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The influence of wood hardness and logging operation on coupling forces exerted by lumberjacks during wood harvesting

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ABSTRACT

Petrol chain saws commonly used in forestry cause mechanical vibration, which may lead to the development of non-specific disorders in upper extremities of the chain saw operator, referred to as hand-arm vibration syndrome (HAVS). Progress of HAVS depends on the intensity of mechanical vibration transmitted throughout the body, which is directly proportional to coupling forces applied to the vibration tool. The aim of the study was to measure coupling forces exerted by lumberjacks on chain saws and find correlation between force magnitude, hardness of cut wood and kind of logging operation.

Coupling forces exerted by workers with right and left hands were measured by means of hydro-electronic force meter. All measurements were done during harvesting wood in real work conditions.

Maximal temporary forces exerted by woodcutters reached 275 N. The smallest average forces of 27 N were registered while limbing. During felling and cross-cutting chain saw operators exerted larger forces, reaching 50 N.

The findings of this study suggest that coupling forces used by woodcutters during logging depend on wood hardness and kind of logging operation.

Relevance to industry: This study shows the relationship between coupling forces, wood hardness and technique of cut which are further expected to enhance our knowledge on the assessment of vibration exposure. Nowadays, understanding how changes in harvesting technique affect the magnitude of coupling force, should lead to improvements in ergonomic design of the tool and the workplace.

1. Introduction

Petrol chain saws are commonly used by lumberjacks in the process of harvesting wood. Excessive overloading of the body with vibration, which are purposefully produced by chain saws, may after some time may lead to the development of sensorineural, vascular and musculoskeletal disorders in upper extremities of the chain saw operator, referred to as hand-arm vibration syndrome (HAVS) (Färkkilä et al., 1986). Many studies have suggested that the magnitude of the hand force exerted on a vibrating tool handle affects the severity of HAVS and hand-wrist cumulative trauma disorders (Pyykkö et al., 1976; Radwin et al., 1987). Different couplings of the hand to a vibrating surface can affect the human body in two different ways. A tight hand-tool coupling increases the transmissibility of vibration to the hand and arm (Aldien et al., 2006; McDowell et al., 2006). Moreover the coupling can result in a synergistic effect with vibration exposure which affects anatomical structures, such as the vascular system, nerves, joints, tendons.

The effect of coupling forces on transmissibility of vibration to the hand is well-known for many years (Hartung et al., 1993; Riedel, 1995; Pyykkö et al., 1976; Adewusi et al., 2010). Even though coupling forces are still not taken into consideration in the risk assessment. Safety standards are based on the measurements of the acceleration of mechanical vibrations emitted by a tool according to its frequency components and time of exposure while the contribution due to the hand force is ignored. Other factors which can modify the intensity of mechanical vibration transmitted throughout the body, i.e. position of the body, hand size, condition of the machines, are not determined in the risk and health assessment too. Therefore, a disparity between the measured exposure to vibrations and the health effects that occur in the exposed workers is often observed (Bovenzi and Zadini, 1990; Harazin et al., 2006a).

A simultaneous measurement of the vibration coming from vibrating tools and the forces applied to the tools by their operators is significant from the health point of view. For several years international standard ISO 15230:2007 concerning the

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