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A REVIEW ON WHOLE BODY VIBRATIONS TOWARDS HUMAN

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ABSTRACT

In today's highly competitive global economy, many organizations are forced to consider more towards their worker's health performance in order to be competitive. Thus, the understanding of ergonomic is very crucial. In ergonomic, whole-body vibration is one of the most important factors that should be emphasized. There are evidences of a relationship between occupational driver and musculoskeletal disorder, which show that the whole-body vibration could contribute to the musculoskeletal disorderin the occupational driver. Many researchers had published studies on whole-body vibration in developed countriesbut none was done for Malaysian drivers. The main objective of this paper is to carry out a critical analysis of literature review on the effects of whole-body vibration towards human. This study will explain the recent literatures related to the postural, physiological and psychological affected by whole-body vibration. This review would help the researchers, academicians and practitioners to take a closer look on how the vibration will affect Malaysian drivers' performance especially in the vehicles and transportation industry.

Keywords: Whole-body vibration, musculoskeletal disorder, driver

INTRODUCTION

The past decade has seen rapid development of Malaysia's automobile and transportation industries. Malaysia's automobile industry has contributed to the economy in terms of employment, exports and revenue from taxes and it has played a major role for the manufacturing sector's growth in Malaysia (Mahidin&Kanageswary, 2004).In 2005, there are 1, 675, 221 people working in manufacturing industry and 23, 521 people working in motor vehicle manufacturing in Malaysia (Department of Statistics Malaysia, 2008). Apart from contributing to the economic growth and job opportunities, this sector could also create an issue such as work-related musculoskeletal disorder. The important high risk groups are drivers of off-road vehicles (for example, earth moving, forestry, and agricultural machines), drivers of forklift trucks, lorries, or buses, crane operators, and helicopter pilots.

There is substantial epidemiologic evidence of associations between physical ergonomics exposures at the workplace, such as lifting, constrained postures, repetitive movements, fast work pace, heavy material manual handling, forceful exertions and vibration, and the occurrence of upper extremity musculoskeletal disorders (Bernard et al., 1997; Grieco et al., 1998; Hagberg et al., 1995; National Research Council and Institute of Medicine, 2001; van der Windt et al., 2000). One of the types of vibration mentioned here is whole-body vibration(WBV).Various definitions have been given to WBV by dictionaries, companies, and authors themselves. WBV is defined as vibration occurring when a greater part of the body weight is supported on a vibrating surface. WBV principally occurs in vehicles and wheeled working machines. In most cases exposure to WBV occurs in a sitting position and the vibration is then primarily transmitted through the seat pan, but also through the back rest. WBV may impair performance and comfort. It has also been claimed to contribute to the development of various injuries and disorders. In many work situations WBV is therefore an evident and annoying occupational health problem (Griffin et al., 1990).

LITERATURE REVIEW

Effects of whole-body vibration to musculoskeletal disorders

Occupational, non-occupational, and individual risk factors play a role in the development, the duration, and the recurrence of musculoskeletal disorder. Presently, musculoskeletal disorders are the most common workdisorders faced by the drivers. The term musculoskeletal disorder (MSD) refers toconditions that involve the nerves, tendons, muscles, and supporting structures ofthe body (Bernard et al., 1998). Tendinitis, epicondylitis and low back pain are examples ofmusculoskeletal diseases (NIOSH USA, 1997). Work-related low back pain represents the most costly musculoskeletal disorders(Woolf andPfleger, 2003).

Many studies have been conducted to investigate the prevalence of musculoskeletal disorders pain among working population especially for the drivers. Table 1 concluded about the recent studies involved in WBV. Joubertand London (2007) had determined the association between back belt usage and back pain amongst forklift drivers exposed to WBV. Low back pain (LBP) has been identified as one of the most costly disorders among the worldwide working population and sitting has been associated with risk of developing LBP (Lis et al., 2007).

It was shown that sustaining trunk sitting postures corresponding to mining vehicle operators generates back muscle fatigue and postural balance (Santos et al., 2008). On the other hand, Noorloos et al. (2008) had been concluded that occupational participants exposed to WBV, with a high BMI do not have an increased risk for the development of LBP, so the focus should be on other factors. WBV impaired postural control of the trunk as evidenced by the increase in kinematic variance and non-linear stability control measures during unstable sitting and a mechanism by which vibration may increase low back injury risk (Slota et al., 2008). A dose-response pattern between exposure to WBV and LBP in a group of drivers contributed to the onset of driving-related LBP (Tiemessen et al., 2008). Subashi et al. (2009) indicated that the lumbar back discomfort is caused by horizontal WBV.

Newell and Mansfield (2008) investigated the influence of sitting in different working postures on the reaction time and perceived workload of subjects exposed to WBV in the vertical and fore-and-aft directions for off-road machine operators. In recent years, it has been found that when subjects are exposed to random WBV, even with the same frequency-weighted rms acceleration signals according to the ISO 2631-1 standard which consists of different frequency spectra will elicit different degree of comfort. Thus, Maeda et al. (2008) hadclarified the relationship between physical values of vibration stimuli applied to the whole-body and the perceived degree of comfort.

A study was done to numerically determine the levels of vibration not to exceed accordingly to the corresponding dynamic stresses in the lumbar rachis when exposed to WBV in order to identify the risk of adverse health effect to which professional heavy equipment drivers are particularly prone (Ayari et al., 2009). The extent of intraspinal forces under WBV depends on several factors like multiple excitations of different body parts, stature and posture. The effects of these forces are determined by individual tolerances. Hence, there is no direct and simple relationship between WBV and health risk of the lumbar spine. Seidel et al. (2008) had used dynamic FE models for the predictionof intraspinal forces caused by real exposure conditionsmeasured in European countries.

Vehicle vibration exposure has been linked to chronic back pain and low-back symptoms among agricultural tractor drivers. Mayton et al. (2008) had assessed the driver of the WBV exposures and recommend interventions to reduce the risk of back-related injuries. Predicted health risks, associated with the operation of load-haul-dump (LHD) vehicles, based on ISO 2631-1 criteria are limited and have not yet been determined according to ISO 2631-5 criteria. Therefore, health risks predicted by ISO 2631-1 and 2631-5 criteria wasdone to report the limited information regarding the characteristics of WBV exposure associated with the operation of LHD vehicles, a description of vibration measured at the operator/seat interface (Eger et al., 2008).

Table 1: Review on MSD Effects due to Whole-body Vibration

Author	**Purpose of Study**	**Industry**	**Research Methodology**	**Effects**
D.M. Joubertand L. London(2007)	To determine the association between back belt usage and back pain amongst forklift drivers exposed to WBV	Forklift drivers	Questionnaire	Low back pain
A. M. Lis et al. (2007)	To assemble and describe evidence of research on the association between sitting and the presence of low back pain	Occupational groups	Critically reviewed	Low back pain
B.R. Santos et al. (2008)	To evaluate the acute effects of seated WBV exposure on the sensorimotor system	Large mining load haul dump vehicles	Experimental	Back muscle fatigue and postural balance
D. Noorloos et al. (2008)	To determine whether body mass index (BMI) influences the risk of low back pain in a population exposed to WBV	Occupational vehicles	Questionnaire	Low back pain
G.P. Slota et al. (2008)	To measure the acute effect of seated WBV on the postural control of the trunk during unstable seated balance	Occupational groups	Experimental	Impaired spinal stability

Table 1: Continue

Author	Purpose of Study	Industry	Research Methodology	Effects
Ivo J.H. Tiemessen et al. (2008)	To analyze of a dose-response pattern between exposure to WBV and low back pain in a group of drivers	Occupational drivers	Questionnaire	Low back pain
G.H.M.J. Subashi et al. (2009)	To investigate the correlation between subjective and dynamic responses of seated subjects exposed to fore-and-aft and lateral vibration, focusing on the effects of vibration magnitude with both responses	Occupational drivers	Experimental	Lumbar back discomfort
G.S. Newell & N.J. Mansfield (2008)	To investigates the influence of sitting in different working postures on the reaction time and perceived workload of subjects exposed toWBV	Off-road machine operators	Experimental	Low back pain
S. Maeda et al. (2008)	To clarify the relationship between physical values of vibration stimuli applied to the whole-body and the perceived degree of comfort	Occupational vehicles	Experimental	Lumbar back discomfort
H. Ayari et al. (2009)	To study the dynamic behavior and stress distribution in the lumbar vertebrae when exposed to low-amplitude mechanical vibrations	Heavy equipment drivers	Experimental	Micro-fractures in the spine
H. Seidel et al. (2008)	To use dynamic FE models for the prediction of intraspinal forces caused by real exposure conditions measured in European countries	Mobile machinery drivers	Experimental	Lumbar spine discomfort
A.G. Mayton et al. (2008)	To assess driver WBV exposures and recommend interventions to reduce the risk of back-related injuries	Agricultural tractor drivers	Experimental & Questionnaire	Low back pain
T. Eger et al. (2008)	To report the limited information regarding the characteristics of WBV exposure associated with the operation of LHD vehicles, a description of vibration measured at the operator/seat interface	Load-haul-dump (LHD) vehicles	Experimental	Musculoskeletal disorder

CONCLUSION

Empirical studies show that there is a relation between an occupational drivers and WBV that lead to musculoskeletal disorders. But, from the scenario of Malaysian population, there is insufficient research on this problem. As mentioned by Baba Md.

Deros et al. (2009), in Malaysia, the awareness of back pain due to work is still at a budding stage. The issue is considered new in Malaysia compared to other developed countries, and it is still being promoted by the professionals especially the Occupational Safety and Health (OSH) practitioners to enhance the awareness level to all Malaysians. Because of insufficient knowledge of diseases affected by WBV, the drivers find difficulty to know exactly the exposure of WBV to them, and how much they have been exposed. In addition, there is still lack of the real-time equipment to analyze the exposure of WBV towards the occupational drivers. As a conclusion, more studies are needed to provide clear evidence of the association between WBV and musculoskeletal disorders especially on Malaysian occupational drivers. Thus, this study of the effects of WBVtowards human should be continued in order to improve drivers' performance in vehicles and transportation industry.

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