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/s²)
Seats, WBV and Vigilance

Industry Standard Passive suspension Seat

Vibration Cancelling Active Suspension Seat

Seat Types

- Whole Body Vibration
- Low Back Pain
- Sleep Disturbances
- Driver Fatigue
- Vigilance/Lapses
- Accidents
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)
• 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.
Results

- Significant differences (50% reduction, p < 0.0001) in the seat measured WBV exposures between the two seating conditions.
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 \((p = 0.021)\).
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

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= Money
$ Millions
$ Billions?
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Reference


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