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EVALUATING THE INFLUENCE OF TRACTION CHAINS ON WHOLE-BODY VIBRATION EXPOSURES AMONG PROFESSIONAL LOADER OPERATORS

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Introduction

Chronic exposure to whole body vibration (WBV) among heavy equipment operators has been found to significantly increase the risk of developing low back pain (LBP)[1-2]. A recent meta-analysis on HEV operators illustrated that the relative risk for LBP among HEV operators is 2.21, indicating that this worker population has more than twice the risk of developing LBP compared to non-HEV operators[3]. The installation of traction chains is expected to significantly increase WBV exposures to HEV operators compared to the stock rubber tire condition. The goal of this study was to compare whole-body vibration (WBV) exposures between three front-end loader tire conditions.

Methods

Utilizing a standardized test route and a repeated measures design, WBV exposures were compared when twelve experienced front-end loader operators drove the same front-end loader with three different tire conditions (Figure 1), stock rubber tires, 2) stock rubber tires with ladder traction chains, and 3) stock rubber tires with basket traction chains.

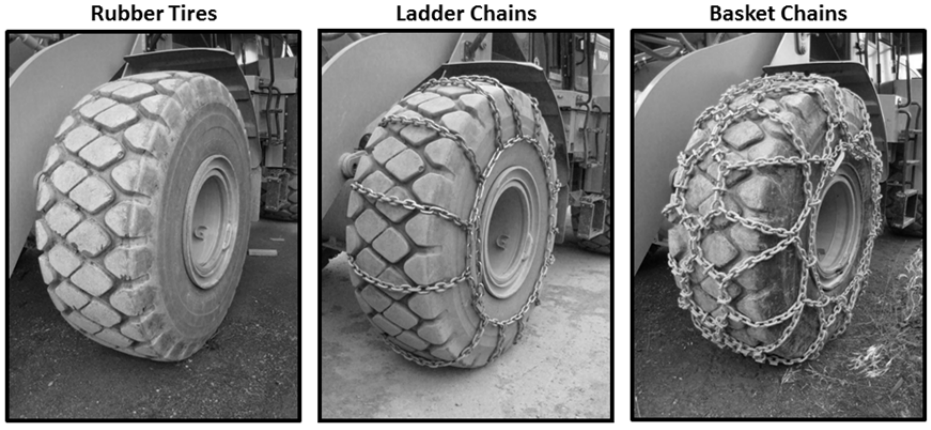

Figure 1. Tire configurations tested in the WBV exposure assessment.

The test route was designed with input from the operators to simulate a typical day of exposures faced by HEV operators. The test route included a segment of driving on paved city streets, a simulated plowing task which included five uniform passes, and a scooping and dumping task. All testing was conducted in the city of Valdez, Alaska. A tri-axial seat pad accelerometer was mounted on the operator's seat and a second tri-axial accelerometer was securely mounted on the floor of the loader directly adjacent to the seat. A data acquisition system was used to collect exposures and data were normalized to represent 8-hour raw ($S_{ed}(8)$ and time weighted average (A(8), VDV(8)) WBV exposures.

Results

When comparing tire conditions, there were significant differences in WBV exposures with the ladder style chains producing the highest WBV exposures as compared to the stock rubber tire or basket chain conditions. As shown in Table 1, according to both ISO 2631 Part 1 parameters (A(8) and VDV(8)) front-end loaders equipped with basket style chains result in lower z-axis WBV exposures than ladder style chains during the standardized driving task.

Table 1. Mean (±SE) Z-Axis WBV exposures for the driving task grouped by tire condition [n=12]. Conditions with different superscripts are significantly different.

	Tire Conditions			
Parameter	**Rubber**	**Basket**	**Ladder**	**P-value**
A(8) (m/s^2)	0.47^a (±0.03)	0.46^a (±0.03)	0.74^b (±0.04)	<0.0001
VDV(8) ($m/s^{1.75}$)	9.2^a (±0.9)	10.1^a (±1.1)	12.7^b (±0.8)	0.01
Speed (km/hr)–	30.3^a (± 0.2)	25.0^b (± 0.3)	26.6^b (± 0.2)	<0.0001

Discussion

Long-term WBV exposure has been linked to occupationally-related low back pain. The key findings of this study were the substantial differences in vibration exposures between the basket and ladder chain conditions, the similarity in vibration exposures between the rubber tire and basket chain conditions, and the task-based differences in vibration exposure across driving, scooping and dumping, and plowing tasks. When selecting traction devices for professional operators it is important that employers consider the associated WBV exposure differences between different types of chains. The results of this study indicated that, ladder style chains have significantly higher WBV exposures than basket style chains.

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