CHARACTERISTICS OF WHOLE-BODY VIBRATION FREQUENCIES AND LOW BACK PAIN IN URBAN TAXI DRIVERS

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Introduction

Occupational exposures to whole-body vibration (WBV) at different frequency domains may differentially affect human comfort and the musculoskeletal system. Under this presumption, a frequency-based weighting scheme has been adapted in many widely accepted standards for WBV measurement. However, there is very little human data showing a direct link between WBV frequency and musculoskeletal disorders. We conducted an epidemiologic study to examine the association between WBV frequency and prevalence of low back pain (LBP) and to identify determinants of specific frequencies associated with LBP in urban taxi drivers.

Methods

The WBV frequency data were collected from 247 professional drivers (aged 44.6±8.3) who participated in an exposure validation study [1] of the Taxi Drivers' Health Study (TDHS) in 2000. [2] In accordance with the ISO 2631-1 (1997) methods, we measured the frequency-weighted acceleration over drivers' seat surface, under conditions representing randomly assigned destinations. We developed a WBV record-replay system at the Liberty Mutual Research Institute (LMRI) in Hopkinton, MA, USA. This system includes two tri-axial accelerometers (PCB Piezotronics, NY, USA), one RD-130T PCM data recorder (TEAC, Tokyo, Japan), and one LMWBV meter 2.0 (LMRI, MA, USA). Only the vertical axis of seat-surface WBV frequency was used in this study. To characterize the WBV frequency curve, we manually identified the presence of any peak within each of the following frequency range: <4, 4-10, 10-20, and >20 Hz. Information about the operating vehicles and driving environment was either collected from the vehicle registration record (manufacturer, year of make, transmission, engine size, etc.) or directly measured (wheel-base length, seat inclination, etc.). Structured interviews were conducted by an occupational physician to gather information on LBP that had led to medical attention or absence from driving in past year. We used multiple logistic regression to estimate the prevalence odds ratio (OR) associated with the presence of each index peak frequency, adjusting for age, body mass index, professional seniority, daily driving hours, seat inclination, and the intensity of predicted root-mean-square WBV exposure in m/sec^2. For any revealed WBV frequency that was associated with LBP, we constructed a multiple logistic regression model to identify the personal and vehicle characteristics associated with the presence of WBV peak within the indicated frequency range.

Results

Of the 236 (96% of 247) all male drivers who had WBV frequency data, 47% complained LBP in the past year. Of all classifiable frequency curves, the proportion of having an identifiable peak, respectively for <4, 4-10, 10-20, and >20 Hz, was 71%, 93%, 47%, and 56% respectively. Drivers whose frequency curves did not reveal the presence of peak frequency < 4Hz had the lowest LBP prevalence (37%). Results of multiple logistic regression showed positive associations between the presence of peak frequency <4 (p=0.06) or 4-10Hz (p=0.35) and increased 1-year prevalence of LBP, with estimated prevalence OR=1.98 (95% confidence [CI]: 0.98-4.01) and 1.74 (95%CI: 0.54, 5.59). No positive associations were found with the presence of peak frequency either at 10-20 or >20Hz. As average driving speed increased, the probability of having a low-frequency (<4Hz) peak on WBV curve increased in a quadratic-linear manner (p<0.001). Other significant determinants of the presence of a WBV peak frequency <4Hz included: engine size <1500c.c. (OR=1.72, 95%CI: 1.46, 9.70) and manufacturer (p<0.001). Our preliminary analyses did not suggest any statistically significant associations with other vehicle or drivers' characteristics.

Discussion

This was the first epidemiologic study linking LBP with WBV frequency profile obtained by directly measuring frequency during the exposure. Our preliminary analyses indicated that the presence of a low-frequency (<4Hz) WBV peak was associated with higher 1-year prevalence of LBP. Although we noted a positive association with the presence of a WBV peak near the resonance frequency of 4-6 Hz, the limited variability of the WBV frequency curve across the 4-10 Hz range, probably as a result of applying the ISO 2631-1 (1997) frequency weighting function, might have precluded the possibility of finding any statistically significant association. We also identified driving speed, engine size, and manufacturer as the most significant determinants of the presence of a low-frequency (<4Hz) WBV peak. Further analyses will examine the association of LBP with the estimated intensity of each WBV peak, and also to identify the determinants of any peak WBV intensity that correlates, if any, with LBP in urban taxi drivers. If the positive association between low-frequency (<4Hz) WBV and LBP was further confirmed, experimental research should look into the biomechanical effects and other pathophysiological changes related to WBV exposure at this frequency range.

References

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