# Workplace Fatigue

Researchers have conducted many studies of fatigue in the past couple decades to better understand how and why fatigue affects workplace and transportation safety. There is anecdotal evidence that fatigue is a major contributing factor to workplace and transportation incidents, but the actual causes and types of fatigue are rarely part of incident data, and there is an ongoing debate as to which demographic groups are at most risk for fatigue. This brief literature review goes into more detail on these research gray areas and describes the concept of Fatigue Risk Management Systems (FRMS), which attempt to reduce and eliminate the effect of fatigue on workers.

Before a discussion of fatigue can be launched, it is essential to begin with a good definition of fatigue. Gander et al. (2011) define fatigue as:

> "…the inability to function at the desired level due to incomplete recovery from the demands of prior work and other waking activities. Acute fatigue can occur when there is inadequate time to rest and recover from a work period. Cumulative (chronic) fatigue occurs when there is insufficient recovery from acute fatigue over time. Recovery from fatigue, i.e. restoration of function (particularly of cognitive function), requires sufficient good quality sleep" (574.)

Lerman et al. (2012) agree for the most part with this definition with the added caveat that there is a difference between sleepiness and fatigue. Sleepiness refers only to the tendency to fall asleep, while fatigue is the body's natural reaction to sleep deprivation *or* physical and mental exertion. In other words, a person can be fatigued not because of a lack of restorative sleep, but due to strenuous physical and/or mental work. Lerman et al. (2012) would therefore state that recovery from fatigue could include rest that does not involve sleeping. Williamson et al. (2011) concur that fatigue is both a physical and mental state, defining fatigue as "a biological drive for recuperative rest" (499).

Published literature reviews of fatigue studies show some correlations of age and fatigue with time of day. For instance, young drivers (under 30 years of age) are more susceptible to drowsiness that can cause car crashes in the late night and early morning hours. Older drivers (over 64 years of age) are more susceptible to drowsiness that causes car crashes in the afternoon (Milia et al., 2011). A reason for this difference can be that biological systems begin to deteriorate around 45-50 years of age – around this time, people experience a tendency toward morningness (waking and being more alert in the morning hours) and reduction in deep sleep (Ibid, 2011).

Regardless of age, drivers with fewer hours of sleep had elevated odds of being involved in a sleep-related crash (Stutts et al., 2003). Young and Hashemi (1996) found that there were basically two types of drivers that are typically involved in fatigue-related crashes: those with regular sleep patterns who developed fatigue on the job, and those with irregular sleep patterns who were fatigued before getting behind the wheel. This finding reinforces the idea that fatigue should be conceptualized as both a lack of sleep and physical/mental exertion.

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Socioeconomic status appears to have an indirect correlation with fatigue, namely that those with higher socioeconomic statuses are less likely to be fatigued or experience fatigue-related incidents. This may be because those with higher-paying jobs are more likely to have better agency over their working conditions, workload, and schedules, which indicates that they have more means to manage fatigue (Milia et al., 2011).

Regarding work schedules, research in this area has found that injury risk increases in the eighth hour of work and continues to increase after twelve and sixteen hours of work. Vesgo et al. (2007) found that the number of hours worked in the week prior to an incident is related to safety risk – the probability of a safety incident increased 88% for those who worked more than 64 hours the week before. Shift work also increases the risk of injury; researchers have found that few employees are able to physically cope with third-shift work, showing elevated risk of metabolic syndrome, circadian rhythm disruption, sleep disruption, and fatigue (Milia et al., 2011).

Although it makes sense anecdotally that natural circadian rhythms have an effect on fatigue and work performance, research is unclear as to a direct link between circadian rhythms, performance, and safety outcomes. More likely is that circadian rhythm plays a role in conjunction with other sleep-related factors, including: time since waking, time since beginning work, rest break timing, workload distribution, and the nature of the work being performed (Williamson et al., 2011). Furthermore, the effect of sleep restriction and time since sleeping is confounded by factors like time on task and mental and physical workload. Rest breaks are effective at offsetting accumulated fatigue, but the effect of the break may be short-lived depending on the nature of the work and the work environment (Ibid, 2011).

Information on how fatigue affects certain demographic groups and work performance has influenced the strategies used by regulatory agencies and industry sectors to combat fatigue that affects workplace performance and safety. Agencies like the Occupational Safety and Health Administration (OSHA) and the Federal Motor Carrier Safety Administration have enacted hours of service regulations that limit the maximum number of work hours and mandate a minimum number of rest periods. The strengths of this approach are that it limits the length of time required for work and the duration of continuous time on task. The hours-of-service approach does not address, however, the challenges of third shift work, the cumulative nature of sleep debt, and non-work-related wake time such as commuting (Gander et al., 2011).

At an industry or company level, Gander et al. (2011) recommend tracking operator fatigue as a leading indicator of safety performance, and responding proactively to negative shifts in operator fatigue. A major proactive measure companies can take to reduce the effect of fatigue on workplace safety is to change aspects of organizational culture that encourage people to work while fatigued. For instance, eliminating the notion that employees must put in a certain amount of "face time" each week in order to be considered an effective employee will reduce the rate of presenteeism, or working while physically or mentally impaired. Hiring adequate staff lightens the workload and schedules of personnel, which reduces the risk of employees leaving work overly fatigued.

These measures at the regulatory and industry/company levels lend credence to Lerman et al.'s (2012) proposal of instituting a Fatigue Risk Management System (FRMS) that is similar to or part of an organization's overall safety management system. Here an FRMS is defined as "a scientifically based, data-driven addition or alternative to prescriptive hours of work limitations which manages employee fatigue in a flexible manner appropriate to the level of risk exposure and the nature of the operation" (Lerman et al., 2012:234). Overall, an FRMS may include:

- Fatigue risk management strategies, such as collecting data on fatigue as a leading indicator and implementing controls to reduce/mitigate risk
- Fatigue reporting system for employees
- Education/training on fatigue management for employees and supervisors
- Fatigue monitoring system

One example of an FRMS in action is an analysis of workload-staffing balance. An organization can examine fluctuations in staffing to build a better scheduling system, reengineer processes to reduce the number of positions required at each shift, and cross-train employees to fill several positions (Lerman et al., 2012). Balkin et al. (2011) write that an ideal FRMS should do three things: predict fatigue, measure/monitor fatigue, and intervene when fatigue is detected. To explain in more detail, an ideal FRMS should be able to forecast fatigue based on factors such as sleep history and circadian rhythm using fitness-for-duty or alertness tests. A good fatigue risk management system would also have the technology to measure and monitor fatigue while on the job using actigraphy devices or ocular measures. Lastly, there should be a way for an FRMS to intervene when fatigue is detected or anticipated with actions to restore or sustain alertness.

A recent study by Ng et al. (2015) analyzed the results of an Australian company's efforts to combat fatigue and sleepiness in the workplace. In this strategy that coupled a fatigue risk management system with an employee health and wellness program, the organization challenged workers to walk at least 10,000 steps per day for 125 days. Researchers analyzed the walking data from over 400 participating employees and compared the data to their answers to a self-administered questionnaire assessing the level of daytime sleepiness. Participants with an excessive daytime sleepiness score (> 10) significantly improved their score four months later through physical activity and sustained this improvement after twelve months. Almost half of the participants no longer suffered from excessive daytime sleepiness by the end of the study.

It should be noted, however, that the above is just one study out of many looking at intervention strategies. Ng et al.'s (2015) study also mainly looks at mitigating sleepiness, which has been established as related to but different from the concept of fatigue. Previous research provides strong evidence that fatigue produces impairments in performance, but it is less well known if those impairments in performance lead directly to adverse safety outcomes. Just as multiple factors related to fatigue can lead to an incident, fatigue is one factor out of many that can contribute to a workplace or transportation incident. This is justification for why research on fatigue should continue, and why fatigue risk management should be an integrated part of an overall safety management system.

**Works Cited**

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