

Exploring the Association between Truck Seat Ride and Driver Fatigue

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Background

- The human and economic cost involving commercial vehicle crashes is significant.
 - The average comprehensive cost of a police-reported crash involving a large truck is \$91,112
 - \$3.6 million per crash involving fatality (Zaloshnja & Miller, 2007)
- 47% of truck drivers have fallen asleep at the wheel of their truck and 25% have done so in the past year (McCartt et al., 2000)
- 54% of adult drivers have driven a vehicle while feeling drowsy and 28% of them actually fell asleep (National Sleep Foundation, 2009).

Fatigue and Vigilance

- Fatigue
 - Cognitive, affective, or physical state of tiredness or weariness caused by exertion.
- Vigilance
 - Ability to sustain attention to a task for a period of time.
 - Declining in sustained attention is a critical factor that can affect task performance and operational safety (Bonnefond, 2010).

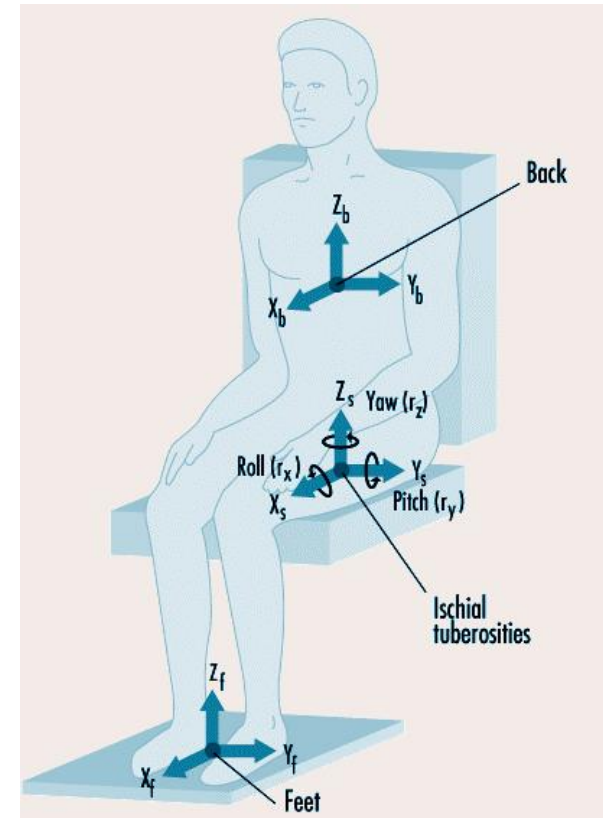
Psychomotor Vigilance Task (PVT)

- Sustained reaction time task
 - Subjects are instructed to respond as they see numbers or a dot appear on a screen.
 - The stimulus appears randomly every 2-10 seconds for 5-10 minutes for a total of 40-80 trials.
- Gold standard to test alertness
- Reliable and Valid



Whole-Body Vibration

- Objective measure to describe operator motion
- Vector quantity with:
 - Magnitude or intensity of motion
 - Direction of motion
- Usually characterized by
 - Frequency (Hz)
 - Acceleration (m/s^2)



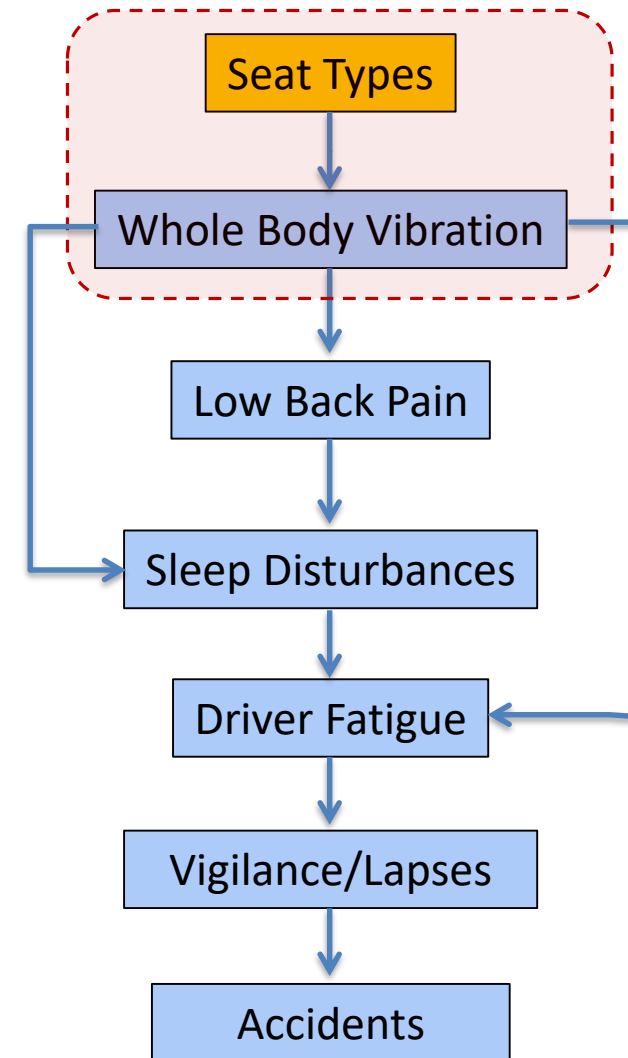
Seats, WBV and Vigilance



**Industry
Standard
Passive suspension
Seat**



**Vibration
Cancelling
Active Suspension
Seat**



Study Objective

Using the PVT

- Determine whether WBV exposure affects a truck drivers' vigilance over their regular shift.
- Determine whether differences in WBV exposures differentially affects drivers' vigilance in a field setting through two different truck seats interventions.

Methods

- Crossover (repeated measure) study design
- Drivers sat in two truck seats each for one shift
 - Original-fitted passive suspension seat
 - An active suspension seat
 - Participants: 11 male truck drivers (mean age 52.3 years)



WBV Measurement

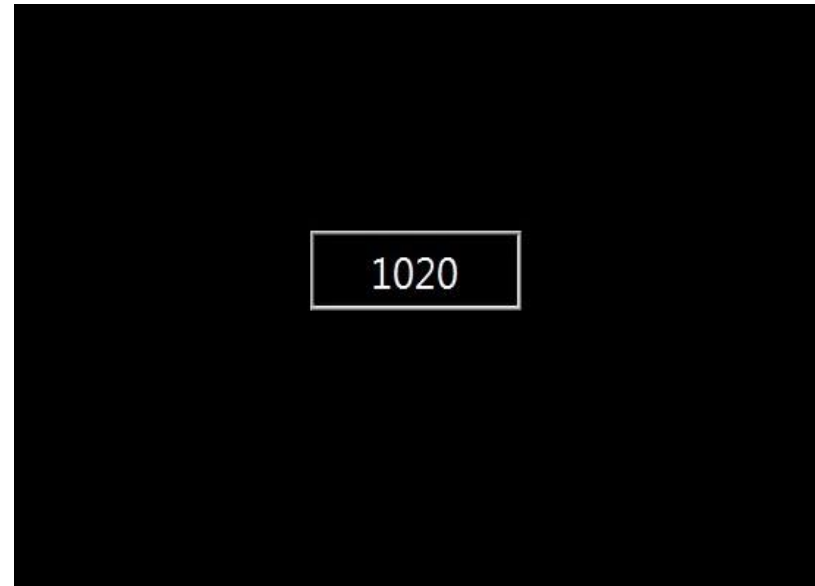
- 11 hour full-shift WBV exposure
- WBV collected per ISO 2631-1 standards
- Tri-axial seat and floor vibration measured at 1280 Hz
- GPS recording of truck speed and location



WBV data acquisition system

PVT Performance Measures

- 5-minute, in-truck tablet-based PVT immediately before and after the 11 hour shift.
 - Mean reaction time (RT) , lapse percentage (RT > 500 ms), mean fastest 10% RT.

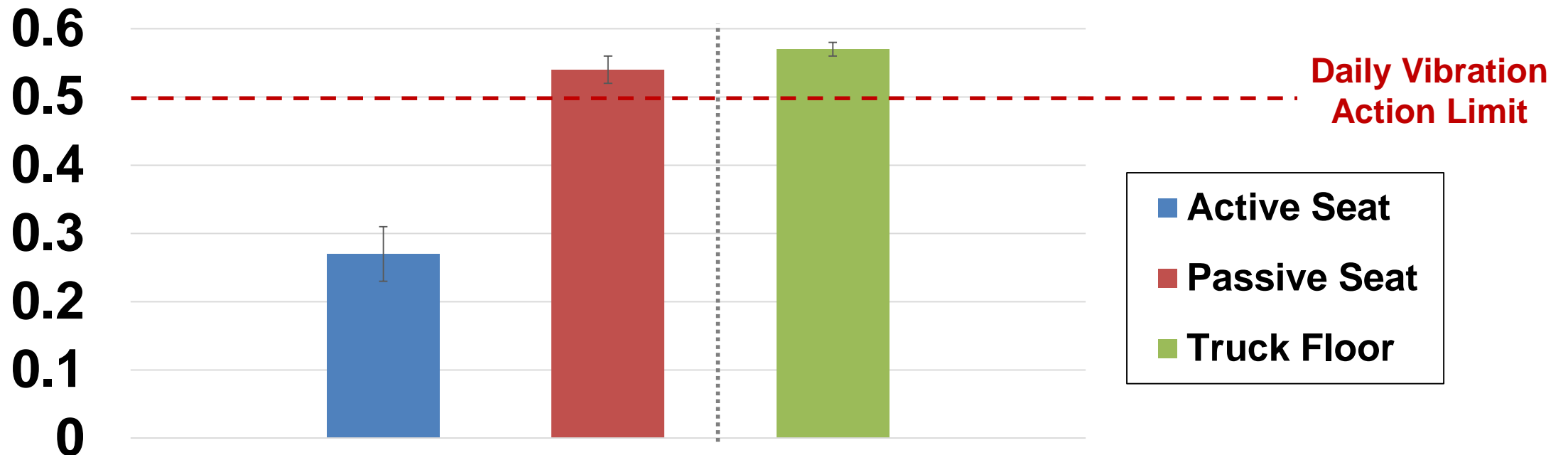


During PVT task

Results

- Significant differences (50% reduction, $p < 0.0001$) in the seat measured WBV exposures between the two seating conditions

WBV Exposures (m/s^2)

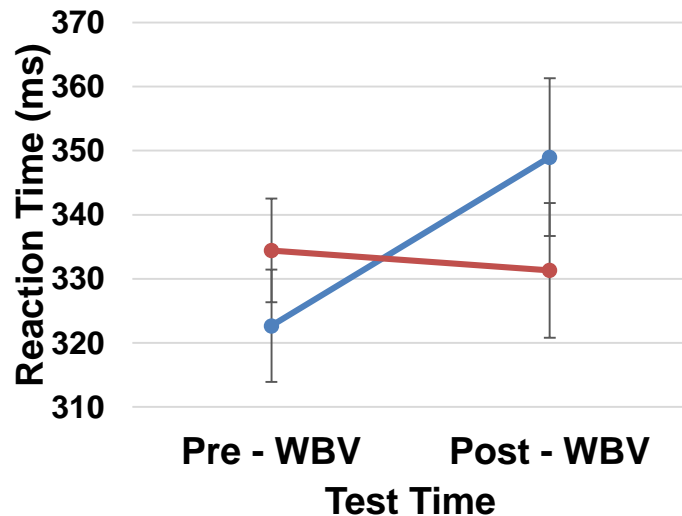


WBV exposures of two seating condition

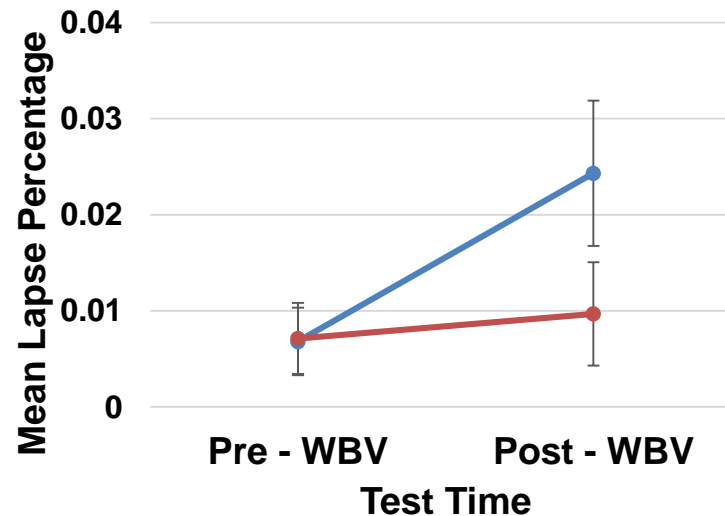
Results [n = 11]

- Potential slower post-WBV reaction times with the passive seat ($p = 0.054$).
- The average number of lapses per trial were significantly greater ($p = 0.025$) after operating truck with the passive seat.
- Longer fastest 10% reaction times after operating truck with the passive seat ($p = 0.021$) .

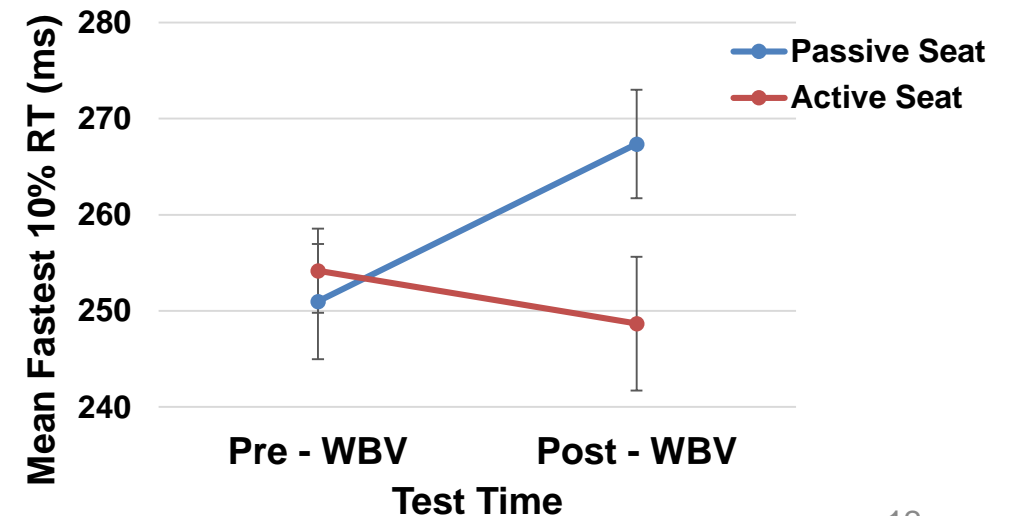
Mean RT



Mean Lapse Percentage



Mean Fastest 10% RT



Summary

- The original-fitted passive, air-suspension seat had 2-fold higher WBV exposures relative to the active-suspension seat.
- Compared to the passive suspension seats, truck drivers were better able to maintain vigilance when operating the truck with the active suspension seat.
 - Consistent with previous studies (Wang & Johnson, 2014; Du et al., 2017)
- Appears reducing WBV can affect and reduce/delay cognitive fatigue.

Limitations

- Small sample size
- PVT cannot be assessed while driving
 - No real time monitoring of vigilance

Practical Implications

- Contribute to growing evidence that vibration reducing seats may help reduce/delay driver fatigue.
- The reduction in WBV exposure may ultimately contribute to a reduction in fatigue-related accidents, injuries and their associated costs.

Practical Implications

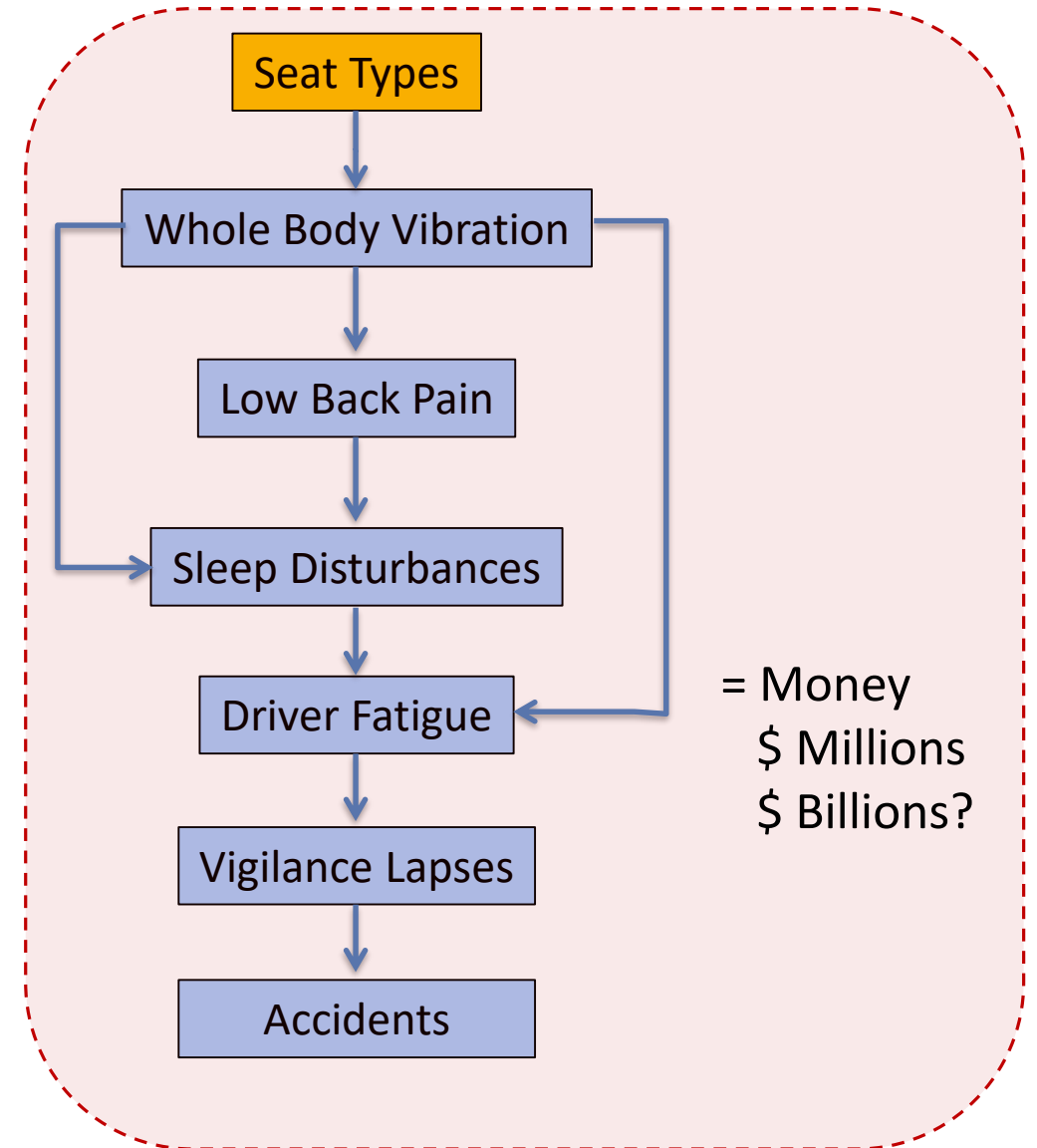
Better Seats = may save money



**Industry
Standard
Passive Suspension
Seat**



**Vibration
Cancelling
Active Suspension
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Reference

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