A Descriptive Study of Women Injured by Hand–Arm Vibration

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The aim of this study was to describe the symptoms and the prognosis of vibration injuries in women. The investigation was based on a study of 374 women who had reported an injury due to hand–arm vibration to the Social Insurance Office or had received financial compensation from the Swedish Labor Market Insurance scheme during 1988–1997. Information on, for example, self-rated health symptoms and vibration exposure was collected by means of a questionnaire. On average, the first symptoms started after 7 yr of exposure and the first visit to a doctor took place after 11 yr. Neurological symptoms developed after a shorter period of exposure compared to vascular symptoms, 6.8 and 9.2 yr, respectively. The prevalence of numbness at the time of reporting the injury was 91% and the prevalence of white fingers was reported by 54%. The occupational group with the highest prevalence of vibration injuries was dental technicians. Two thirds of the women had stopped using vibrating machines in their work. Among the women who suffered from white fingers when they reported the injury, 50% declared impairment or no improvement of the symptoms. One woman in five was retired and the same number of women had retrained due to the occupational injury.

Keywords: hand–arm vibration; white fingers; carpal tunnel syndrome; women; questionnaire

INTRODUCTION

The use of hand-held vibrating tools can cause various vascular, neurological, muscular and skeletal symptoms or disorders. The vascular symptoms are white fingers—an intermittent blanching of the fingers. The neurological symptoms include intermittent tingling, pins-and-needles sensations, paresthesiae and numbness (Griffin, 1990). The use of vibrating tools and high-force and repetitive hand–wrist movements are important risk factors for work-related carpal tunnel syndrome (CTS), which can cause pain, paresthesiae and numbness (Cannon et al., 1981; Delgrosso and Boillat, 1991; Hagberg et al., 1992; Tanaka et al., 1997; Viikari-Juntura and Silverstein, 1999). Muscular weakness, decreased grip strength and symptoms in the wrists, elbows, neck, shoulders and back may occur among vibration-exposed workers (Färkkilä, 1978; Dimberg et al., 1989; Musson et al., 1989; Bovenzi et al., 1991; Burdorf and Monster, 1991; Stenlund et al., 1993; Kihlberg and Hagberg, 1997; Ariëns et al., 2000). The symptoms may lead to a reduction in the quality of life and the ability to cope with job tasks and leisure activities (Gemne et al., 1993).

Previous research on vibration injuries has predominantly been done on men (Bylund, 1998). There are indications, however, that vibration-induced injuries could be more common in women (Dimberg and Odén, 1991). Women also seem to develop injuries after a shorter period of vibration exposure compared with men (Dart, 1946; Urban and Lukás, 2000). Therefore, there is an urgent need for additional studies on women.

Twelve per cent of the female members of the Swedish Trade Union Confederation are exposed to hand–arm vibrations in their working environment (Swedish Trade Union Confederation, 1996) and 2% of all women in Swedish working life use vibrating tools for more than a quarter of their working time (Statistics Sweden, 1997).

Against this background, the objectives of this study were to investigate what symptoms the vibra-
tion-injured women suffer from, in which professions the injuries occur, the prognosis for the injured women and after how long a period of exposure the symptoms appear.

**MATERIALS AND METHODS**

**Subjects**

The Swedish Workers Compensation System includes all employed, employees, self-employed persons and persons undergoing education. The employers are obliged to ensure that all work-related illness is reported to the Social Insurance Office. ISA, the Swedish Work Injury Information System of the National Board of Occupational Safety and Health, gets a copy of the reports. The illness should also be reported to AMF, the Swedish Labor Market Insurance scheme.

When the injured person has a reduced work capacity because of the illness, an inquiry is made. A financial benefit is obtained if the Social Insurance Office approves the illness as an occupational disease. AMF is managing a supplementary collective insurance scheme and might compensate for medical care, pain and suffering, and for lasting impairment of bodily functions.

The study base consisted of women born in 1934 or later, who during the years 1988–97 reported a disease to the Social Insurance Office, or had received financial benefit from AMF because of the injury. The data were extracted from the databases at ISA and AMF and the women in the study base were coded as ‘hand–arm vibration cases’. There was no information available on whether the injury was approved as an occupational disease related to hand–arm vibration or not.

The study base consisted of 941 women, when those who were deceased or had emigrated were excluded. In addition, 225 women who did not consider their injury to be related to hand–arm vibration were excluded. This information was retrieved from the reply form, through telephone calls or from a question in the questionnaire, where the women were asked to assess the cause of the symptoms. This means that among those who gave some sort of response to the questionnaire, more than a third stated that their injury was not related to hand–arm vibration or not.

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Women with possible constitutional white fingers and muscular or joint diseases were not excluded from the study.

**Questionnaire**

The questionnaire was partly developed on the basis of earlier surveys (Johansson and Hagberg, 1990; Nilsson and Jonsson, 1992; Atroshi et al., 1998). Questions were asked about neurological and vascular symptoms in fingers and hands, decreased hand strength, tremor, and pain in the hands and neck. To identify vascular symptoms, the subjects were asked ‘Do your fingers get white in the cold?’ and ‘Do you have a sensation of cold in your fingers?’ To identify neurological symptoms, the subjects were asked about symptoms of numbness. To identify constitutional white fingers, the subjects were asked ‘Did you have blanching fingers when you were a teenager?’ Questions concerning the history of vibration exposure were also included. Information was also collected on individual factors such as smoking habits, current work situation and other occurring occupational factors.

The questionnaires were sent by post and reminder letters were sent to the women who had not responded within 2 weeks. To those who had not responded even after two letters, questionnaires with fewer questions were sent.

Reply forms where the women could mark ‘Hand–arm vibrations are not the cause of my injury’ or ‘I don’t want to participate in this survey’ were also sent with the third letter.

**Vibration exposure**

Three different terms concerning the period of vibration exposure have been used in this study, as follows.

- First appearance of symptoms—the time when the first signs of symptoms appeared based on self-reported information.
- Recording day—mainly the first visit to a physician or any other medical personnel. Information concerning the date was obtained from ISA/AMF. The accumulated vibration exposure was calculated up to this day.
- Reporting day—the day when the injury was reported to the Social Insurance Office or the Swedish Labor Market Insurance databases. Information concerning the date was obtained from ISA/AMF. The questions concerning the prevalence of symptoms referred to this day.

The accumulated vibration exposure was calculated for each woman on the basis of self-reported yearly and daily exposure to hand–arm vibration up to the recording of the injury. Most of the women had specified what machine they had used. Information about this was also available from the ISA database. Information concerning the vibration level was received from measurement data from former studies (National Institute for Working Life, 2000). The
accumulated vibration exposure (mh/s²) was calculated as the product of the total numbers of hours (h) of exposure to vibration up to the recording day and the vibration level (m/s²) of the tools used. The calculation was based on 200 working days a year. For each period of maternity leave during 1988–97, 1 yr of exposure was subtracted.

The accumulated vibration exposure was categorized into the following three classes: 0–1599 mh/s², 1600–11999 mh/s² and ≥12000 mh/s². The class 1600 mh/s² represents a vibration exposure of 1 m/s² during 8 h/workday for 200 days/yr. The vibration level of 1 m/s² is the threshold limit according to the proposal to the Physical Agent Directive (Council of the European Union, 1989, 1993). In the annex of the International Standard ISO 5349-1 (International Organization for Standardization, 2001), it is suggested that 10% of a population, which is exposed to a vibration level of 3 m/s² for 4 h/day, will develop white fingers within 10 yr. Those figures correspond to an accumulated vibration exposure of 24000 mh/s²; 12000 mh/s² represents half of this value.

Statistical analyses

The statistical analyses were performed with SPSS. The χ² test was used to test for differences in categorical variables; the t-test was used to compare the mean values of continuous variables.

The prevalence was calculated as the percentage of the number of answers. The symptoms were classified into: ‘every day/night’, ‘several times/week’, ‘once a week’, ‘once a month’, ‘a few times a year’ and ‘never’. The symptoms were dichotomized so the answers ‘never’ and ‘a few times a year’ were considered as ‘no symptoms’. In some questions ‘I don’t remember’ or ‘I don’t know’ were alternate answers. Those were excluded from the calculation of prevalence figures.

Body mass index (BMI) was calculated as the women’s body weight/length² in kg/m².

RESULTS

The study group comprised 374 women. The professions have been divided into 17 groups (Table 1). One-third of the study group were metal-workers and 30% were dental and medical personnel. The table also shows the most common tools used in the occupational groups. Relative to the number of women in each occupational group, the dental technicians were at the highest risk of vibration injuries.

The average length of time from the initial vibration exposure to the first appearance of symptoms—and to the recording day—was shorter for neurological symptoms than for vascular symptoms (P = 0.06 and 0.002, respectively; Table 2).

Numbness and loss of grip strength were the most common symptoms at the time of reporting the injury (Table 3). Pain in the hands and symptoms from the neck/shoulders were also frequent complaints. Thirty per cent reported pain in the hands/fingers, numbness and blanching fingers. The prevalence of symptoms differed among the occupations.

Three per cent of the women reported that they had blanching fingers when they were teenagers and 9% reported that they had relatives suffering from white fingers. Twenty-eight women reported that they suffered from muscle and/or joint diseases, principally myalgia and rheumatoid arthritis.

The prevalence of some of the symptoms was age-related (Fig. 1), but not significantly.

The mean cumulative vibration up to the recording of the injury differed between the occupations (Table 4). The mean exposure was 4000 (95% CI 3100–4800) mh/s². More than half of the women had an accumulated vibration exposure of <1600 mh/s².

The prevalence of some of the symptoms was related to the accumulated vibration exposure (Fig. 2). Forty-three per cent of the women had undergone surgery for carpal tunnel syndrome. The prevalence of carpal tunnel surgery ranged from 17% for dental technicians up to 60% for metal workers. Those who had undergone a carpal tunnel operation had a significantly higher BMI (P = 0.001). The prevalence of carpal tunnel syndrome was not related to the accumulated vibration exposure.

A high proportion of the women (96%) reported that they performed repetitive hand movements and 86% reported that they had the same work tasks every day at the work-place where they got the vibration injury.

A high percentage reported current problems with household chores and leisure activities. Eighty-three per cent reported difficulties in carrying grocery bags, 80% that they were not able to cope with needlework and 70% had difficulties in handling small objects. Sleep interference was reported by 67% and one-third of the women stated that the injury had affected their relations with their family. The complaints were more frequent in the older age groups.

Twenty-nine per cent of the women were current smokers and 39% ex-smokers. The current prevalence of all symptoms, except vascular symptoms, was significantly higher among current smokers compared to non-smokers. As an example, 45% of women suffering from tremor in the hands were current smokers, while among women not suffering from tremor the smokers represented 17%.

The current vibration exposure differed between the occupational groups. Two-thirds of the women, principally unskilled workers, had stopped using vibrating tools in their work and had, at the time of the survey, other work tasks than they had when they reported the vibration injury. Among dentists and dental hygienists, on the other hand, 83 and 78%
respectively, still worked with vibrating tools. Two-thirds of them worked part-time.

Nearly half of those who had taken a new job (45%) had done so because of the vibration injury. Eighteen per cent of the women had retrained due to the injury and 22% were retired; 58% of the women were still active in working life.

Among the women suffering from vascular symptoms when they reported the injury and who were no longer exposed to hand–arm vibration, 2% reported total relief, 48% reported improvement, while 32 and 18%, respectively, reported no improvement or impairment. The degree of improvement was related to age when reporting the injury and when answering the questionnaire, but was not related to the time passed since vibration exposure stopped, or to accumulated vibration exposure (Table 5).

**DISCUSSION**

This study presents prevalence data on symptoms among Swedish women exposed to hand–arm vibration. Surprisingly, 30% of the study group were dental and medical personnel. The prevalence of symptoms differed between the different occupational groups. Dental technicians had the highest incidence of vibration injury related to the number of women in that occupation. The relative risk of getting a vibration injury was 680 times greater for dental technicians compared to the group with the lowest
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incidence (administrative personnel). The differences in the incidence of vibration injury between the occupational groups may also reflect the knowledge of the risk associated with vibration exposure. It is also related to the awareness of the obligation to report the injury. This may relate to the employer as well as to the activity of the occupational health service and safety representatives.

Neurological symptoms from the hands and fingers were more frequent than vascular symptoms, which is in agreement with previous studies (Pyynkö et al., 1978; McGeoch and Gilmour, 2000). Ninety-one per cent of the women suffered from numbness when they reported the injury, while 54% stated that they suffered from blanching fingers. Neurological symptoms are known to be the main reason among vibration-exposed patients for seeking medical care, as they cause the most troublesome problems (Strömberg, 1997).

The period of hand–arm vibration exposure before the first appearance of symptoms was on average 6.8 yr and the latent period until recording the injury was

Table 2. Average time of vibration exposure until the first appearance of symptoms and the recording day. The table also shows the age of the women when recording the injury. The table shows mean and 95% CI.

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Interval between initial exposure and first appearance of symptoms, yr (95% CI)</th>
<th>Interval between initial exposure and recording of the injury, yr (95% CI)</th>
<th>Mean age when recording the injury, yr (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fingers getting white in the cold</td>
<td>9.2 (7.0–11.4)</td>
<td>15.1 (12.3–17.9)</td>
<td>41.5 (38.8–44.1)</td>
</tr>
<tr>
<td>Numbness in the hands</td>
<td>6.8 (5.7–7.8)</td>
<td>10.3 (9.2–11.5)</td>
<td>39.2 (37.8–40.6)</td>
</tr>
<tr>
<td>All</td>
<td>6.8 (6.0–7.7)</td>
<td>10.8 (9.7–11.8)</td>
<td>39.9 (38.8–41.1)</td>
</tr>
</tbody>
</table>

Table 3. Prevalence rates of subjective complaints at the time of reporting the injury for some of the occupational groups. The prevalence is reported in %.

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Numbness in the hands</th>
<th>Decreased grip strength</th>
<th>Pain in the fingers</th>
<th>Pain in the neck/shoulders</th>
<th>Fingers getting white in the cold</th>
<th>Tremor in the hands/arms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Cleaners</td>
<td>83</td>
<td>10</td>
<td>73</td>
<td>8</td>
<td>82</td>
<td>9</td>
</tr>
<tr>
<td>Dental hygienists</td>
<td>94</td>
<td>16</td>
<td>69</td>
<td>11</td>
<td>75</td>
<td>12</td>
</tr>
<tr>
<td>Dental technicians</td>
<td>92</td>
<td>24</td>
<td>85</td>
<td>22</td>
<td>83</td>
<td>20</td>
</tr>
<tr>
<td>Dentists</td>
<td>79</td>
<td>15</td>
<td>69</td>
<td>11</td>
<td>72</td>
<td>13</td>
</tr>
<tr>
<td>Drivers</td>
<td>92</td>
<td>12</td>
<td>100</td>
<td>14</td>
<td>91</td>
<td>10</td>
</tr>
<tr>
<td>Metal workers</td>
<td>96</td>
<td>71</td>
<td>96</td>
<td>66</td>
<td>89</td>
<td>55</td>
</tr>
<tr>
<td>Wood product assemblers</td>
<td>100</td>
<td>16</td>
<td>100</td>
<td>16</td>
<td>100</td>
<td>14</td>
</tr>
<tr>
<td>All</td>
<td>91</td>
<td>244</td>
<td>88</td>
<td>220</td>
<td>80</td>
<td>189</td>
</tr>
</tbody>
</table>

Fig. 1. Prevalence of complaints related to age at the time of reporting the injury. The prevalence is reported in %. No. of answers = 189–226.
Previous studies on men reported a latent period of 11–19 yr, depending on job category (James et al., 1989; McGeoch and Gilmour, 2000). A Czech study showed that the average duration of vibration until the development of an occupational disease was shorter for women than for men (Urban and Lukás, 2000). However, comparisons between the latent period for women and for men are cautious, as the two groups seldom have the same work tasks. The study showed that vasospastic symptoms increased with higher vibration exposure. The mean value of the accumulated vibration exposure up to the recording of the injury was 4000 mh/s². More than half of the women had been exposed to

Table 4. Accumulated vibration exposure (mean, SD) and distribution of women in the three exposure categories. The vibration exposure concerns the conditions up to the recording day

<table>
<thead>
<tr>
<th>Occupational group</th>
<th>Accumulated vibration exposure (mh/s²)</th>
<th>Accumulated vibration exposure (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤1599 mh/s²</td>
<td>1600–11999 mh/s²</td>
</tr>
<tr>
<td>Administrative personnel</td>
<td>40 (120)</td>
<td>9</td>
</tr>
<tr>
<td>Agricultural workers</td>
<td>2000 (2100)</td>
<td>7</td>
</tr>
<tr>
<td>Chiropodists</td>
<td>8500 (3700)</td>
<td>7</td>
</tr>
<tr>
<td>Cleaners</td>
<td>1200 (1000)</td>
<td>11</td>
</tr>
<tr>
<td>Dental hygienists</td>
<td>720 (560)</td>
<td>20</td>
</tr>
<tr>
<td>Dental technicians</td>
<td>4800 (3800)</td>
<td>5</td>
</tr>
<tr>
<td>Dentists</td>
<td>1000 (490)</td>
<td>24</td>
</tr>
<tr>
<td>Drivers</td>
<td>2400 (1900)</td>
<td>5</td>
</tr>
<tr>
<td>Metal workers</td>
<td>4100 (6600)</td>
<td>57</td>
</tr>
<tr>
<td>Wood product assemblers</td>
<td>8400 (18000)</td>
<td>11</td>
</tr>
<tr>
<td>Steel/mould workers</td>
<td>22000 (26000)</td>
<td>4</td>
</tr>
<tr>
<td>All</td>
<td>4000 (8200)</td>
<td>199</td>
</tr>
</tbody>
</table>

Fig. 2. Prevalence rate of symptoms at the time of reporting the injury in relation to the accumulated vibration exposure. The exposure is presented in three intervals. The prevalence is reported in %. No. of answers = 192–260.

Table 5. Change of symptoms among women suffering from blanching fingers when reporting the injury and no longer exposed to hand–arm vibration. The table shows the change of symptoms related to accumulated vibration exposure, age when reporting the injury, age when answering the questionnaire and time passed since vibration exposure. The table shows mean and 95% CI

<table>
<thead>
<tr>
<th>Change of symptoms</th>
<th>Total relief/improvement (n = 32)</th>
<th>No improvement/impairment (n = 30)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accumulated vibration exposure, mh/s² (95% CI)</td>
<td>3800 (1500–6100)</td>
<td>4500 (1600–7500)</td>
<td>0.69</td>
</tr>
<tr>
<td>Age when reporting the injury, yr (95% CI)</td>
<td>39.7 (35.9–43.4)</td>
<td>45.9 (43.2–48.6)</td>
<td>0.008</td>
</tr>
<tr>
<td>Age when answering the questionnaire, yr (95% CI)</td>
<td>47.3 (43.5–51.1)</td>
<td>53.4 (50.8–56.0)</td>
<td>0.010</td>
</tr>
<tr>
<td>Time passed since vibration exposure, yr (95% CI)</td>
<td>6.2 (4.9–7.6)</td>
<td>7.1 (5.7–8.5)</td>
<td>0.37</td>
</tr>
</tbody>
</table>

10.8 yr. Previous studies on men reported a latent period of 11–19 yr, depending on job category (James et al., 1989; McGeoch and Gilmour, 2000). A Czech study showed that the average duration of vibration until the development of an occupational disease was shorter for women than for men (Urban and Lukás, 2000). However, comparisons between
<1600 m/s², which can be considered to be a very low exposure. The results reveal that the women had a high prevalence of symptoms, even though they had received a low accumulated vibration exposure. This might be due to the fact that women are more susceptible to vibrations, or that the injuries might also have other causes. One must also consider that, on average, women have two-thirds of the muscle strength of men (Laubach, 1976; Pheasant, 1983; Miller et al., 1993) and that machines, work-place layouts and safety equipment are most often designed for men.

A higher percentage of the women with symptoms were smokers, compared with those without symptoms. This concerns all the symptoms inquired about in the questionnaire.

Our study showed that women with a high BMI were at a greater risk of developing carpal tunnel syndrome, which is in accordance with previous studies (de Krom et al., 1990; Tanaka et al., 1997).

Sixty per cent of the women were no longer exposed to vibration. Half of those suffering from white fingers reported impairment or no improvement after the discontinuation of the exposure. A higher percentage of the women with neurological symptoms stated that their symptoms had improved, compared with women suffering from vascular symptoms. Recovery from vascular symptoms required more time than from neurological symptoms, while a previous study showed the opposite (Futatsuka et al., 1985). Studies have indicated that the vascular symptoms often persist for a long period, if they ever improve, even if the vibration exposure is reduced or discontinued (Östman et al., 1996). Non-smokers had a higher rate of improvement or total relief of symptoms compared with smokers. Our results are consistent with a study (Petersen et al., 1995) which showed that improvement of white fingers has a good prognosis in persons who stop using vibrating tools and who do not use tobacco.

The fact that a majority of the dentists and dental hygienists work part time might be a reason why a high proportion of them still have the same work tasks and why they still work with vibrating tools.

This study has some limitations which should be noted. It does not give a complete picture of all vibration-injured women in Sweden, since it is known that only a small proportion of work-related diseases are reported (Statistics Sweden, 1999) despite the obligation. This is mainly due to a new concept of occupational injuries with poorer compensation levels, which in turn leads to underreporting. Furthermore, the information on symptoms and occupational history is based on self-reports without medical validation, which could have resulted in recall bias. Therefore, the incidence figures probably underestimate the prevalence of vibration injuries among Swedish women. However, despite the limitations, the study indicates the occurrence of health hazards of occupational origin as the subjects experienced them and gives useful information about women injured by vibration. Several studies conclude that self-reported information on work history, occupational exposure and physical work situation is good enough to identify causes of problems (Bourbonnais et al., 1988; Viikari-Juntura et al., 1996; Torgén et al., 1997; Hollman et al., 1999). Other studies (Burdorf and Laan, 1991; Wiktorin et al., 1993), on the other hand, state that the reliability of questionnaire methods for the assessment of physical activity and postural load is not very high. Rosenstock concludes that health history information can be obtained by self-administered questionnaires (Rosenstock et al., 1984). Studies (Åkesson et al., 2000; Palmer et al., 2000) have shown that workers tend to overestimate occupational exposure to vibration.

There are no age-matched control data available concerning the prevalence of problems with household chores and leisure activities among Swedish women. The information on current disability is consequently limited.

The vibration exposure was roughly calculated from the average vibration level for the machine type in question, although the vibration level differs from machine to machine, according to age and wear.

The number of dropouts was high in this study. One reason for this could be that the survey included a large number of questions. Recollection problems might be another reason. There is probably a high percentage of women among the dropouts who do not regard the symptoms as related to hand–arm vibration, which has probably led to an underestimation of the incidence figures.

The prevalence of Raynaud’s phenomena among women is reported to be 10–20% (Leppert et al., 1987). Among the women in this study, 3% reported that they had blanching fingers when they were teenagers. This has not been taken into consideration when calculating the prevalence figures.

The fact that a third of the women did not consider hand–arm vibration to be the cause of the injury was not expected and could be due to several factors. The classification of the injury in the databases might be wrong and the women might not be aware of the detrimental effects of hand–arm vibration and might, for example, consider repetitive movements to be the main reason for the symptoms.

In the study, we found that the accumulated vibration exposure was relatively low. The symptoms could be caused by ergonomic or non-environmental factors, but there is also a possibility that women are vulnerable to vibration. These questions require further investigation.

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REFERENCES


Dart E. (1946) Effects of high speed vibrating tools on the approximation of laws of the member states, relating to physical workload, vibrations and mercy.