Sleep Deficiency and Common Sleep Disorders

Sleep deficiency

Adults require seven or more hours of sleep per night, but more than a third of Americans do not get enough sleep.[11] Overall, 30% of civilian employed U.S. adults (approximately 40.6 million workers) report an average sleep duration of less than six hours per day. Sleep duration is influenced by many factors, including social norms and interactions, as well as characteristics of the local or regional environment. As a result, there is substantial geographic variation in sleep deficiency. In particular, sleep deficiency is more common in the Appalachian region of the U.S. and less common in other areas such as Wisconsin.[12]

State-wide data on sleep duration was obtained from the 2014 BRFSS dataset. Using the location of the business, the calculator estimates the proportion of the workforce that sleeps less than six hours a night and the proportion that sleeps between six and seven hours a night. The cumulative proportion that sleeps less than seven hours a night is the proportion of the workforce that is considered to be sleep deficient.

Sleep deficiency is more common among night shift workers than the general worker population. Responses from the National Health Interview Survey suggest that 44% of night shift workers get less than six hours of sleep every 24 hours.[13] The calculator incorporates an adjustment to the geographic prevalence of sleep deficiency among night shift workers by projecting a 44% prevalence of sleeping less than six hours among the subset of the workforce who engages in night shift work.

34.8% of Americans are sleep deficient

Obstructive sleep apnea

Obstructive sleep apnea (OSA) occurs when a person's airway becomes partially or completely blocked many times during sleep. This results in poor-quality sleep because the individual must repeatedly wake up to reopen the airway. Therefore, people with OSA do not get sufficient quantity or quality of sleep, resulting in sleepiness and/or fatigue. Because OSA sufferers typically do not gain full consciousness when they wake after episodes of not breathing, they often do not know the cause of their sleepiness and/or fatigue. The impact on health is significant. OSA is associated with increased risk of diabetes,[14] hypertension,[15,16] cardiovascular disease,[15-22] stroke,[23-25] myocardial infarction[26] and death.[24,27]

The severity of OSA is characterized by the number of times breathing is stopped during sleep, as well as the duration of time the airway is blocked. Individuals with mild OSA average between five and 15 events per hour. Mild OSA affects 34% of men and 17% of women. Moderate to severe OSA (more than 15 events per hour) affects 13% of men and 6% of women.[28] The risk of OSA is increased among those who are obese, overweight or have a neck/collar size above 17 inches.[29] The calculator assumes a 13% prevalence of OSA among men in the workforce and 6% prevalence among women. These percentages should be considered conservative. Individuals with mild OSA have not been included in our estimates, although they often experience sleepiness and work-related impairment as well.

OSA prevalence is moderate-severe in 13% of men and 6% of women; mild in 34% of men and 17% of women

Insomnia

Chronic insomnia is the recurring experience of not being able to fall asleep, waking up frequently after falling asleep, or the inability to fall back to sleep, resulting in a reduction in daytime performance. Individuals with insomnia do not feel refreshed upon awakening and are often tired during the day, with diminished mental and physical performance.[30] Additionally, they are at increased risk for depression, lower quality of life, other medical conditions, and even death.[31]

Approximately 10% of the general population reports chronic insomnia symptoms that result in daytime consequences.[32]

Women are more likely to experience insomnia symptoms, and the prevalence of insomnia increases with age.[33] The calculator assigns a 12% prevalence of insomnia to women and an 8% prevalence of insomnia among men.

More than 20% of workers are engaged in shift work, defined as work outside of standard daylight hours. Shift workers are at increased risk of insomnia. According to a National Sleep Foundation poll, 61% of shift workers experience insomnia, and approximately one-third suffer from sleepiness during the day.[34] The ATUS provides data on the proportion of workers in each industry that work night or rotating shifts. The calculator links the chosen industry to these data and classifies that proportion of the workforce as shift workers. In cases where an industry does utilize shiftwork, the calculator estimates a 33% prevalence of insomnia among that subset of the workforce, regardless of gender.

8% of men and 12% of women suffer from insomnia

Restless Legs Syndrome

Restless legs syndrome (RLS) is a condition where sufferers experience uncomfortable sensations in their legs at night when they are attempting to fall asleep. The discomfort is improved by movement of the legs. In severe cases, the symptoms will be present during the day when sitting, and also may involve the arms. RLS occurs to some degree in approximately 10% of the population. Prevalence increases with age and is more common among women.[35,36] The calculator predicts RLS among 9% of women and 5% of men in the workforce.

Shift work sleep disorder

Shift work sleep disorder (SWD) occurs when the body's internal clock becomes misaligned with the sleep-wake schedule because of shift work. Symptoms of SWD include excessive sleepiness during night work and/or insomnia during daytime sleep. The risk for SWD is higher with frequent overnight shifts or a rotating shift work schedule. The calculator estimates a conservative 10% prevalence of SWD among of the proportion of the workforce that is scheduled to work night or rotating shifts.[37]

The Economic Impact of Sleep Deficiency and Common Sleep Disorders

Absenteeism

The Centers for Disease Control and Prevention (CDC) and the International Monetary Fund estimate that lost productivity due to absenteeism costs over $225 billion annually in the U.S., with employers sustaining annual costs of approximately $1,685 per employee.[38] Rates of absenteeism are influenced by physical and mental health, occupational demands, stress, age, and importantly, sleep health.

Insomnia has been identified as a leading cause of workplace productivity loss. The estimated costs attributable to insomnia vary by study.[39] This calculator incorporates a conservative estimate using data from self-insured, employer-sponsored health insurance plans in the U.S.[40] Researchers estimated that individuals with insomnia cost employers an additional $405 in absenteeism over a six-month study interval. Projecting this estimate to a 12-month interval and adjusting for inflation (conversion to June 2017 dollars was performed using the Consumer Price Index Inflation Calculator at https://www.bls.gov/data/inflation_calculator.htm), it is estimated that each individual with insomnia costs employers $985 each year in absenteeism. While much of the research in this area has focused on insomnia, absenteeism is also increased among those with OSA.[41] Our definitions for both insomnia and OSA also entail daytime sleepiness or dysfunction, which is believed to be a driver of absenteeism and presenteeism. For this reason, the calculator incorporates the same absenteeism costs for both insomnia and OSA.

The rate of absenteeism is further increased by 202% among those who work at night.[42] Assuming annual costs of absenteeism of $1,685 per typical employee as estimated by the CDC, a 202% relative increase would be $3,404 per year, or an excess of $1,719. The fatigue calculator links industry categories to the ATUS estimates of the proportion of the workforce that regularly works between midnight and 6 a.m., and allocates an additional $1,719 in annual absenteeism cost to each employee in this subset.

In order to estimate the collective cost of absenteeism attributable to sleep deficiency and common sleep disorders,

the number of employees estimated to have insomnia or OSA is multiplied by $985, and the number of employees who regularly work between midnight and 6 a.m. by $1,719, then the totals are summed.

Presenteeism or decreased productivity

The difference between a person's actual performance at work and possible performance is considered lost productivity, or presenteeism. The cost of this deficit can be estimated using employees' compensation. In 2003, the American Productivity Audit estimated that lost productive time cost U.S. employers $225.8 billion, the equivalent of $300 billion in 2017 after adjusting for inflation.[43] Common health-related reasons for lost productivity included depression, anxiety, pain, and headache. Subsequent research has revealed that fatigue-related performance deficits as a result of sleep deficiency or sleep disorders are important primary and intermediate sources that directly contribute to lost productivity as well as contribute to mental and physical health complaints, such as pain and mood disorders.[44]

The American Insomnia Survey sought to quantify the costs of insomnia in the U.S. workforce by surveying a representative subsample of members of a national health insurance plan.[4] The study was designed to result in nationally representative estimates. The survey concluded that $59.8 billion was being lost as a result of decreased productivity due to insomnia, a sum that would be worth $66.8 billion in 2017 dollars. Individuals with insomnia were estimated to cost business an excess of 11.3 workdays each year in presenteeism (7.8 days after adjusting for comorbid conditions, which are commonly found along with sleep disorders). Using national average wage information in June 2017 dollars, each person with insomnia would be expected to be responsible for approximately $2,548 in lost productivity costs each year.[4]

Presenteeism is not limited to those with sleep disorders. Insufficient sleep leads to fatigue and daytime sleepiness, often resulting in decreased productivity in the workplace. The RAND Corporation estimates that individuals who sleep less than six hours each night on average lose six full work days of productivity each year, while those who sleep six to seven hours on average lose 3.7 work days annually compared to workers who obtain sufficient sleep.[45]

Total presenteeism costs are calculated by first multiplying the median hourly wage for each occupation by eight hours and adding 30% to account for the employer's fringe benefit costs. In 2015, the mean annual wage was $46,120, while the median wage was $29,930.46 Our use of the median represents a conservative estimate of daily costs. This daily cost is then multiplied by 7.8 days (consistent with the American Insomnia Survey findings) for the number of employees in the workforce expected to have insomnia or OSA. The rationale for including both insomnia and OSA in this calculation is the same as discussed previously. Presenteeism costs associated with sleep deficiency follow a similar pattern. The number of employees in the workforce who are estimated to sleep between six and seven hours is multiplied by their daily cost for 3.7 workdays, while those expected to sleep less than six hours each night are multiplied by the cost of six work days. The cumulative cost from all sources is the annual total cost of presenteeism used in the calculator.

Health care costs

Although short-term bouts of insomnia contribute to absenteeism and presenteeism through fatigue-related performance decreases,[47,48] there are tangible chronic health consequences as well. Insomnia has been associated with fatigue, depression, and significantly diminished quality of life.[30,49] Persistent long-term insomnia has been associated with mortality.[31] As discussed earlier, OSA is associated with increased risk of diabetes,[14] hypertension,[15,16] cardiovascular disease,[15-22] stroke, [23-25] myocardial infarction, [26] and all-cause mortality.[24,27]

A study of self-insured, employer-sponsored health insurance plans in the U.S. was used to estimate increased health care costs associated with insomnia.[40] Individuals with insomnia accounted for excess healthcare expenditures of $924 over the six-month study period, or $1,848 annually. After adjustment for inflation, we expect that individuals with insomnia generate $2,246 in excess healthcare costs annually.

Individuals with untreated OSA have increased health care expenditures relative to similar individuals who do not have OSA. The magnitude of the incremental increase varies. A recent review collected relevant studies and estimated the incremental increase in cost to be between $1,950 and $3,899 in 2015 dollars.[50-53] In order to use one fixed cost

as the assumption for this calculator, the midpoint between these values ($2,924) was used and adjusted for inflation. This approach suggests that individuals with OSA conservatively account for $3,001 in excess healthcare costs each year.

The calculator projects total healthcare costs by multiplying the number of employees with insomnia by $2,246 and employees with OSA by $3,001 before summing the totals.

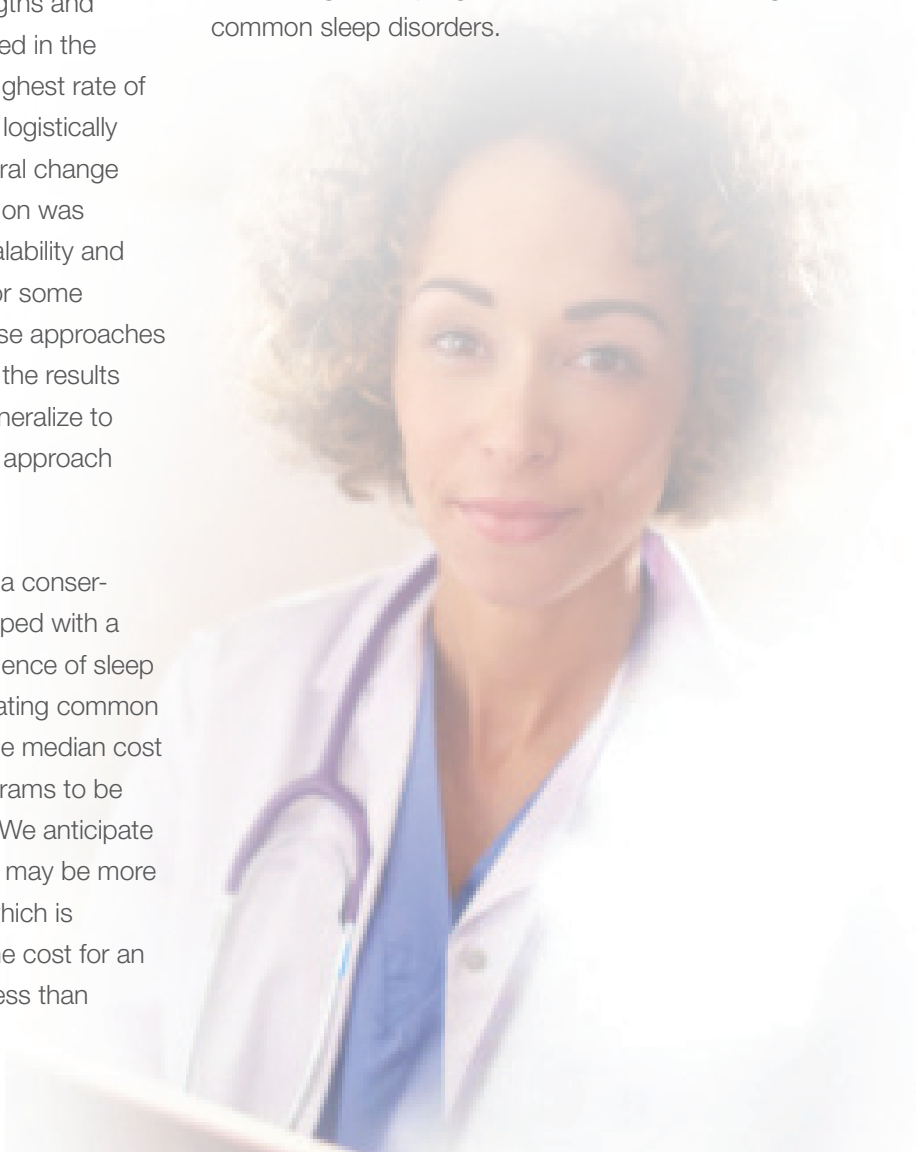
Improving performance, health and savings

Occupationally based sleep health education and sleep disorder screening programs have been shown to reduce fatigue costs by improving the sleep, performance, health and safety of the workforce.[54] These programs are often delivered through either in-person expert-led sessions, a train-the-trainer type model or online. These approaches were compared in a sample of eight fire departments, and while all approaches had positive results, each approach had strengths and weaknesses.[55] The expert-led approach resulted in the greatest improvement in knowledge and the highest rate of clinical evaluation when indicated, but may be logistically difficult and costly. Reports of positive behavioral change were common across all modalities. Participation was generally lower in the online group, but the scalability and expense for this approach may be favorable for some employers. The costs and effectiveness of these approaches would be expected to vary by workplace, and the results from the study of fire departments may not generalize to other settings. Employers should consider the approach that would most benefit their own workforce.

The savings section of the calculator provides a conservative estimate of the costs that may be recouped with a program that is effective at reducing the prevalence of sleep deficiency and identifying, diagnosing, and treating common sleep disorders. We conservatively estimate the median cost of expert-led, train-the-trainer, and online programs to be $20,000, with an additional $5 per employee. We anticipate that businesses with less than 100 employees may be more likely to choose the online education option, which is estimated at $8,000 plus $5 per employee. The cost for an online program is applied to businesses with less than 100 employees.

The calculation starts by dividing the prevalence of sleep deficiency, insomnia, and OSA by the total cost of each to produce an average cost per employee. The savings are calculated by determining the costs on a per-person level, and then computing the impact of reducing the number of persons affected on a sliding scale from 100% to 0%. A program that is 50% effective would lead to treatment for 50% of employees with insomnia or OSA. A 50% effective program would also be expected to lead to sufficient sleep duration among 50% of those who sleep less than seven hours each night. The costs of implementing the program are automatically subtracted from the potential savings.

This online fatigue cost calculator conservatively projects the costs borne by employers as a result of sleep deficiency and common sleep disorders in the workforce. It helps employers see the potential return on investment that could be expected from implementing an effective fatigue risk management program that includes screening for common sleep disorders.



Tables and Figures

Table 1. Proportion of employees who are scheduled for night shifts, rotating shifts, or work between midnight and 6 a.m. by occupational group.[9]

Type of Industry	Night Shift	Rotating Shift	Work between midnight and 6 a.m.
Overall Industry Average	**3.2%**	**2.5%**	**6.4%**
Management, Business, and Financial Operations Occupations	0.5%	0.9%	3.6%
Computer, Engineering, and Science Occupations	1.3%	1.2%	3.1%
Education, Legal, Community Service, Arts, and Media Occupations	1.0%	1.5%	2.8%
Service Occupations	6.2%	5.2%	8.3%
Sales and Related Occupations	1.9%	3.8%	3.9%
Office and Administrative Support Occupations	3.0%	1.4%	5.1%
Farming, Fishing, and Forestry Occupations	2.4%	1.4%	12.5%
Construction and Extraction Occupations	0.8%	1.2%	6.0%
Installation, Maintenance, and Repair Occupations	3.4%	1.5%	8.8%
Production, Transportation, and Material Moving Occupations	6.5%	4.2%	17.0%

Table 2. Geographic variation in sleep deficiency.[10]

State	Insufficient Sleep	State	Insufficient Sleep
Overall	34.8%	Connecticut	34.5%
Guam	48.7%	Illinois	34.2%
Hawaii	44%	Massachusetts	34.1%
Kentucky	38.9%	California	33.7%
Georgia	38.8%	Texas	33.2%
Maryland	38.5%	Missouri	33.1%
Alabama	38.5%	Arizona	32.7%
New York	38.1%	North Carolina	32.4%
Indiana	37.8%	Maine	32.2%
South Carolina	37.7%	District of Columbia	32%
Michigan	37.5%	New Hampshire	32%
West Virginia	37.4%	New Mexico	31.6%
Delaware	37.4%	Washington	31.6%
New Jersey	37.1%	Wisconsin	31.3%
Ohio	37.1%	Oregon	31.2%
Pennsylvania	36.8%	Wyoming	31%
Tennessee	36.7%	North Dakota	31%
Arkansas	36.5%	Utah	31%
Puerto Rico	36.5%	Kansas	30.5%
Mississippi	36.4%	Idaho	30.3%
Nevada	36.2%	Vermont	30.3%
Rhode Island	36.1%	Iowa	30.2%
Virginia	35.9%	Montana	30%
Louisiana	35.7%	Nebraska	30%
Oklahoma	35.2%	Minnesota	28.9%
Alaska	35.1%	Colorado	28.5%
Florida	34.9%	South Dakota	27.8%

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