

Can cab engineering create passive improvements in driver sleep, health, and fuel efficiency?

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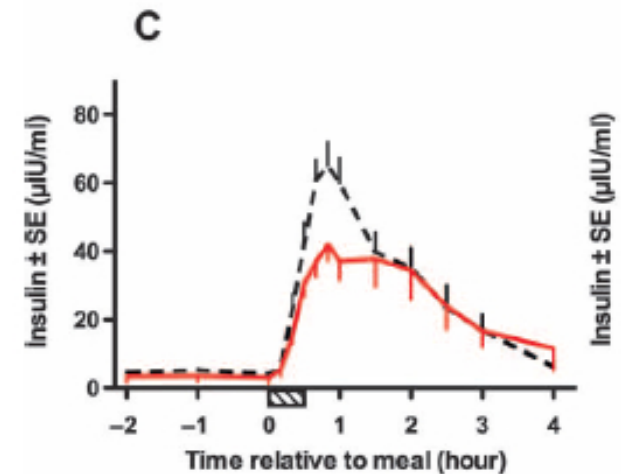
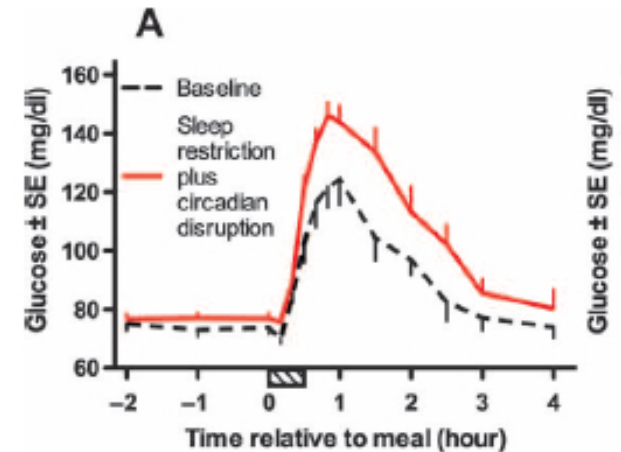
Where are we going?



- Driving and cab impacts on sleep/health
- Daimler naturalistic study findings
- Need for scientific U.S. trials

Sleep and circadian disruption: impacts on physiology and behaviors

- Metabolism
 - **impaired insulin and glucose response** in healthy people (at right)
- Inadequate Sleep
 - **20% increase in calories consumed**
(Brondel, 2001)
- Exercise
 - **50% reduction in sleep disorders**
(Sherril, 1998)



(Buxton et al, 2012)

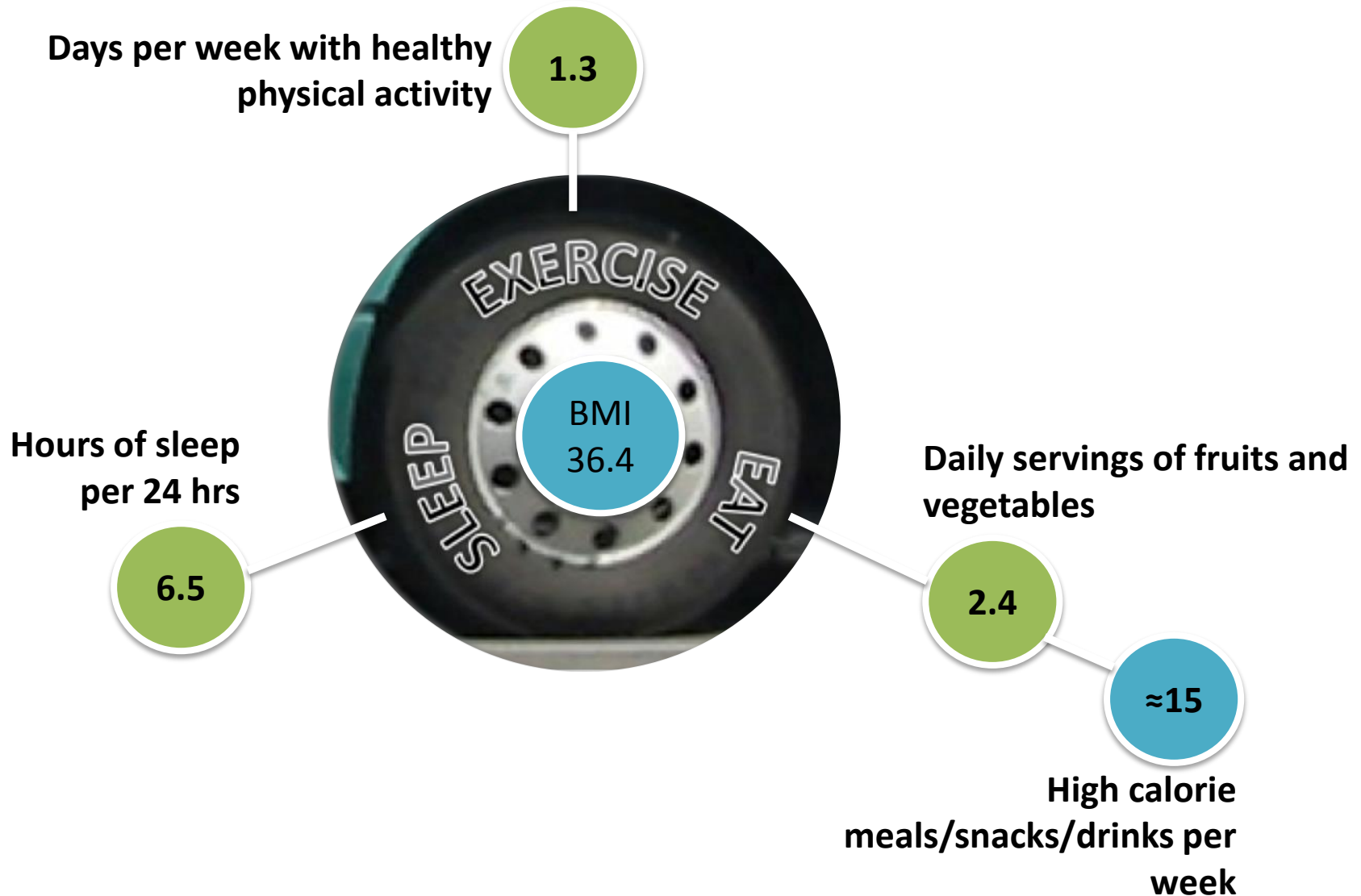
Driver health:

*Long work hours + shift work + sedentary
+ poor food options*



- **86%** of truck drivers are overweight or obese (2x gen pop)
- An obese driver incurs **\$1,000** more in health care costs annually
- Obesity, diabetes, sleep apnea
= **double+** crash risk
- Average cost of a fatal crash is **\$3.6 million**

SHIFT Randomized Trial: Wave 1 Baseline Means





Driving hours and cab impacts

- Van Dongen et al (2014) naturalistic study
 - **On duty driving: sleep = 6.1 hrs**
 - **Restart home: sleep = 8.8 hrs**
- Lab and sleeper berth studies of noise effects
 - cardiovascular reactivity, sleep structural changes, increased latency to REM stage
- Dinges et al (2002)
 - Driving = more awakenings, less REM, 50% worse sleep efficiency vs. home

Driving Trucks and Sleep

- Irregular work and sleep patterns
- Noisy truck stops
- Environmental challenges (heat & cold)
- Schedule pressures
- Lack of parking



Daimler Trucks Top Fit Program



Driver Health & Wellness Research & Development

Noise Impact on Driver Sleep

- Popp et al (2008) naturalistic driver study

- Highway Noise: sleep = 6.2 hrs
- Control: sleep = 6.36 hrs

- REM On-set: 89 min
- REM On-set: 69 min

- Arousals/hr 16
- Arousals/hr 14

- Increased reaction times and errors



Daimler ECO Driver Study

- Rothe et al (2009) naturalistic driver study
 - Control vs. Sleep deprived Significant Difference?
 - Subjective Sleep quality Yes
 - Subjective & Objective drowsiness Yes
 - Objective driving performance Yes
 - **Rested drivers used 2.26% less fuel (100k miles/\$1,700 yr.)**
 - **Rested drivers used the service brake 30% less**



Daimler Customer Fleet Study

- Rothe et al (2008) naturalistic driving study
 - Top Fit Truck vs. Series Actros (fleet trucks)
 - Top Fit: enhanced sound insulation, bed and seat
 - 12 customer fleet drivers
 - 2 weeks in each truck: normal route & working schedule
 - **Average fuel savings with Top Fit truck 4.52% (850 gallons/100,000 miles = \$3,400)**

Daimler Truck Study New Actros

- Rothe et al (2012) naturalistic driving study
 - New Actros 2011: with Top Fit Truck enhancements
 - New Actros vs. Old Actros
 - **Reduced mental stress (EEG)**
 - **Improved fuel efficiency with New Actros**



Discussion

- Daimler Trucks naturalistic driving studies
 - Cab engineering positively impacted driver sleep
 - Rested drivers were more economical drivers
 - However, small samples, short durations, and European routes were used in studies
- Daimler Trucks implemented Health & Wellness Features in New Actros (2011)
- **Same results under U.S. driving conditions?**

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