

# Fatigue Statistics and Evaluating Impairment Risk

## Fatigue in the Workplace

The National Safety Council reported that 43% of workers are sleep-deprived and fatigued workers cost companies \$1,200 to \$3,100 per employee annually.<sup>1</sup> Fatigue at work is impacted by shift (day, evening, night, changing shift schedules), travel time to and from work, amount and quality of sleep, lifestyle, activity outside of work, and sleep-related disorders.

### Cost of Fatigue (United States)<sup>2</sup>

(Based on 1000 employees for each industry nationwide)

Industry	Total Annual Cost	Absenteeism Cost	Decreased Productivity Costs (Job Turnover and Re-Training)	Healthcare Cost
Construction and Extraction*	\$1,624,236	\$ 312,945	\$ 737,008	\$ 574,283
Production, Transportation, and Material Moving*	\$1,755,961	\$ 524,690	\$ 615,145	\$ 616,126
Installation, Maintenance, and Repair*	\$1,735,223	\$ 370,927	\$ 767,553	\$ 596,743
Farming, Fishing, Forestry	\$1,406,652	\$ 424,680	\$ 417,504	\$ 564,468
Service*	\$1,421,919	\$ 366,272	\$ 478,610	\$ 577,037
Office and Administrative Support**	\$1,352,377	\$ 285,654	\$ 555,632	\$ 511,091
Management, Business, and Financial Operations Occupations**	\$1,919,782	\$ 257,899	\$1,140,184	\$ 521,699
Computer, Engineering, and Science Occupations**	\$2,014,064	\$ 255,683	\$1,213,410	\$5 44,971
Other*	\$1,499,656	\$ 319,821	\$ 628,202	\$ 551,633

\* Rotating shifts

\*\* Day shift

## Prevalence of Sleep Disorders (United States)<sup>2</sup> (Industries nationwide)

Industry	Employee Sleep Disorders (%)			
	Obstructive Sleep Apnea	Insomnia	Restless Legs Syndrome	Shift Work Disorder
Construction and Extraction*	12.7	8.6	5.0	1.0
Production, Transportation, and Material Moving*	11.4	12.2	5.7	1.0
Installation, Maintenance, and Repair*	12.7	9.6	5.1	4.0
Farming, Fishing, Forestry*	11.4	9.9	5.7	2.0
Service*	8.9	13.8	7.1	1.0
Office and Administrative Support**	7.9	12.2	7.7	4.0
Management, Business, and Financial Operations Occupations**	9.9	10.0	6.7	< 0.5
Computer, Engineering, and Science Occupations**	10.9	9.7	6.1	1.0
Other*	9.7	11.6	6.8	0.5

\* Rotating shifts

\*\* Day shift

## Driver Fatigue

In a study using in-vehicle cameras to monitor drivers over several months, drowsiness just prior to an accident was found in 9.5% of all crashes and in 10.6% of crashes that resulted in significant property damage, airbag deployment, or injury. In addition, compared to daylight driving, accidents were more than twice as likely to occur at dawn and dusk and more than three times as likely to occur in dark conditions.<sup>3</sup> The GHSA stated that 10% to 20% of large truck and bus crashes involved a tired driver<sup>4</sup>.

In mining, driver fatigue is a critical safety issue. In open pit mines, fatigue-related accidents account for up to 65% of truck driving accidents alone.<sup>5</sup> Fatigue related Injuries and fatalities have driven the development of in-vehicle systems to identify driver fatigue. Systems monitor facial movement, biometrics, vehicle movement, and vehicle status. Data is used to provide fatigue alerts and build individual fatigue profiles to predict fatigue risk. Some of these systems can also collect biometric data from individuals outside of work to improve fatigue profiles. This requires individuals to wear a smart wrist band and this can create privacy concerns.

## **Pupillary Light Reflex (PLR) Testing for Fatigue Impairment Risk**

In a report on fatigue at work the National Safety Council stated that fatigue causes impairment of many basic cognitive functions such as alertness, concentration, accuracy, short-term memory and decision making. It can also result in physical impairments such as decreased reaction time and lower performance speeds. Psychomotor skills, which combine both cognitive and physical functions, are also impaired by fatigue (e.g. coordination and balance). Declining work performance from fatigue has been observed in those working night or rotating shifts, overtime, long hours or sustained time on task, and employees with sleeping problems such as insomnia or untreated obstructive sleep apnea.<sup>6</sup>

PLR is an involuntary reflex that controls the eye's pupil in response to changing light intensity. Changes in brain function due to fatigue, alcohol, or drugs can result in PLR changes. Measuring PLR can be used to evaluate impairment risk. When fatigue is combined with sleep disorders, alcohol or drugs, impairment can be much greater than fatigue alone and can result in significant PLR changes. A PLR test is a quick fit-for-duty test that can evaluate impairment risk. The PLR test is easy to do before a shift starts or between shifts and can be used to supplement a company's existing fatigue monitoring systems. As an example, mining companies using in-vehicle systems to monitor driver fatigue may have a fatigued driver take a short power nap and then go back to work. This avoids taking a vehicle out of service. Adding a PLR test is a quick way to check for a possible impairment. If a PLR test is given before and after the power nap, and both indicate a potential risk, the issue may be more than fatigue and a supervisor may need to get involved.

### **1. Sleep Deprivation – Long, repeated working shifts**

A study of sleep deprivation (without sleep disorders) over 28 hours found that pupil constriction latency was one of several pupil responses that could be used to assess state of alertness and fatigue.<sup>7</sup> Another study (18 hours of sustained operation during a night of sleep deprivation) found that pupil diameter and pupil constriction latency combined with saccadic velocity measurement (measures quick, simultaneous movement of both eyes) could be used to predict performance changes on psychomotor vigilance tasks.<sup>8</sup>

If fatigue is the only issue (no alcohol, drug or a sleep disorder), a saccadic velocity measurement system or an in-vehicle system is a good way to monitor fatigue during a shift. An in-vehicle system for example, will detect someone "nodding off" during the shift. This can occur before the individual starts experiencing physical and mental impairment that effect PLR.

### **2. Sleep Deprivation Combined with Alcohol and Marijuana**

When fatigued employees consume alcohol or use marijuana, impairment can be greater than fatigue, alcohol or marijuana alone. Alcohol and marijuana are used by workers in all industries. As discussed earlier, almost 80% of full-time employees used alcohol in 2017 and more than 16% used marijuana.<sup>9</sup> Of those who used marijuana and alcohol in the last month of the survey, 17.1% (age 18 to 25) and 5.3% (over 25) used both at the same time or within 2 hours of each other.<sup>9</sup>

Taking alcohol or drugs the day or night before work can increase fatigue impairment. Alcohol reduces REM sleep and sleep quality, while increasing non-REM sleep. While a small amount of

alcohol generally has little or no effect on the sleep cycle, excessive drinking can affect a person's ability to function the next day.

In the case of marijuana, different strains of marijuana contain different amounts of THC and CBD (cannabinoids in marijuana) and these affect sleep differently. Some users have reported that they sleep better after taking cannabis while others have feelings of drowsiness that can be hard to shake the morning after.<sup>10</sup> Even when alcohol or marijuana is consumed the night before work, taking either when a person is fatigued can result in increased impairment and show up as changes in PLR.

### 3. Sleep Disorders

More than 20% of the employees working in the industries listed in the sleep disorder table (page 11) suffered from insomnia or Obstructive Sleep Apnea (OSA). Approximately 23% of working Americans suffer from insomnia.<sup>6</sup> Insomnia prevents an individual from achieving a restful night's sleep and can cost companies an additional \$976 per person per year due to absenteeism and an additional \$2,530 through decreased productivity at work.<sup>11</sup> Individuals with insomnia frequently turn to alcohol to help them get to sleep. As discussed earlier, alcohol reduces sleep quality and makes it more difficult for someone to reach deep sleep. It's not uncommon for someone with insomnia to have a co-dependency on alcohol.

Mild OSA affects 34% of men and 17% of women; moderate to severe OSA affects 13% of men and 6% of women.<sup>6,12</sup> People with OSA have a nearly twofold increased odds of work accidents than people who don't have OSA.<sup>13</sup> Data compiled on drivers with sleep apnea find that they commit more lane deviations, take longer to stop their vehicles and have at least a two- to three-fold increased risk of crashes compared to drivers without sleep apnea<sup>14</sup>. In a study of driving performance of people being treated for OSA who also consumed alcohol, there was approximately a 40% greater increase in steering deviation in OSA patients who were subjected to sleep restrictions and consumed alcohol versus control subjects. Compared with healthy subjects, patients with OSA had worse driving simulator performance and were more vulnerable to the effects of alcohol and sleep restriction.<sup>14</sup>

## SOBEREYE Impairment Risk Measurement System

Existing workplace systems that indicate fatigue or measure the level of alcohol consumption or the presence of drugs each focus on a specific area. They do not measure impairment and they do not measure the effects of combining fatigue with alcohol and/or drugs. Measuring PLR can evaluate impairment risk regardless of whether the impairment is due to a single source or multiple sources.

SOBEREYE's smartphone-based mobile system provides a quick PLR check to evaluate risk of impairment. PLR measurements are compared against each individual's baseline (normal, unimpaired) PLR and iris recognition verifies the user's identity so the system can be used remotely without supervision. A software dashboard controls testing schedules. Results are displayed on the smartphone and the software dashboard. The SOBEREYE system provides a quick way to evaluate impairment risk, particularly when sleep disorders, alcohol or drugs are combined with fatigue.



## References

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