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Fatigue and Sleep Factors Related to Safety Critical Events

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Problem

While there has been increasing research investigating acute impacts of fatigue on safety critical events (SCE), including crashes and near misses, there has not been a population based evaluation of relationships between measures of chronic fatigue and SCEs. Furthermore, there are potential confounding factors, including diagnosis of sleep problems and obesity, which may impact these relationships. These analyses assess relationships between self-reported measures of sleep quality and duration and SCEs while adjusting for age, gender, Body Mass Index, and diagnosis of a sleep problem among a large (n=817) population of truck drivers.

Method

Truck drivers (n=817) were enrolled at truck stops, truck shows, and companies across the United States. Drivers completed questionnaires on laptop computers and had measurements taken (e.g., height and weight). Safety critical events (SCE) recorded included self-reported near misses in the past 12 months and lifetime frequency of Department of Transportation reportable crashes. Each of these outcomes were collapsed into binary categories (Yes vs. No) for purposes of these analyses. Height and weight were measured and used to calculate body mass index. Restless sleep in the past month, average hours of sleep per night while on the road, and past diagnosis of sleep problems were all self-reported from an electronically administered questionnaire. Additional data were collected but not used in these analyses. Self-reported sleep Frequencies and means were assessed to describe the population. Crude and adjusted logistic regression was used to assess associations between SCEs and self-reported measures of fatigue captured from the questionnaire. Regression analyses were adjusted for all other factors in the model.

Results

The sample was largely male (86.3%) and the overall mean age was 47.3 years (see Table 1). There was a wide range of average number of hours that drivers sleep while on the road, with nearly 1/3 reporting averaging 6 or fewer hours of sleep per night while on the road. 100 drivers (12.2%) reported having been diagnosed with a sleep problem. Slightly less than half (47.4%) reported having one or more near miss within the past month, and 39.9% reported having had one or more DOT reportable crash in their lifetime. Approximately 1/3 of drivers reported often or always being mentally exhausted after work, and 2/3 of the drivers reported using something (Roll down windows, music, talk, etc.) to help them stay awake while they drive. There was a statistically significant inverse relationship seen between hours of sleep while away from home and near misses, with a meaningful increase in odds ratios with fewer reported hours of sleep, after adjustment for age, gender, body mass index, restless sleep, and diagnosis of a sleep

problem. There were similar trends seen with fatigue factors related to lifetime DOT reportable crashes regarding hours of sleep, with few exceptions. Increasing age was protective for near misses, but was an increased risk for lifetime DOT reportable crashes. Diagnosis of sleep problems were associated with near misses, but there was no relationship with DOT reportable crashes. BMI was not related to either outcome.

Table 1. Demographic Factors of Truck Drivers

	Mean	Standard Deviation
Age	47.3	10.5
Body Mass Index Category	Frequency	Percent
Underweight	5	0.61
Normal Weight	80	9.79
Overweight	225	27.54
Obese	393	48.10
Morbidly Obese	114	13.95
Average Hours of Sleep Per Night while on the Road		
Less than 4	16	1.97
4 to 5	85	10.44
5 1/2	26	3.19
6	128	15.72
6 1/2	63	7.74
7	105	12.9
7 1/2	52	6.39
8	130	15.97
8 1/2	48	5.90
9	37	4.55
More than 9	64	7.86
I Sleep at Home Every Night	60	7.37
Gender		
Female	112	13.71
Male	705	86.29
Diagnosed with a Sleep problem	100	12.24
Mentally Exhausted		
Never	162	19.83
Seldom	383	46.88
Often	215	26.32
Always	57	6.98
Help you stay awake while you drive?	525	64.26
At Least 1 “Near Miss” in the past month	387	47.37
At Least 1 D.O.T. Reportable crash in their Lifetime	326	39.90

Table 2. Adjusted Odds Ratios and 95% Confidence Intervals for Relationships between Factors and Safety Critical Events

	Near Misses	Lifetime D.O.T. Reportable Crashes
	Odds Ratio (95% CI)	Odds Ratio (95% CI)

Age (per year)	**0.99 (0.97, 0.99)***	**1.03 (1.01, 1.04)***
Body Mass Index Category		
Underweight	1.00 (0.15, 6.59)	0.47 (0.05, 4.75)
Normal Weight	1.00 (Reference)	1.00 (Reference)
Overweight	0.98 (0.57, 1.69)	0.79 (0.46, 1.35)
Obese	1.15 (0.69, 1.92)	0.88 (0.53, 1.47)
Morbidly Obese	1.13 (0.61, 2.10)	0.99 (0.54, 1.83)
Average Hours of Sleep Per Night while on the Road		
Less than 4	**5.16 (1.55, 17.16)***	1.61 (0.43, 5.98)
4 to 5	**2.07 (1.01, 4.27)***	**2.52 (1.18, 5.38)***
5 1/2	2.45 (0.92, 6.50)	2.73 (0.99, 7.55)
6	**3.51 (1.79, 6.87)***	1.99 (0.98, 4.04)
6 1/2	**2.51 (1.17, 5.37)***	1.97 (0.88, 4.43)
7	**2.17 (1.09, 4.33)***	**3.53 (1.71, 7.29)***
7 1/2	**2.25 (1.01, 4.99)***	**3.71 (1.62, 8.49)***
8	1.84 (0.94, 3.58)	**2.88 (1.43, 5.81)***
8 1/2	1.81 (0.80, 4.11)	**2.99 (1.29, 6.95)***
9	1.41 (0.57, 3.49)	1.83 (0.72, 4.68)
More than 9	1.00 (Reference)	1.00 (Reference)
I Sleep at Home Every Night	1.72 (0.79, 3.74)	2.33 (1.04, 5.24)
Gender		
Female	0.94 (0.61, 1.45)	**0.45 (0.28, 0.72)***
Male	1.00 (Reference)	1.00 (Reference)
Diagnosed with a Sleep problem	**1.59 (1.00, 2.53)***	0.81 (0.51, 1.29)
Mentally Exhausted		
Never	1.00 (Reference)	1.00 (Reference)
Seldom	**1.77 (1.18, 2.66)***	0.84 (0.56, 1.24)
Often	**2.28 (1.45, 3.58)***	0.92 (0.59, 1.44)
Always	**5.00 (2.46, 10.16)***	**1.96 (1.02, 3.76)***
Help you stay awake while you drive?	**1.57 (1.15, 2.15)***	1.32 (0.96, 1.80)
*p<0.05. factors were adjusted for all other variables in the table.		

Discussion

These analyses suggest that there are relatively strong associations between average sleep duration and SCEs, even after adjustment for confounding factors. There was a stronger relationship between hours of sleep on the road and near misses in the past year, as compared to lifetime DOT reportable crashes. Similarly, reporting mental exhaustion after work was more strongly related to near misses than DOT reportable crashes.

There were many differences seen in the relationships between the two outcomes. Age was protective for near misses in the past year, but was an increased risk for lifetime DOT reportable crashes. This difference is most likely attributed to the nature of the outcomes, past year vs lifetime. The lack of statistical significance for being diagnosed with a sleep problem between the two outcomes may be due to the strong healthy worker effect, particularly for sleep problems. If a driver has a sleep problem, s/he may be less likely to be a driver for a long time, and therefore less likely to have had a DOT reportable crash. The relationship between near misses in the past year may be somewhat less likely to be influenced by the healthy worker effect.

Most prior studies evaluate acute relationships between sleep duration (e.g. hours of sleep the night before) and SCEs. This is the first study to our knowledge to evaluate relationships between chronic sleep deprivation, measured in hours of sleep, and SCEs over a long period of time among a large cross-section of drivers.

Summary

These data suggest that long term sleep deprivation while on the road is associated with SCEs, both near misses in the past year, and lifetime DOT reportable crashes. These relationships are present after for adjusting for confounding factors. Similarly, being mentally exhausted after work is associated with SCEs, particularly with having a near miss in the past year.