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Quality of life in Swedish workers exposed to hand-arm vibration

Running head: quality of life in workers exposed to hand-arm vibration

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ABSTRACT

The objective of this study was to analyse whether differences existed among hand-arm vibration (HAV) exposed workers in regard to quality of life issues. One hundred and eight male workers from a heavy manufacturing plant with and without HAV symptoms and workers referred to a hand surgery department with severe HAV symptoms participated in the study. The participants were administered a clinical interview, a physical examination of the hands, Göteborg Quality of Life instrument, and Evaluation of Daily Activity Questionnaire [EDAQ]. Results indicated that workers referred to a hand surgery department with more severe HAV symptoms described a lower quality of life, here defined as lower subjective wellbeing, more symptoms of ill-health, and ADL difficulties, than workers with no HAV symptoms. Workers from a heavy manufacturing plant with HAV symptoms experienced more ADL difficulties, especially while working outdoors in cold weather, than workers with no HAV symptoms. Limitations of the study include the use of a subjective scale to describe hand-arm vibration symptoms. Further research is recommended on a larger sample of workers at risk for HAV symptoms, to develop preventative ergonomic strategies.

Key words: Ergonomics, hand-arm vibration, quality of life

Introduction

Hand-arm vibration syndrome (HAVS) is a complex condition that includes various symptoms associated with vibration exposure and the use of hand-held vibrating machines (Taylor, 1993). White fingers is the best-known complication first described in 1911 (Agate, 1949; Gemne, 1994; Noël, 2000). Sensory disturbances, reduced dexterity (Brammer et al., 1987; Dahlin and Lundborg, 2001; Lundborg et al., 1992), and in more severe cases of the disease (Bilgi and Pelmeur, 1993), reduced hand grip strength despite well-preserved muscle volume (Färkkilä et al., 1986) is another recognised symptom. Additional hand symptoms described are cold intolerance, pain, and muscle cramps (Fridén, 2001; Strömberg et al., 1996). HAV symptoms developed after long exposure from hand-held vibrating instruments can be irreversible (Bovenzi et al., 1994) and chronic injuries in hands and arms (NIOSH, 1989) and can lead to difficulties in performance of daily activities (Cederlund et al., 2001) and reduced working capacity (McGeoch and Gilmour, 2000; NIOSH, 1989; Palmer et al., 2001).

Measuring the variable quality of life is an important issue in current medical research (Anderson and Burckhardt, 1999; Atroshi et al., 1999; Grahn et al., 1996; Wood-Dauphinee, 1999). However, quality of life research in workers with HAVS is an under-investigated area even though it is well known that severe HAV symptoms affect working ability (McGeoch and Gilmour, 2000; NIOSH, 1989; Palmer et al., 2001). For example, Agate (1949) reported more than 50 years ago from a survey of workers that they were hindered in their present work due to attacks of Raynaud's phenomenon with symptoms of white and cold fingers. Some workers described that they were handicapped when counting coins, had difficulties in washing up and laundering, lacked control and speed when writing and filing, were unable to dress in winter due to

numbness, and pain in the hands and had to give up their work because of decreased function. These symptoms greatly affected the workers' daily life, and it could be hypothesised that the symptoms had a negative impact on their quality of life. Since then health professionals have witnessed a reduction of quality of life in workers with HAVS (Nilsson, 1998) but only a few studies have evaluated the consequences of vibration exposure on quality of life (Haines et al., 1998; Poole and Mason, 2005).

As proposed by Post et al. (1999) quality of life is a superordinate construct including both health and wellbeing in a broader sense. According to Ware (1984), quality of life includes both objective and subjective dimensions. Objective factors based on external judgements are e.g. measures of economic status and environmental factors. Subjective factors based on self-report are e.g. self-rated health, self-esteem, and wellbeing (Iwarsson and Isacson, 1997). Tibblin et al. (1990a) argue that by incorporating quality of life measures in combination with clinical assessments, a broadened understanding of the total impact and consequences of a disease for the person's physical, social, and mental status could be achieved. In this study quality of life is defined as a superordinate construct, comprising the variables focusing on subjective wellbeing, symptoms of ill-health, and difficulties in performing activities of daily living (ADL).

Subjective wellbeing consists of personal perceptions and emotions of life, and varies over the life-span (Westerhof et al., 2001). The concept can include an emotional aspect relating to a person's affective state, a cognitive aspect relating to a universal judgement of life as a whole, and a person's specific opinion about, for example, family, leisure, and health, (Anderson and Burckhardt, 1999; Nygren, 2003; Westerhof

et al., 2001). The expression ill-health was proposed by Nordenfelt (2001) and should be interpreted as the opposite of health.

In this paper, *symptoms of ill-health* describe the negative impact of 30 symptoms included in a quality of life instrument. Activity limitation is a difficulty in the performance, accomplishment or completion of an activity for an individual (WHO, 2001). The expression *ADL difficulties* describe difficulties in performance of specific activities of daily living included in an ADL questionnaire.

Many workers are exposed to hand-arm vibration and some of them will develop HAVS, which is a progressive disease if vibration activities continue (Petersen et al., 1995). There is a need for occupational therapists and other health professionals to further develop strategies for prevention and intervention for individuals with HAV. This is in line with new directives from the European Parliament proposed in 2002 for implementation in vibration health surveillance in which early detection and prevention are put forward as key words in vibration management and research (EU, 2002). The objective of this study was to analyse whether differences existed among hand-arm vibration exposed workers with respect to quality of life operationally defined as subjective wellbeing, symptoms of ill-health, and ADL difficulties.

Method

Participants

The participants came from two study groups: workers from industry (later divided into two subgroups) and workers referred to a hand surgery department for vibration related problems. In the group of workers from industry (n=81) all male workers exposed to

vibration by hand-held tools and working at a heavy manufacturing plant in southern Sweden took part in health surveillance with a special focus on vibration investigation. To be able to describe workers at risk of developing HAVS, this group was divided into two subgroups: workers with no hand-arm vibration (HAV) symptoms (n=55), and workers with HAV symptoms (n=26). The workers referred to a hand surgery department consisted of 30 vibration-exposed workers, almost all of them representing different heavy occupations. All of them were referred consecutively to a hand surgery department due to vibration symptoms characterised by white fingers and/or sensory disturbances in the hand. Three workers did not answer one of the questionnaires administered, leaving 27 workers in the study sample. To sum up, there were three groups of subjects in this study: workers with no HAV symptoms, workers with HAV symptoms, and workers referred to a hand surgery department with more severe HAV symptoms. The final number of participants included in this study was 108 men.

In all, the participants represented several types of manual professions such as iron-plate workers, mechanics, carpenters, machine fitters, electricians, construction workers, building constructors, and technicians. Ninety-eight participants (92%) were right-handed and eight (8%) were left-handed.

Assessment instruments

To divide the sample into subgroups based on symptoms acquired after hand-arm vibration exposure, in this study called *HAV symptoms*, the most frequently used classification system for vibration injury, i.e. the Stockholm Workshop Scales (SWS) for vascular (white fingers) (Gemne et al., 1987) and neurological (numbness, reduced sensibility) symptoms (Brammer et al., 1987), was used. The assessment is based on an

interview and the investigated workers' subjective complaints (table 1). To describe the sample, age and number of years of exposure to hand-arm vibration was recorded (table 2).

Insert table 1 about here

The Gothenburg Quality of Life instrument (Gothenburg QoL) was used to assess *subjective wellbeing* and *symptoms of ill-health*. The instrument was developed by Tibblin et al. (1990b) and consists of two separate parts, one assessing 18 aspects of subjective wellbeing (Iwarsson and Isacson, 1997), and the other assessing 30 different symptoms of ill-health. The subjective wellbeing scale is divided into three subscales. *Physical wellbeing* includes health, fitness, hearing, vision, memory, and appetite. *Social wellbeing* includes work, family, economy, housing, leisure, sense of significance and appreciation at home and outside home, and *mental wellbeing* includes mood, energy, endurance, self-esteem and sleeping. For each of the 18 items the respondent is asked to answer a question "How do you perceive your...?" A seven step ordinal scale is used and the respondent rates each item from 1 = "very bad" to 7 = "excellent, couldn't be better". The maximum score of the summed subjective wellbeing scale is 126. Reliability of the summed subjective wellbeing score was calculated with Cronbach's alpha (Cronbach, 1951). In this study the internal consistency was high, Cronbach's alpha = 0.89(Tibblin et al., 1990a).

The second part of the instrument covers 30 *symptoms of ill-health* grouped in seven domains (Tibblin et al., 1990b). The domains are head, heart and lung, metabolism, musculoskeletal, gastrointestinal and urinary tract, tension, and depression.

The question asked is: “Have you been troubled by any of the following symptoms during the last three months?” The response alternatives are “yes” and “no”.

The Evaluation of Daily Activity Questionnaire (EDAQ) is a self-administered questionnaire measuring the person’s difficulty in performance of *activities of daily living (ADL)* (Nordenskiöld and Grimby, 1997). The instrument consists of 102 daily activity items grouped in 11 dimensions, each comprising between 4 and 13 activities. The rating score ranges from 0–3, where 0 = without any difficulty, 1 = with some difficulty, 2 = with great difficulty, and 3 = unable to do. Since the EDAQ questionnaire was primarily designed for patients suffering from rheumatoid arthritis and a majority of such patients are women, 22 specific activity items considered important for men with vibration injury were included (Cederlund et al., 2001). In the analyses for this study, the included response choices were dichotomised as with or without ADL difficulties. For the result the number of ADL difficulties was used.

Procedures

A clinical interview including the Stockholm Workshop Scales (Brammer et al., 1987; Gemne et al., 1987) and a physical examination of the hands was performed by a hand surgeon. All participants filled out the Gothenburg QoL instrument (Tibblin et al., 1990b) and the EDAQ (Nordenskiöld and Grimby, 1997).

Data analysis

In order to analyse whether differences existed among the hand-arm vibration-exposed workers included in this sample, analyses were run among the three groups of subjects: the workers with no HAV symptoms, the workers with HAV symptoms and the workers

referred to a hand surgery department with more severe HAV symptoms. The Kruskal-Wallis ANOVA was used for group comparisons, and the Mann-Whitney U-test was used for bivariate comparisons. P-values <0.01 were considered statistically significant. Since many group comparisons were made, a higher p-value was chosen. The statistics were computed with SPSS version 10.0.

Ethics

The study was approved by the Ethics Committee, Lund University.

Results

Overall, the study showed that the most prominent significant differences were seen between workers with no HAV symptoms and workers with more severe HAV symptoms, in all aspects (table 2). But a notable finding was the significant difference in the number of ADL difficulties among all three groups. The workers with and without HAV symptoms did not differ in perceived subjective wellbeing and symptoms of ill-health.

Insert table 2 about here

Subjective wellbeing

The participants rated their subjective wellbeing high. The median sum score in the three groups of participants ranged from 99 to 104; the workers with no HAV symptoms experienced the highest wellbeing compared to workers with more severe HAV symptoms, who experienced the lowest wellbeing. Analysing the results from the

18 subjective wellbeing items, significant differences were demonstrated between workers with no HAV symptoms and workers with more severe HAV symptoms in health, and work situation.

Symptoms of ill-health

The median numbers of symptoms of ill-health in the three groups were low. The lowest numbers of symptoms were reported by the workers with no HAV symptoms closely followed by workers with HAV symptoms, while the workers with severe HAV symptoms reported the highest number of symptoms (table 2). To obtain an idea of which symptoms of ill-health were most commonly reported in the three groups of participants, all symptoms of ill-health reported by a third or more of the workers were presented (table 3). No symptoms of ill-health were reported by a third or more of the workers with no HAV symptoms. Musculoskeletal problems such as back pain and pain in the leg were reported by almost half of the workers with HAV symptoms. Feeling cold, pain in the joints and general fatigue were reported by more than half of the workers with more severe HAV symptoms (table 3).

Insert table 3 about here

ADL difficulties

The median number of ADL difficulties was very low among workers with no symptoms or with less severe HAV symptoms, while the number of ADL difficulties was notably higher among workers with more severe HAV symptoms (table 2). But there were significant differences in the number of ADL difficulties described among all

three groups of subjects. To give a picture of the ADL difficulties that were most commonly reported in the participants all ADL-difficulties reported by a third or more of the workers were presented (table 4). No ADL difficulties were reported by a third or more of the workers with no HAV symptoms. Working outdoors in cold weather was reported as most difficult of the workers with HAV symptoms. More than half of the workers with more severe HAV symptoms reported working outdoors in cold weather, and using vibrating machines as their most difficult activity. (table 4).

Insert table 4 about here

Discussion

The results of this study indicate that workers referred to a hand surgery department with more severe HAV symptoms describe a lower quality of life, operationally defined as lower subjective wellbeing, more symptoms of ill-health, and ADL difficulties, than workers with no or less severe HAV symptoms. The results also show that a third of the workers from a heavy manufacturing plant are already demonstrating HAV symptoms, and more than half of them experience ADL difficulties. This group is at risk for developing more severe symptoms with consequences on quality of life if vibration exposure is continued. The findings indicate that quality of life issues are tied to the consequences of hand-arm vibration exposure and are important knowledge for development of future prevention and intervention strategies. The results indicate that there is a need to develop effective programs to prevent HAV symptoms in workers at risk.

The results show that with more severe HAV symptoms, reduced health and subjective wellbeing and more ADL difficulties can develop. (Poole and Mason, 2005)

also found that HAVS has a significant effect on an individual's perceived ability to perform everyday tasks involving the upper extremity, and their quality of life. Similar results have also been shown in research in related diseases (Atroshi et al., 1999; Grahn et al., 1996; Welch et al., 1999). For example, (Welch et al., 1999) reported that workers who developed chronic symptoms after musculoskeletal injuries reported substantial negative effects on their quality of life. The same trend is seen in this study, particularly in the group of workers with more severe HAV symptoms, referred to a hand surgery department for vibration investigation.

The fact that significant differences in the number of ADL difficulties were clearly shown between all groups in this study indicates that information on performance of daily activities is important knowledge in vibration investigation. The results from this study also indicate that workers with more severe HAV symptoms have many ADL difficulties and may therefore need help to develop strategies to better manage their daily activities for example by changing ways of performance and using assistive devices. It is not possible from this study to clarify whether the number of ADL difficulties was due to vibration symptoms, symptoms of ill-health, cumulative effects of vibration exposure, or a combination of these aspects. Further studies should be carried out to investigate this.

The results showed that workers with more severe HAV symptoms were older than workers with no HAV symptoms. As age and metabolic disease are known to be the primary potential confounders in HAVS (NIOSH, 1997), this confirms that age is a confounding factor among the three groups of participants. It is also well-known that there is an exposure-response relationship between years of vibration exposure and prevalence of HAV symptoms such as vibration white fingers (Gemne et al., 1993;

Nilsson, 1998) as well as reduced tactile sensitivity (Lundström et al., 1999). Along with previous knowledge, the workers with more severe HAV symptoms in this study also had more years of vibration exposure than the other two groups. This is important to bear in mind when interpreting the results of this study, as other factors can influence the workers' perceptions of quality of life, especially the amount of vibration exposure.

The ideal situation would be to stop vibration exposure before workers develop signs of HAV symptoms. Since HAVS is usually progressive if vibration exposure continues their performance on daily activities will also decrease along with their perception of wellbeing and health. It is therefore possible that ADL difficulties in hand-arm vibration-exposed workers should be considered as indicators for more severe consequences of vibration exposure while further studies are necessary to confirm this.

Within the European Union, the employer is responsible for the minimum health and safety requirements regarding the exposure of workers to the risks arising from vibration (EU, 2002). Strategies to implement the new directives has been developed (Malchaire and Piette, 2005). General work instructions are to use the right tools for the job, to use as little force as possible when holding the tool, to avoid long periods using equipment, to take breaks, to introduce job rotation, to keep the tools in good order, to take part in the employer's health and safety training, and to be observant of any symptoms (HSE, 2006). Other recommendations are to reduce or stop smoking and keep the hands and body warm (HSE, 2006; Shelmerdine, 1999). If cold sensitive, mitts should be worn rather than gloves (Pelmeur and Leong, 2000). Heated gloves may be necessary in the winter (Chetter et al., 1998). Ergonomic intervention and antivibration gloves can be affective to minimize hand-arm vibration at work (Griffin, 1998; Jetzer et al., 2003) .

Conclusion

It is clear that workers with more severe HAV symptoms experience lower quality of life than workers not suffering from such symptoms. However, workers without HAV symptoms can easily acquire such symptoms with continuous vibration exposure. Therefore such “workers at risk” still not experiencing symptoms represent a target group for prevention and should be informed of possible consequences of vibration exposure and HAV symptoms. Workers with less severe HAV symptoms may also be considered at risk for developing more severe symptoms and should be assessed continuously. It is important to incorporate different quality of life measures in investigations of HAVS, to broaden the understanding of the impact of HAV symptoms on individual workers’ life in general. Early detection and prevention are key factors in vibration management and research. The results of this study confirm the importance of occupational therapists and other health care practitioners in developing prevention and intervention strategies for exposed workers with HAV symptoms.

The implications for prevention and intervention are to: increase knowledge of the signs and symptoms and possible consequences of HAVS, assess impairment and activity limitations regularly, add quality of life measures in vibration investigation, offer ergonomic intervention, recommend coping strategies and assistive devices if relevant and advise on general safety precautions as recommended by the national and international occupational health and safety boards.

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TABLE 1. Distribution of neurological (numbness, reduced sensibility) and vascular (white fingers) HAV symptoms according to the Stockholm Workshop Scales ^{a, b} in three groups of subjects, N=108.

Stage	Symptom	Workers		
		No HAV Symptoms n=55	HAV Symptoms n=26	More severe HAV symptoms n=27
<i>Neurological symptoms</i>				
0 SN	Exposed to vibration but no symptoms	0	4	3
1 SN	Intermittent numbness, with or without tingling	0	21	12
2 SN	Intermittent or persistent numbness, reduced sensory perception	0	1	6
3 SN	Intermittent or persistent numbness, reduced tactile discrimination and/or manipulative dexterity	0	0	6
<i>Vascular symptoms</i>				
0	No attacks	0	18	6
1	Occasional attacks affecting only the tips of one or more fingers	0	2	4
2	Occasional attacks affecting distal and middle (rarely proximal) phalanges of one or more fingers	0	4	10
3	Frequent attacks affecting all phalanges of most fingers	0	2	7
4	As in stage 3, with trophic skin changes in the fingertips	0	0	0

^a (Brammer et al., 1987), ^b (Gemne et al., 1987)

TABLE 2. Differences in age, years of vibration exposure and quality of life among vibration-exposed workers in three groups of subjects, N=108.

	Workers			Group differences			
	No HAV symptoms (median, range) n=55	HAV symptoms (median, range) n=26	More severe HAV symptoms (median, range) n=27	Group 1 vs 2 vs 3 p-value	Group 1 vs 2 p-value	Group 2 vs 3 p-value	Group 1 vs 3 p-value
Age, years	39 (19–62)	42 (21–61)	48 (29–64)	0.007	ns	ns	0.002
Vibration exposure, years	13 (1–45)	17 (5–44)	30 (11–40)	0.001	ns	0.008	<0.001
<i>Aspects of quality of life</i>							
Subjective wellbeing ^a	104 (76–125)	101 (79–119)	99 (64–118)	0.042	ns	ns	0.009
Symptoms of ill-health ^b	3 (0–15)	4 (0–15)	7 (0–19)	0.004	ns	0.008	0.002
ADL difficulties ^c	0 (0–12)	1 (0–65)	12 (0–95)	<0.001	<0.001	<0.001	<0.001

Kruskal-Wallis ANOVA and Mann-Whitney U-test were used, $p < 0.01$ was considered statistically significant.

Note. Total score from the three questionnaires: Gothenburg Quality of Life instrument; ^a subjective wellbeing (126),

^b number of symptoms of ill-health (30), ^c EDAQ; number of ADL difficulties (124).

TABLE 3. The symptoms of ill-health most frequently reported by one third or more of the workers in three groups of subjects, N=108.

Workers					
No HAV symptoms n=55		HAV symptoms n=26		More severe HAV symptoms n=27	
Symptoms of ill-health					
	No. (%)		No. (%)		No. (%)
None	0 (0)	Back pain	13 (48)	Feeling cold	16 (59)
		Pain in the legs	11 (42)	Pain in the joints, general fatigue	14 (52)
		Headache	10 (38)	Depression, difficulty in relaxing	12 (44)
		Overweight	9 (35)	Headache, feeling restless	11 (41)
				Backache, eye problems	9 (33)

TABLE 4. The ADL difficulties most frequently reported by one third or more of the workers in three groups of subjects, N=108.

Workers					
No HAV symptoms n=55		HAV symptoms n=26		More severe HAV symptoms n=27	
ADL difficulties					
	No. (%)		No. (%)		No. (%)
None	0 (0)	Working outdoors in cold weather	9 (33)	Working outdoors in cold weather	17 (63)
				Using vibrating machines	16 (59)
				Opening lids, buttoning	11 (41)
				Writing, picking up needles/pins, using screwdriver, light gardening	10 (37)
				Lifting and carrying, using motor lawnmower, tying shoelaces	9 (33)