Trucker sleep patterns influence driving performance

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Large truck crashes and fatigue driving

Every year in the United States

3,500

fatal crashes involving large trucks

4,000

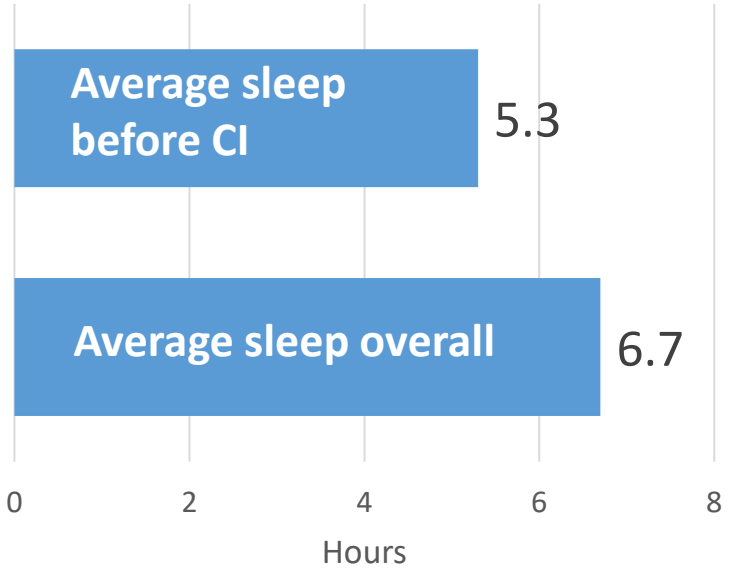
died from large truck crashes

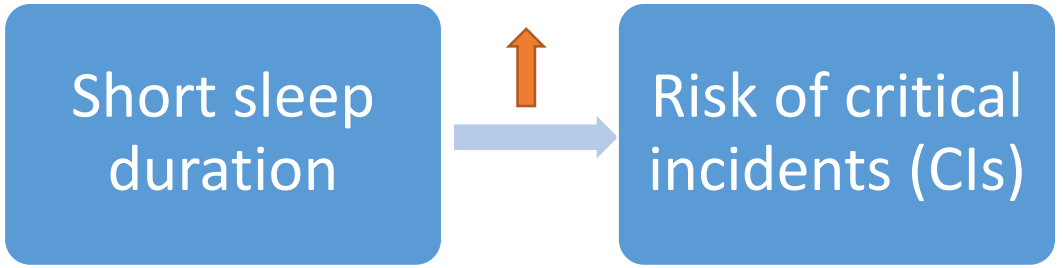
350-700

were caused by fatigued drivers

FMCSA. 2016. 2016 Pocket Guide to Large Truck and Bus Statistics. May 2016.

What we know about sleep and driving

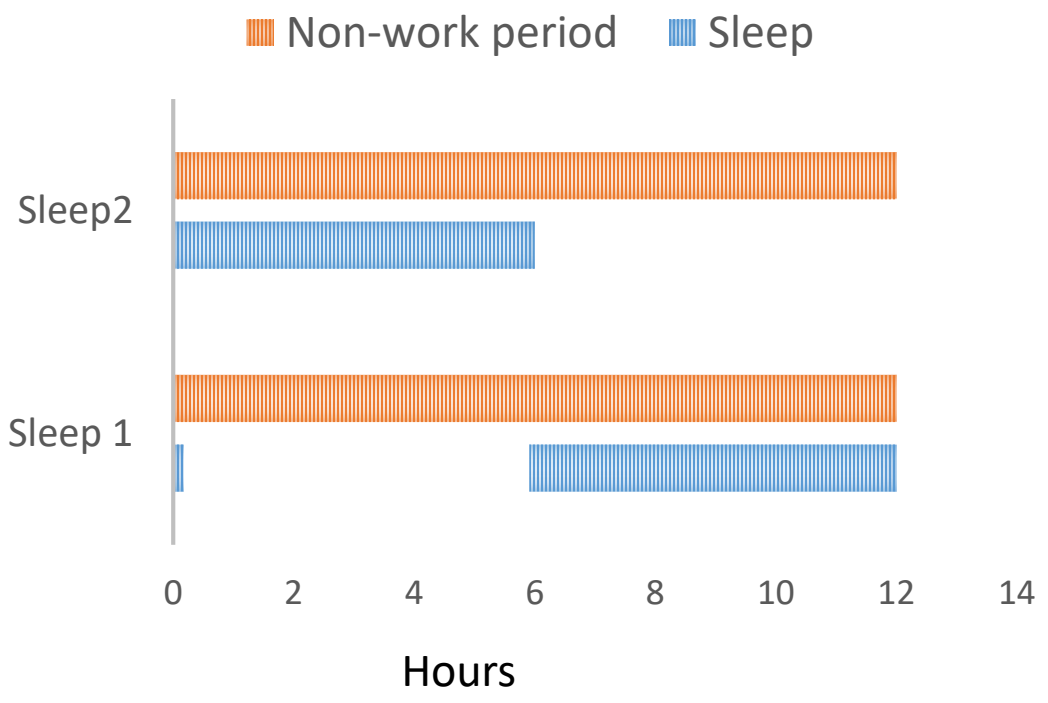




Critical Incidents include crashes, near-crashes, crash-relevant conflicts.

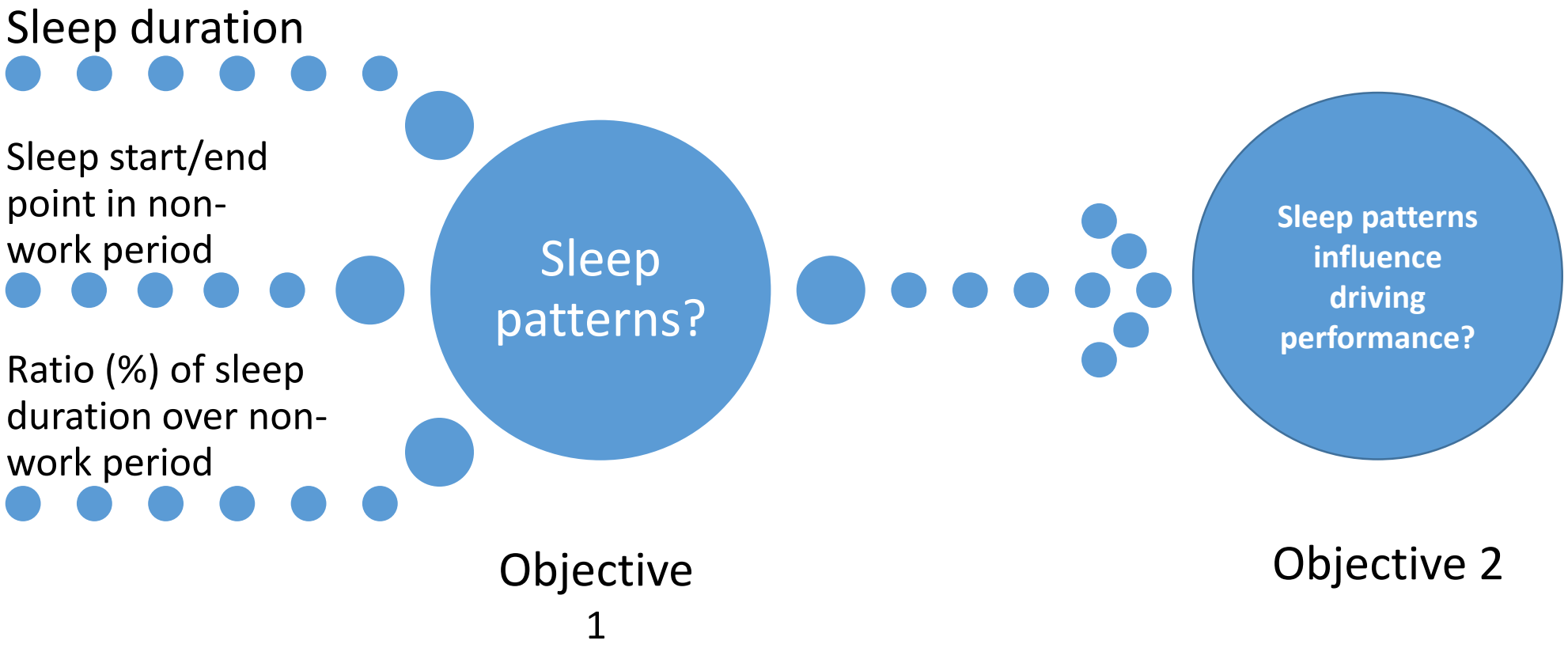
Hanowski et al., 2007. The sleep of commercial vehicle drivers under the 2003 hours-of-service regulations. Accident Analysis & Prevention 39, 1140-1145

Hypothesis



- Two sleeps have the same duration
  - One sleep occurs in the early stage of a non-work period
  - The other occurs in the late stage of a non-work period
- Whether there is a difference in driving performance between the two?

Two objectives



Study population and design

Naturalistic Truck Driving Study

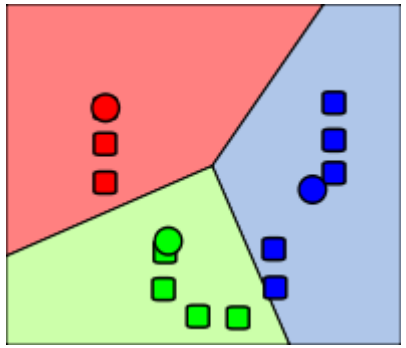
- 96 commercial truck drivers
- Each driver drove a test truck for 4 weeks and data were collected over a 2-year period
- Test trucks continuously collected data on vehicle movement and drivers' performance/behaviors
- Daily activity register: work and non-work activities

Measure of driving performance

- Safety critical events (SCEs)
  - Crashes
  - Near crashes
  - Crash-relevant conflicts
  - Unintentional lane deviation

Crash-relevant conflicts: Any circumstance that requires a crash-avoidance response with the severity between near crash and normal maneuver. A crash-avoidance response can include braking, steering, accelerating, or any combination of control inputs.

Statistical method



- K-mean cluster analysis was used to identify distinct sleep patterns
  - Sleep duration
  - Sleep starting point in a non-work period
  - Sleep ending point in a non-work period
  - The amount of sleep as a percentage of the non-work period

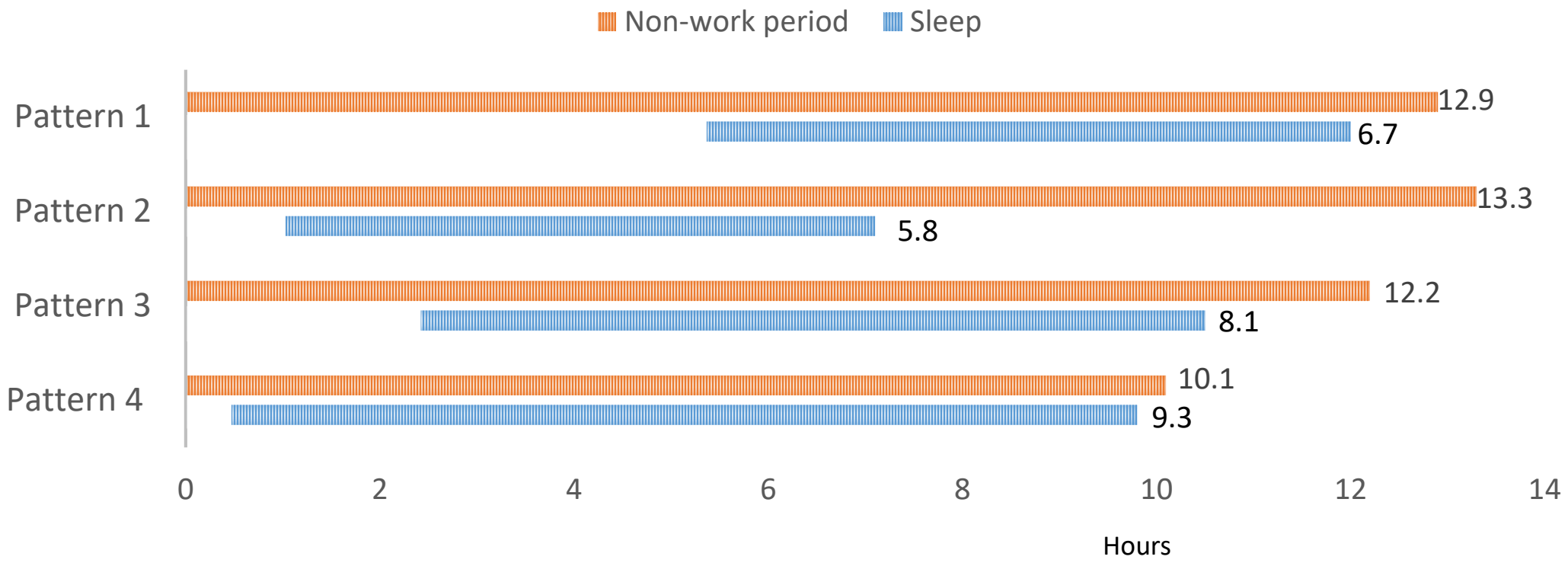
Statistical method (continued)

- Negative binomial regression was used to model the association between SCEs and sleep patterns
  - Sleep patterns
  - Age
  - Gender
  - Years of commercial vehicle driving
  - Body mass index (BMI)

Driver demographic information

Number of drivers (male)	96 (91)
Average age	44 years
Average years of commercial vehicle driving	9 years
Average BMI	32

Four distinct sleep patterns were identified



Characteristics of the four sleep patterns

Sleep pattern	Average non-work period	Average sleep	% of non-work period	% with any sleep 1-5 a.m.	SCEs per 100 h driven
1	12.9 h	6.7 h	53	86	16.4
2	13.3 h	5.8 h	44	35	21.8
3	12.1 h	8.1 h	68	83	13.4*
4	10.1 h	9.3 h	93	89	13.7*

h: hours

*SCE rate was significantly different from Pattern 2 (p-value <0.05).

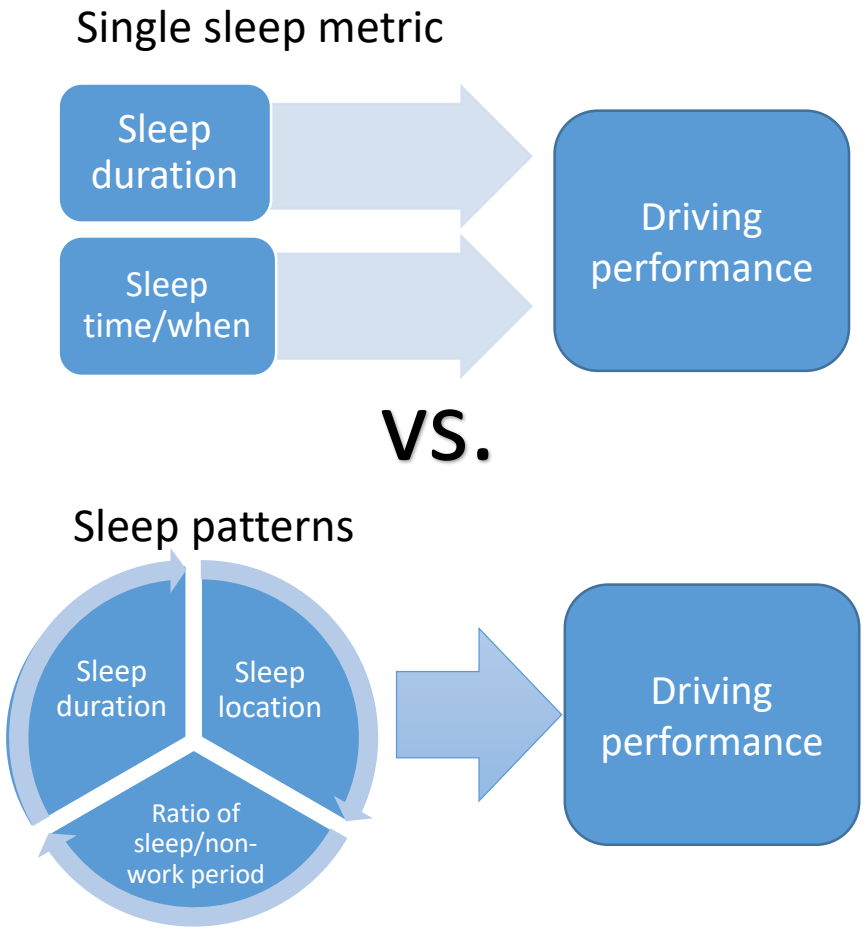
SCE rate ratios by driver demographics

	Rate Ratio	95% LCL	95% UCL	p-value
Gender (M vs. F)	1.98	1.21	3.26	0.007*
Age	1.00	0.99	1.01	0.644
Years of Commercial Vehicle Driving	0.98	0.97	0.99	0.010*
BMI	1.03	1.01	1.04	0.005*

Limitations

- Small sample size
- Small number of female truck drivers
- Human error and recall bias in the self-reported activity register

Implication for methodology



- Sleep pattern is a new and more accurate description of sleep behaviors
- Alleviate multicollinearity issue faced by using multi-single sleep variables in a multivariate regression model

Implication for prevention

- Truck drivers:
  - Get adequate sleep (at least 7 hours) before starting work shift
  - Ensure sleep duration including the period between 1−5 a.m.
- Employers:
  - Train drivers on the safety and health benefits of getting adequate sleep
  - Avoid scheduling work time or driving in the time period between 1− 5 a.m.
  - Incorporate health and wellness program into fatigue management program

Future research needs

- Address the limitations of this study, i.e.,
  - Larger sample and more female drivers
- Answer new research questions that are raised by this study, i.e.,
  - Add new variables to describe sleep patterns, such as
    - Whether a sleep duration covers the time period between 1 to 5 am.
  - Is there an association between scheduling methods and sleep patterns among commercial truck drivers

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