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Implementation of ergonomic programs to reduce sick leave due to low back pain among nickel mining operators

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ABSTRACT

Whole body vibration (WBV) has been recognized as a main risk factor for low back pain (LBP) in coal mining activities. Heavy equipment operators in nickel mining may be exposed to a higher LBP risk due to the land condition of the overburden overlying nickel deposits, which is less stable than that of coal deposits. This report summarizes the efforts of a nickel company in managing LBP complaints among mining operators. The programs included risk assessment and mitigation, musculoskeletal complaint management, LBP training, and macroergonomic intervention. These programs were integrated into the occupational health management system of the company. Within a 3-year period, a decrease in LBP-related sick leave was reported. The present report shows how ergonomic programs may help to manage LBP and could be extended to other musculoskeletal cases.

1. Introduction

Low back pain (LBP) has been reported as the most common musculoskeletal complaint worldwide. As many as 15% of adults, in general, suffer from frequent back pain or pain lasting more than 2 weeks, and 37% of LBP is attributable to occupational risk factors (Punnet et al., 2005). It is also estimated that 15% of the total number of sick leave days annually is due to LBP (Kuijer et al., 2014). We refer to the definition of LBP, proposed by Punnet et al. (2005), as any nontraumatic musculoskeletal pain or disorder affecting the low back. In addition to direct medical costs, companies also pay referral costs to the national hospital and incur costs related to lost production time. Such indirect costs have been estimated to account for 30%–95% of the total cost (Tymecka-Woszczerowicz et al., 2015), depending on the severity of the case.

Previous studies have concluded that there is an association between occupational factors and LBP among miners, with whole body vibration (WBV) as the main factor (Mandal and Srivastava, 2010; Xu et al., 2012). Significant levels of shock and WBV during mining activities over extended periods could elevate the spinal load, may cause muscle fatigue in the supporting musculature, and seems to be linked to thinning of the intervertebral discs (Blood et al., 2010), early spinal degeneration (Chen et al., 2003), and herniated lumbar disc (Boshuizen et al., 1992; Bovenzi, 2009).

The present report documented the implementation of a 3-year ergonomic program in a nickel mining company in Indonesia, which aimed to reduce the sick leave rate due to LBP among nickel mining operators. The company produces nickel through opencast mining by using heavy earth-moving machineries, such as heavy-duty dump trucks (haul trucks), shovels, graders, and excavators. The operation of such machines is associated with prolonged sitting and high exposure to WBV, which are both known to be main risk factors for LBP (Amari et al., 2014). The risk may increase due to awkward posture while driving and, perhaps, psychosocial stressors (Widanarko et al., 2015). Compared with several coal mining companies we have worked for, the issue of LBP in this nickel company seems to be more severe. Although there is limited evidence, the more serious LBP issue may be related to the difference in topsoil characteristics between coal and nickel mines. The topsoil and rock (overburden) overlying nickel deposits seem to be less stable than that of coal deposits. Therefore, nickel mining workers may be exposed to higher vibration compared with coal mining workers.

In the beginning, the company poorly managed the LBP issues of its workers, as indicated by the following:

- Activities with high risk of LBP were not mapped.
- The WBV exposure of the operators has never been measured and monitored.
- Yearly medical checkups failed to detect LBP cases early. Further, the results of the checkups and medical examination of workers

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with LBP were not communicated to the occupational health management. No diagnosis was provided in relation to occupational factors.

- There was no standard procedure for handling LBP injury in the medical emergency response plan.
- The training and health promotion programs on LBP were limited.
- Job rotation was not applied as a strategy to reduce the WBV exposure of workers who had experienced LBP. An initial field survey of 74 workers who had LBP complaints in 2012 showed that as much as 43% of them have never been rotated. Only 15% of these workers have been rotated to two different types equipment; i.e., 9% was rotated between a haul truck and a dozer, 3% between a haul truck and a grader, and 3% between a dozer and a grader.

Initially, a pilot ergonomic program was established in response to workers' complaints of low back pain (LBP), which seemed to increase substantially among heavy equipment operators. The complaints raised by the operators varied, ranging from intermittent back pain to herniated nucleus pulposus (HNP), based on medical records. The pilot program was aimed to measure the WBV exposure from selected heavy equipment. Based on the results of the program, management commitment was attained. We hypothesized that the company needs comprehensive programs to manage its LBP cases, including: risk assessment and monitoring, musculoskeletal complaint management, LBP training, and macroergonomic intervention to reduce LBP-related sick leave days. These programs were integrated into the occupational health management system of the company. They were designed to be cost-effective because the company had undertaken a budget reduction due to nickel price decreases in recent years.

2. Risk assessment

The first step toward managing LBP risks was to investigate the main LBP risk factors. Because the use of heavy equipment and machinery was prominent in most mining operations, we hypothesized that the WBV imposed by such equipment was among the main factors. Therefore, WBV measurement was carried out to quantify the existing WBV and to develop recommendations for risk mitigation.

2.1. Procedures

A total of 53 heavy equipment operated by the Department of Process Plant and the Department of Mining were sampled to obtain baseline data for the WBV measurement (Fig. 1). Two sets of portable whole body vibration (WBV) data acquisition systems (Svantek SV-100 and 3M™ Quest Vibration Monitors, Meters, and Analyzers) were used to collect raw WBV data. The systems had triaxial seat pad accelerometers connected to data loggers and were located on the seat and on the floor of the heavy equipment (Fig. 2). Duct tape was used to prevent the accelerometers from slipping away during the measurement. The equipment were calibrated by using the method recommended by the manufacturer. After each measurement, the obtained data were copied to a laptop computer for further processing.

The operator was briefed about the purpose of the measurement before the actual procedure was carried out and was given the option to decline participation in the study. To ensure that representative work cycles were measured, the WBV measurement for each heavy equipment consisted of a minimum of continuous 20-min duration. Care was taken to ensure that the heavy equipment was operated at normal and regular operating conditions (in terms of speed, route, and activity). More specifically for the haul truck, the measurement duration was designed to represent a cycle of operation, including loading, hauling, dumping, and returning to the loading point. Based on interviews with supervisors, a 20-min duration was considered adequate to represent a complete work cycle.

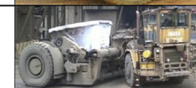
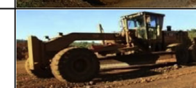
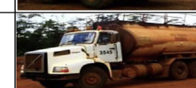
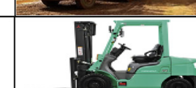
Equipment Type		Quantity
Haul Truck		11
Haul Master		6
Dozer		6
Wheel Loader		6
Grader		5
Excavator		4
Compactor		2
Water Truck		1
Fuel Truck		1
Dump Truck		2
Trailer Truck		4
Lowboy		1
Forklift		4
Total		53

Fig. 1. Number of sample for the WBV measurement.

The analysis was done according to ISO 2631–1:1997 and EN 14253:2003. The exposure was considered to be of no risk when the daily exposure, A(8), was up to 0.5 m/s^2 and the vibration dose value (VDV) was up to 9.1 m/s$^{1.75}$. Moreover, the exposure was deemed to be of risk when A(8) was above 1.15 m/s^2 or VDV was above 21 m/s$^{1.75}$. Because two sets of vibration meters were used (i.e., located on the seat and on the floor of the heavy equipment), the effectiveness of the seat suspension could be evaluated.