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Evaluation of hand-transmitted vibration exposure on basis of a questionnaire

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The implementation of European directive 2002/44/EC has raised the question also in Finland about the current exposure to hand-arm vibration (HAV) and its consequences on workers' health. In this study we collected data on different worker groups in metal and aircraft industry by a questionnaire about their exposure to HAV and symptoms of upper extremities. We found that the more the workers were exposed to HAV the more they reported finger blanching, numbness and tingling of fingers in cold and musculoskeletal symptoms of upper extremities. The distribution of symptoms of a group exposed to impulsive vibration was strikingly different. The results indicate that a short compact questionnaire can be recommended to screen the exposure to HAV and health effects of HAV at a workplace.

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1 Introduction

Hand-arm vibration (HAV) has been known to cause the vibration-induced white finger (VWF) syndrome for the past hundred years. Classical VWF has been considered to be a typical occupational disease of forestry workers. Technical improvements in chain saws have reduced the vibration, and the incidence of VWF has diminished worldwide. However, the negative health effects of HAV have not disappeared, but are, instead, prevalent in many occupations in which vibrating handheld tools are used, for example, among metal workers, grinding workers and riveters. In addition to attacks of finger blanching, HAV has been shown to cause neurosensory symptoms, musculoskeletal disorders of the upper limbs, and carpal tunnel syndrome (CTS). In a study of Swedish car mechanics, 24% of the workers reported VWF in a questionnaire [1].The prevalence of VWF reported in occupations of the metal industry varies from 5% to 31% [2, 3]. The number of cases of VWF varies depending on whether the diagnosis is based on information from a questionnaire or on the results of clinical examinations. According to the Register of Occupational Diseases in Finland, the number of reported cases of VWF has been 10-26 annually [4]. Most have occurred in forestry or agricultural work, but the second largest group consists of various metal workers. Still, it is uncertain whether or not the number is underestimated. The aim of this study was to evaluate the symptoms of VWF, neurological disorders and upper-extremity musculoskeletal disorders and their relation to exposure to HAV in a population of Finnish metal workers, and to see if the adverse health effects of impulsive type of vibration are different. We also wanted to test usability of a short questionnaire that contained questions of symptoms related to HAV and the self-estimation of the worker about the exposure to HAV.

2 Materials and methods

A questionnaire on symptoms of finger blanching, numbness and tingling, decreased grip force, manipulative dexterity or pain in the upper extremity, neck or shoulder, as well as current exposure to HAV, was sent to the 530 metal workers in the Pirkanmaa region in middle Finland [5]. These workers were chosen randomly from the register of the Metalworkers' Union. Altogether 285 (54%) workers returned the questionnaire after two reminders. The workers who reported finger blanching, numbness or tingling of the fingers or symptoms of CTS (n=133) filled comprehensive questionnaire focussing on cumulative exposure to HAV and upper arm symptoms. The data on metal workers reported here are based on the results of the questionnaires of 133 participants. The metal workers were divided into three categories according to their cumulative vibration exposure (I, II and III). They were typically not exposed to very impulsive vibration.

In addition, the same questionnaire formula was sent to a group of 22 riveters. Riveting is an example of highly impulsive vibration.

The vibration exposure over lifetime was asked. The cumulative HAV dose was calculated as a HAV index determined on the basis of the questionnaire, in which jobs, tools and active work time (hours/day, days/week, moths/year) had been requested. The average daily HAV exposure was calculated with the equation $a_{8h}=a_m \sqrt{x/8h}$, where a_m is the vibration of the machine and x is the daily exposure time. An index, AI, describing the total HAV exposure was determined by AI= a_{8h}^2 x y x d, where I = cumulative exposure index (m^2ad/s^4), y = exposure time in years (a), and d = annual exposure time in days.

For the riveters, instantaneous vibration values was measured. For the metal workers, general information on grinding and other tools were used.

3 Results

Table I shows estimated vibration exposures. In group III there is a possibility that the exposure to vibration exceeds the action levels and in riveters even the limit value proposed by the European directive.

Table I Evaluation of vibration exposure in different groups of metal workers and riveters.

group	n	impulsive vibration	exposure, years (mean)	average daily exposure, m/s2	cumulative exposure index, AI
metal workers I	37	partly	6	0,5	<5000
metal workers II	70	partly	21	1,7	5000-35000
metal workers III	26	partly	27	2,9	>35 000
riveters	22	mostly	16	11	660 000

Evaluation of metal workers' and riveters' exposures to HAV and the risk of VWF can be seen in Figure 1. The median daily vibration level in the total group of metal

workers (I,II and III) was 2.4 m/s². According to the ISO 5349 standard concerning cumulative exposure to HAV, the risk of VWF was over 10% for more than half of the workers. In the group of riveters the measured average instantaneous vibration value could be very high (4-150 m/s^2). For the riveters the daily vibration level exceeded the limit value and the risk of VWF was over 50% for all workers in the group.

Figure 2 shows the symptoms of different groups of metal workers and riveters. In the groups of metal workers I, II and III the prevalence of most of the symptoms increased as the cumulative vibration index increased. For the group of riveters, who were exposed to impulsive vibration, pain and numbness were prominent. Especially, neck and shoulder pain were often reported. Interestingly, the symptoms of white fingers were reported less often by the riveters than by the other metal workers although according to the ISO standard they had a significantly higher risk of VWF.

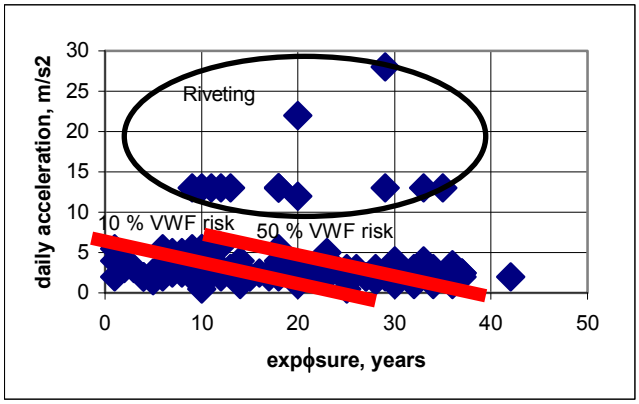

Figure 1. Vibration exposure of metal workers compared to exposure of riveters. Vibration white finger risk lines (10% and 50%) have been calculated according to a standard ISO 5349.

4 Discussion

The study revealed that the exposure of metal workers varied 1-5 m/s^2, and the average was 2.4 m/s^2 that is close to the action value of European directive. In the group of riveters the limit value of 5 m/s^2 was clearly exceeded. However, the estimation of the cumulative exposure may be biased, because the evaluations of life-long vibration exposure were based on the participants' own recall. For the impulsive vibration the exposure is even more difficult to estimate. The amount of daily usage of tools is crucial in this evaluation and there is evidence that the exact action time is difficult to estimate [6].

For the riveters the measured average instantaneous vibration value could be very high (4 - 150 m/s^2). However, for this group the duration of vibration impulses were very short, and the daily action time could often be overestimated. This may result in overestimation of the cumulative vibration dose and subsequently overestimation of the risk of VWF. According to ISO standard all riveters should have more than 50 % probability of VWF symptoms (Figure 1), but only about 18 % of the respondents recognised white finger symptoms. Another explanation may be that those having serious symptoms and consequently difficulties at work have already left the work. Intermittent exposure to very short periods of impulsive vibration may also be less hazardous to the vascular system than continuous exposure [7]

According to our study, exposure to HAV among Finnish metal workers is common, and the cumulative exposure is relatively high. Symptoms related to hand arm vibration syndrome, as well as musculoskeletal symptoms of the upper extremities increased according to increasing vibration exposure for metal workers (Figure 2). However, the riveters' spectrum of symptoms was different, the musculoskeletal symptoms being reported most often. The repetitive minimal trauma to muscles and tendons caused by impulsive vibration may explain why the riveters reported so often pain in upper extremities and neck.

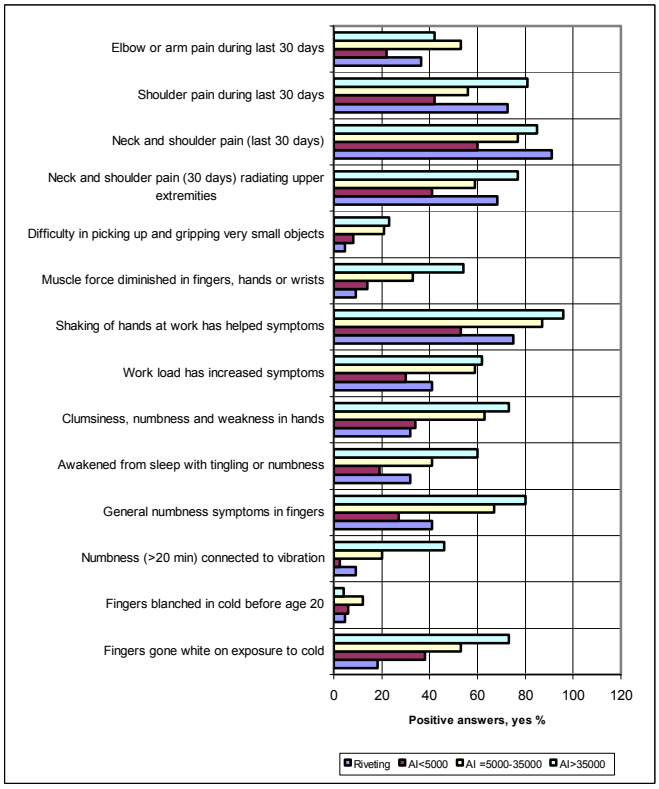

Figure 2. Reported symptoms of riveters (impulsive vibration), less exposed (AI<5000), moderately exposed (AI 5000-35 000) and most exposed (AI>35 000) metal workers

Neurological disorders were common among the metal workers exposed to HAV. In another Finnish study involving a 19-year follow- up of forestry workers, the prevalence of VWF decreased, but numbness increased from 23% to 40% [8]. Numbness was associated with upper-extremity musculoskeletal disorders, which were common also in our study. Metal workers use vibrating handheld tools, but they also perform repetitive, forceful movements that may partly explain the musculoskeletal problems. Ergonomic problems were not explored in this study but they may explain why musculoskeletal symptoms were common especially among the riveters.

The use of a short questionnaire helps the workplace and occupational health personnel to estimate the vibration exposure and occurrence of symptoms related to vibration exposure. Therefore, it is a first step practical tool for vibration risk analysis. Although the questionnaire has many disadvantages, inaccuracies and it may not estimate exposures and health effects correctly, it does the first

evaluation and screening. The use of symptoms of metal industry workers does not necessary work on other branches of industry. A questionnaire also helps to recognise workers who are sensitive to the effects of vibration which is required according to the European directive.

There are many examples of international questionnaires for evaluation of exposure to HAV and symptoms. The disadvantage of these is the large number of questions which decreases the compliance of the workers to fill in such a formula. Our experience with a short screening questionnaire was quite promising. However, to evaluate the cumulative vibration dose expertise is needed.

5 Conclusion

Work with vibrating tools in the metal industry not only causes VWF, but is also often related to neurological and musculoskeletal symptoms. The higher the cumulative vibration dose is, the more common are the adverse health effects. Impulsive vibration exposure seems to be related to a different spectrum of symptoms than non-impulsive vibration. Exposure to HAV and symptoms can be recommended to screen at workplaces by a short questionnaire.

References

[1]. Barregaard, L, Ehrenström, L. and Marcus, K. "Hand-arm vibration syndrome in Swedish car mechanics" Occupational and Environmental Medicine **60**, 287-294 (2003)

[2]. Bovenzi, M. and Petronio, L., "Epidemiological survey of shipyard workers exposed to hand-arm vibration" International Archives of Occupational Environment and Health **46**, 251-266 (1980)

[3]. J. Starck, J and Pekkarinen, J "Physical characteristics of vibration in relation to vibration-induced white finger" American Industrial Hygiene Association Journal **51**(4), 179-184 (1990)

[4]. Finnish Institute of Occupational Health, "Ammattitaudit [Statistics of occupational Diseases]" (Finnish Institute of Occupational Health, Helsinki, 1993- 2002)

[5]. Sauni, R., Pääkkönen, R., Toppila, E. and Uitti, J., Prevalence of vibration induced white finger in a population of Finnish metal workers. 11th International conference of hand arm vibration, Bologna Italy, 3-7 June 2007.

[6]. Palmer, K-T., Haward, B., Griffin, M.J., Bendall, M and Coggon, D. "Validity of self reported occupational exposures to hand transmitted and whole body vibration" Occupational and Environmental Medicine **57**, 237-241 (2000)

[7]. Mason H, Poole K. Evidence review on the clinical testing and management of individuals exposed to hand transmitted vibration. Faculty of Occupational Medicine of the Royal College of Physicians, London (2004).

[8]. Sutinen, P., Toppila, E., Starck, J., Brammer, A., Zou, J. and Pyykkö, I., "Hand-arm vibration syndrome with use anti-vibration chain saws: 19-year follow-up study of forestry workers" International Archives of Occupational and Environmental Medicine **79**(8), 665-671 (2006) environment?", *J. Acoust. Soc. Am.* 107, 28-34 (2005)