


Research Brief

Investigation of the Effects of Split Sleep Schedules on Commercial Vehicle Driver Safety and Health

BACKGROUND

This study was designed to answer the question: Is split sleep as beneficial as a consolidated sleep with respect to sustaining driver safety and operational performance and, over the long term, with respect to sustaining driver health? In other words, is split sleep as recuperative as consolidated sleep? The study compared daily sleep split into two periods versus sleep consolidated into a single period to determine the effects of these sleep patterns on total sleep time, performance, subjective state (sleepiness, mood, and effort), and biomedical parameters associated with long-term health.

The study was an in-residence laboratory study conducted from January 10, 2010 to May 5, 2011. Three sleep conditions were examined: consolidated nighttime sleep, split sleep, and consolidated daytime sleep. Fifty-three participants, divided among the three conditions, were studied in the laboratory for 9 days, which included 2 baseline days, a 5-day simulated workweek, and a 2-day recovery period. The recovery period allowed the participants in the split sleep and consolidated daytime sleep conditions to transition back to nighttime sleep before leaving the laboratory.

The core of the study was a 5-day simulated workweek spent in one of the three conditions. All three sleep conditions had the same total sleep opportunity of 10 hours per day—consolidated nighttime sleep (10 p.m.–8 a.m.), split sleep (3 a.m.–8 a.m. and 3 p.m.–8 p.m.), and consolidated daytime sleep (10 a.m.–8 p.m.).

During the study, participants slept, ate, took performance tests, and had blood draws within the confines of the sleep laboratory. Participants had no contact with the outside world (no cell phones, email, visitors, live television, radio, or Internet).

Sleep Pattern by Sleep Time, Performance, Sleepiness, and Blood Chemistry

	Nighttime Sleep	Split Sleep	Daytime Sleep
Average Total Sleep Time per 24 Hours	8.4 hrs. ± 13.4 mins.	7.2 hrs. ± 14.2 mins.	6.4 hrs. ± 15.3 mins.
Performance Measures Across the Workweek	No difference identified	No difference identified	No difference identified
Average Karolinska Sleepiness Scale (KSS)	3.5 ± 0.2	3.5 ± 0.2	4.3 ± 0.2
	("1" = very alert to "9" = very sleepy)		
Blood Chemistries (on Blood Draw Days)	No difference identified	No difference identified	Glucose and testosterone increased

STUDY FINDINGS

Total sleep time was measured twice during the baseline period (BL1, BL2), twice during the workweek (W1, W2), and once during the recovery period (R). During the 5-day simulated workweek, participants in the nighttime sleep condition slept the most (total sleep time per day 8.4 hours ± 13.4 minutes standard error of the mean) followed by participants in the split sleep condition (total sleep time per day 7.2 hours ± 14.2 minutes standard error of the mean). Participants in the daytime sleep condition slept the least (total sleep time per day 6.4

hours ± 15.3 minutes standard error of the mean).

Performance was measured by a psychomotor vigilance task (PVT), a driving simulator, and a digit-symbol substitution task (DSST) multiple times throughout the study. For the driving simulator testing, the participants drove a 40-minute route in a driving simulator used for professional driver training. The PVT is a 10-minute reaction time test which is a sensitive measure of lapses in attention. The DSST is a performance test involving matching numbers to symbols. It is sensitive to inadequate sleep in the short-term or long-term.

During the 5-day simulated workweek no significant differences were found in the performance among the three sleep conditions on the PVT, driving simulator, or the DSST. Though even mild sleep restriction (6–7 hours) can degrade performance over time, the sleep in all three conditions appears to have been adequate to sustain performance at least for the duration of the 5-day simulated workweek.

A neurobehavioral test battery was used to assess subjective state. The battery consisted of measures of sleepiness, mood, positive and negative emotion; and performance and effort.

Subjective sleepiness was increased in the daytime sleep condition compared to the split sleep and nighttime sleep conditions. Other subjective measures did not differ by condition.

Biomedical parameters were measured by blood chemistries and blood pressure (BP). Glucose, interleukin-6 (IL-6), leptin, and testosterone were measured multiple times per day on two blood draw days, before and after the 5-day workweek. BP was measured once a day in the evening throughout the study.

From the first to the second blood draw spanning the workweek, no condition-specific changes in IL-6 or leptin levels were found. Glucose and testosterone appeared to increase in the daytime sleep condition. There were no changes in BP over the simulated 5-day workweek.

LIMITATIONS

The participants in this study were young men (age range 22–40 years), healthy, and non-obese (body mass index less than 30). The homogeneity of the population and the controlled laboratory environment were instituted to reduce the possibility of random factors affecting the data. Thus, the study population and the study environment were purposely not representative of the population of CMV drivers and their normal working environment.

If a difference was found in the laboratory setting between split and consolidated sleep, then the expectation was that these findings would be followed up with a field study using drivers in their usual environment driving their usual revenue-producing routes. The study population in such a field study would be chosen to be representative of the industry and would therefore be older, heavier, include women, and generally more heterogeneous.

What appears to be a limitation of the study actually is a strength and puts the study in the mainstream of translational research, beginning in the lab and ending in the field. In the laboratory, the research team asks is there a difference? In the field, the research team asks does the difference found in the laboratory make a difference in real world measures of sleep and performance for drivers in their normal environment?

CONCLUSION

The study found that daytime consolidated sleep resulted in less total sleep time, increased sleepiness, and an increase in blood glucose and testosterone at the end of the workweek. However, performance was not significantly affected by sleep opportunity placement. Results of this study suggest that when consolidated nighttime sleep is not possible, split sleep is preferable to consolidated daytime sleep.

Further information is available on the FMCSA Web site: http://www.fmcsa.dot.gov/facts-research/art.htm.

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