Whole body vibration in the South African mining industry

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Abstract

Large numbers of workers in the South African mining industry are exposed to vibration. Vehicle operators and drivers in particular are exposed to whole body vibration (WBV). Very little data is available quantifying the exposure. The most common adverse health effect associated with driving a vehicle is low back pain. Back pain is common in the general population and vehicle drivers often perform other tasks such as lifting and loading. The posture of drivers may also be a confounding factor. The effects of WBV are difficult to study. The weight of evidence in the literature from many countries suggests a consistent and strong association between vehicle operation and low back pain. In Europe there is legislation to control exposure to WBV. There is no legislation governing exposure to WBV in South Africa. SIMRAC is developing capacity to measure and monitor WBV in the South African mining industry.

Introduction

The human response to vibration is described in terms of hand-transmitted vibration and whole-body vibration (WBV). Hand-transmission occurs through the hand whilst holding a vibrating tool. If the exposure is of sufficient duration and intensity, hand arm vibration syndrome (HAVS) may develop. In 1998, a Safety in Mines Research Advisory Committee (SIMRAC) study reported that rock drills used in the mining industry had the potential to cause HAVS. A more recent SIMRAC study has shown that HAVS occurs in South African gold miners and is associated with the use of rock drills.

Workers are exposed to WBV when the body is supported on a surface that is vibrating. Static machinery can cause floors and work platforms to vibrate, but the most common way in which a worker is exposed to WBV is through the seat of a vehicle. The vehicle’s engine, machinery attached to the vehicle and the road surface may all contribute to the vibration received by the driver, operator or passengers.

Whole body vibration (WBV) is commonly experienced in the mining industry from a variety of vehicles used in surface and underground operations. There is a scarcity of data in the public domain concerning WBV in the South African mining industry. A Chamber of Mines Research Organisation (COMRO) study in 1987 and a SIMRAC study in 1998, on equipment and vehicles used in the South African mining industry, showed that a large number of vehicle operators were exposed to whole body vibration.

Scope of problem

Neither the number of workers exposed in South African mines, nor the magnitude of the exposure is known. However, the literature does give some indication of occupational exposure. In Great Britain it is estimated that 9 million people are exposed to WBV in the course of their work. The most common self-reported symptom associated with WBV is low back pain (LBP). In the USA, back pain is calculated to be the most frequently filed claim for workers compensation, accounting for approximately 25% of all claims.

Although there has been no documented evidence of WBV-induced disease in the SA mining industry, the potential for vibration-induced disease was highlighted in a COMRO study and a SIMRAC report. SIMRAC GEN 503 reported on the levels of vibration from vehicles used on mines. It was shown that articulated dump trucks, bulldozers, front-end loaders, hydraulic shovels and tractor tippers exposed the drivers to the highest levels of vibration. Variables, such as how well the vehicle is maintained and the condition of the road surface, contribute to the level of vibration that is transmitted to the driver. Potentially, therefore, a large number of workers in the South African mining industry are exposed to WBV.

Health effects

While the number of exposed workers may be large, little is known and understood about the possible health effects of such exposures.

There is a good deal of literature from other countries concerning the association between WBV and adverse health effects. A search of the literature up to 1998, by Teschke et al., 1999, identified over 400 articles. The more recent literature has been reviewed in 2002. A good deal of the literature, how-
ever, is of questionable scientific merit. Many studies are poorly designed with inadequate controls. Confounding factors have not been taken into account and there are no clearly defined criteria for diagnosing WBV-induced disease8,9.

The effects of WBV may be divided into the more easily recognised acute effects and the more controversial long term effects.

**ACUTE EFFECTS**
In experiments designed to test the tolerance to short term vibration, back pain is not reported10. At low vibration frequencies of less than 20 Hz, symptoms of motion sickness have been reported along with general symptoms of discomfort. At accelerations above 0.315 m/s² subjects begin to complain of discomfort. At accelerations above 2 m/s² subjects are extremely uncomfortable. These acute effects of vibration are not disputed and can impair visual perception and the ability to control a vehicle11.

**LONG TERM EFFECTS**
The long term effects of WBV are more controversial12. The most common self-reported symptom associated with WBV is lower back pain (LBP). Some authors refer to ‘lumbar syndrome’ (LS), which includes LBP, sciatica and lumbar disc herniation. Regular exposure to WBV, while operating a vehicle, is strongly associated with back pain10. However, only a few studies have demonstrated any pathological damage to the back10,15. Studies of LBP and WBV have been unable to show conclusively a cause and effect or a dose response relationship. There are many reasons for this. LBP is common in the general population, whether they have been exposed to WBV or not10,11,13. There are no clinical or pathological features of LBP that are specifically associated with or are unique to WBV exposure. There are many confounding factors that make a study of the association difficult. Vehicle drivers often perform tasks other than driving, such as loading or maintaining the vehicle. These confounders and, in particular, the posture of the driver may also contribute to LBP. The relationship between WBV and LBP is, therefore, difficult to study. There is overwhelming evidence from the literature that LBP is associated with many vehicle operating jobs. These jobs expose the vehicle opera-
disturbances are specifically related to exposure to WBV.

STANDARDS

The South African Bureau of Standards (SABS) has adopted ISO 2631 as SABS 2631-1 as the standard for measuring whole body vibration. Guidelines can also be found in BS 6841. WBV is measured by placing accelerometers under the seats of vehicles. The standards for measuring equipment are covered in ISO 8041. SABS 2631 does not set exposure limits or action levels.

There are no South African standards governing exposure limits to WBV and there is no defined limit for vibration for vehicle operators.

Despite the lack of clear evidence in the literature for a cause and effect relationship, the European Parliament has approved legislation for the European Union (Directive 2002/44/EC) to protect workers from the risk of adverse health effects from WBV. Standardised to a working day of 8 hours, an action level has been set at 0.5 m/s² with an exposure limit value of 1.15 m/s². The highest vibration dose, measured in three axes is used to calculate the daily dose (in accordance with chapters 5, 6 and 7, Annex A and B of ISO standard 2631-1).

CONCLUSION

The adverse health effects of long term exposure to WBV remain unproven. Unlike the effects of hand-transmitted vibration, the health effects due to exposure to WBV are not clearly defined. WBV is not specifically mentioned in the Compensation for Occupational Injuries and Diseases Act (Act 130 of 1993). In South Africa, to date, no occupational disease has been attributed to WBV and no worker has been compensated.

There are many difficulties and confounding factors associated with research in this area. So far, research that has been carried out has failed to establish evidence of a dose response between WBV and LBP. There have been no intervention studies to show that reducing exposure to WBV reduces the incidence or prevalence of LBP in a working population. Such prospective, cohort or intervention studies would have to span a minimum 5 year period.

However, in situations where there is exposure to WBV, there does appear to be an association between the occupation of the vehicle driver and LBP.²,³,⁴,¹⁰

In Europe, the increased risk of LBP to vehicle drivers has prompted legislation to limit WBV exposure.

If South Africa adopts its own standards or follows international standards, there needs to be a development of capacity for measuring and monitoring WBV. SIM 020703, a SIMRAC project on seat transmission of vibration, will begin to address this.

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