



# THE LEADER

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## HAND-ARM VIBRATION HAZARDS

features continued

## 34 Whole Body Vibration: The Wrong Chair Can Impact Your Driver's Health and Hinder Your Bottom Line

Back injuries, particularly lower back pain (LBP), are among the most prevalent and costly non-lethal medical conditions affecting adults. A number of scientific studies have shown an association between an exposure to vehicle-related whole body vibration (WBV) and the development of LBP. The potential adverse health effects associated with the exposure to whole body vibration is common knowledge to our neighbors over in Europe, where they have a health standard to limit a worker's exposure to whole body vibration; but the same can't be said for those of us working in the United States.



## 38 The ABC's of Identifying, Assessing And Reducing Vibration Exposure In the Workplace

Most of us don't think about being exposed to vibration, but we are on a daily basis: when we drive our cars, mow the lawn and even when we are riding a bike on a rough surface. These exposures are usually short-term and may result in a tingling feeling or temporary discomfort. However, many people working in a number of different industries are exposed to vibration through the daily use of powered hand tools. These workers may develop a condition known as hand-arm vibration syndrome (HAVS).

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BY PETER JOHNSON, PhD

# WHOLE BODY VIBRATION

**The Wrong Chair Can Impact Your Driver's Health**



**B**ack injuries, particularly lower back pain (LBP), are among the most prevalent and costly non-lethal medical conditions affecting adults. A number of scientific studies have shown an association between an exposure to vehicle-related whole body vibration (WBV) and the development of LBP (for a summary, see the National Research Council publication).<sup>1</sup>

The potential adverse health effects associated with the exposure to WBV is common knowledge to our neighbors over in Europe, where they have a health standard to limit a worker's exposure to WBV; but the same can't be said for those of us working in the United States. Currently, the U.S. only has voluntary standards for controlling a vehicle operator's exposure to WBV.

WBV is created as a vehicle travels over terrain and the perturbations from the terrain are transmitted from the floor of the vehicle, through the seat suspension and into the driver. The musculoskeletal system and the body's organs then dissipate the vibration energy as it travels through the body. One body structure heavily affected by these vibrations is the spine. The frequency of the vibration entering the spine matches the spine's natural frequency and the movements in the structures of the spine are accentuated. If you remember seeing the Tacoma Narrows Bridge clip as a kid, where the frequency of the wind energy matched the natural frequency of the bridge, making the bridge move violently until it failed, WBV has a similar effect on a vehicle operator's spine. Unfortunately, the adverse health effects associated with WBV are not limited to the back alone. WBV may also contribute to cardiovascular, gastrointestinal, nervous and urological disorders. The bottom line is that efforts should be made to reduce you or your employees' exposure to WBV when possible.

Seat research has shown that the type of seat suspension matters and will affect how much of the vehicle-generated vibration is transmitted to the operator. Around 60 years ago, the only protection from WBV was the foam padding used in the seat cushion. It was typical for the seat to adjust only in height, and there was no shock absorbing capability in the seat suspension. In the 1960s, mechanical suspension seats were introduced followed by air-suspension seats in the late 1970s. Both of these seat suspension advancements were thought to incrementally reduce a vehicle operator's exposure to WBV.

A seat's performance can be measured by taking the ratio of vibration measured at the seat of the operator and dividing it by the vibration measure from the vehicle floor. This ratio indicates the percentage of the vehicle-generated vibration being transmitted to the seat of the operator, with lower values indicating better seat performance (less vibration transmission). Research has shown that investing in a quality constructed seat may be a cost effective way to reduce a worker or vehicle operator's exposure to WBV.<sup>2</sup> In a simple study comparing a mechanical and an air-suspension seat made by the same seat manufacturer (Grammer Seating, Hudson, WI), in a group of 13 forklift operators, the slightly more expensive air suspension seat was shown to attenuate 55 percent of the vehicle transmitted vibration and have lower WBV exposures relative to the mechanical suspension seat. Just like a loan with a slightly higher interest rate, the slightly higher WBV exposures with the mechanical seat may accumulate over time leading to earlier injury onset and/or greater levels of LBP.

**and Hinder Your Bottom Line**



(left) Industry standard air-suspension seat; (above) Cab-over truck

Vehicle design can also affect WBV exposures and worker health. One of the major epidemics that all employers will face is the aging of the workforce as the baby boomers make their way towards retirement. Ensuring your most experienced older workers stay healthy will take on even greater importance over the next two decades. To evaluate the impacts of vehicle design,<sup>3</sup> WBV exposures were compared between a European cab-over light duty truck where the driver sits over the front axle and a conventional North American truck where the cab is situated behind the front axle. There were substantial differences in WBV exposures between the two vehicles with the conventional truck's WBV exposure 25 percent lower compared to the cab over truck's exposure. Additionally, the ease of

getting in and out of the cab was much greater and the impact on the joints much lower in the conventional truck where the floorboards are much lower to the ground. Although companies may choose the less-expensive cab-over design, the down-road and down-stream expenses associated with the day-in and day-out wear and tear on the driver's body may exceed the procurement savings. Most companies do not take the downstream, hidden, claims-related medical costs into a procurement decision, but

if they did, they may be surprised by the substantial, long-term cost savings.

Although air-suspension seats performed well in our forklift tests, we find different seat performance results in on-road vehicles which travel at higher speeds (e.g. city buses and semi-trucks). At higher speeds, the typical air-suspension seat may only attenuate between 5–15 percent of the vehicle-induced vibrations. A common problem arises when suspension seats wear out; the seat's suspension can "bottom out", hitting the end range of downward travel and sending an impulsive shock to the driver. These seat-induced shocks can be two- to ten-fold higher than the road perturbations that created the seat movement. Anecdotally, many of the oldest bus drivers stated that they preferred their 1950's era bus seats with no suspension. Additionally, many truck drivers state that they prefer to bleed the air-out of their air suspension seat, in order to reduce how much they bounce around. Bleeding the air out of the seat is referred to as "low-riding", and low riding is frowned upon because smaller saturated drivers may have reduced visibility.

In Europe, some of these old-school, 1950's era height-adjustable suspensionless seats are still being produced and sold.

In a group of 16 drivers, we tested one of these old school seats in a bus, and found that relative to the industry standard air-suspension seat, there were no differences in WBV exposures between the two seat types. This indicates that there may be



## UNIVERSITY OF WASHINGTON ERGONOMICS PROGRAM

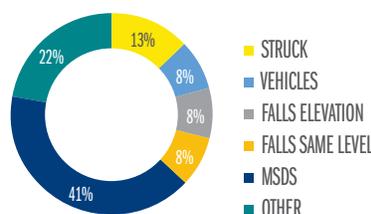
### The Estimated Average Cost per Claim and Total Cost of All Claims

INJURY GROUP TYPE	LOST WORK TIME CLAIMS	
	AVG. ESTIMATED COST PER CLAIM	AVG. TOTAL COST \$1,000,000
VEHICLES	\$46,500	68
FALLS FROM ELEVATION	\$36,700	69
FALLS FROM SAME LEVEL	\$30,300	51
MSDS	\$29,600	265
STRUCK BY OTHER	\$23,700	68
OTHER	\$21,500	104
ALL TYPES COMBINED	\$29,500	641

### Injury Rates per 100 FTE for Trucking Industry Groups Compared to All Industries in Washington State



### Occupational Injury and Illness in the Trucking Industry by the Injury Type





(above) Conventional truck; (right) Modern, height-adjustable pedestal seat



some merit behind the old timer bus drivers' preferences for suspensionless seats. Alternatively, some of the fancier semi-truck seats have two air controls, one air control adjusts the seat height and the other air control adjusts the seat stiffness. These dual control seats are relatively new to U.S. semi-trucks and have yet to be formally tested. Consequently, if the driver sets the correct height and then stiffens the seat suspension, they may have the best of both worlds, a less bouncy ride without the dangers associated with low-riding.

Finally, after 30 years of very little change, vehicle seating may be entering a renaissance. Around three years ago, Bose Corporation came out with a truck seat which cancels out much of the vehicle-induced vibrations reaching the driver. The seat uses vibration cancellation algorithms which are similar to those used in their noise-cancellation headphones. Using a group of 16 truck drivers, we tested Bose's active suspension seat against an industry standard air-suspension seat, and relative to the air suspension seat, the Bose seat reduced the drivers exposure to WBV by 50 percent.<sup>4</sup> These seats are not necessarily cheap (\$3,995 to \$5,995 each, depending on the quantity), but with a musculoskeletal-related work-loss claim costing trucking companies on average \$30,000 and injury rates three to four times higher than most other industries, there may be a payback, especially where older, more experienced drivers are concerned. Finally,

there may be other less expensive seating solutions on the horizon. We have evaluated an air-filled seat cushion originally designed to absorb the impulsive shocks when a military vehicle drives over improvised explosive devices (IEDs). Compared to the current standard form used in most seats, the IED seat cushion reduced WBV exposure by 25 to 30 percent. These seat cushions are not commercially available yet, but hopefully we will see them on some seats in the future.

Cushion, seat and vehicle design can substantially influence a vehicle operator's exposure to WBV. As a result, the procurement of seats and vehicles merit close attention when exposure to WBV is a concern. Rather than making procurement decisions on price alone, the long-term health savings by investing in superior equipment may far outweigh the short-term savings. 

### Further Reading

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