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The Influence of Occupational and Non-Occupational Factors on the Prevalence of Musculoskeletal Complaints in Users of Portable Computers

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Introduction. *Portable computers are becoming an increasingly common main work tool; however, they are not properly adapted to the workstation. Musculoskeletal complaints are a very frequent complaint reported by workers who use computers in their work.* ***Aim.*** *The aim of the study was to assess the prevalence and intensity of pain in the musculoskeletal system in workers who regularly use a portable computer in their work and to determine the influence of working conditions and duration of work with a portable computer.* ***Material and methods.*** *The study covered 300 workers. Musculoskeletal complaints were assessed with the Nordic musculoskeletal questionnaire complemented with a visual analogue scale. Working conditions was assessed with a questionnaire developed as part of the study.* ***Results and conclusions.*** *The most prevalent faults in the organization of workstations were lack of a computer desk with an adjustable keyboard tray/drawer, no adjustment of chair armrests and no possibility to use an additional keyboard. The most frequent complaints among computer operators were headaches, low-back pain and neck pain. The use of an additional keyboard reduced the intensity of shoulder pain.*

musculoskeletal complaints   portable computer   working conditions

1. INTRODUCTION

Work with personal computers has recently become very common. Computers are most often used in administration, finances, management, education, health services or commerce. Numerous studies on the influence of computer work on workers' health were carried out in the past 25 years. Their results showed that computer workers most frequently complained of eyesight fatigue and musculoskeletal complaints [1, 2, 3, 4, 5, 6]. Those results were the basis for developing guidelines and guidebooks for designers of computer workstations [7, 8, 9]. They determined the way in which ergonomic solutions should be used to adapt workstations to the worker, to ensure comfort and to minimize musculoskeletal and eyesight load.

Portable computers are special personal computers that thanks to their light weight and ease of installation at any location can be used away from a regular workplace, e.g., when travelling or at a client's premises. Their systematic and increasingly advanced technological development has been observed alongside an increasing demand among both private users and companies. A portable computer is very often used in everyday professional duties, usually without any additional ergonomic improvements, at a stationary office workstation. Earlier applications of a portable computer as an additional work tool, useful mostly away from the office and on business trips has changed, too [10].

This paper has been prepared on the basis of the results of a research task carried out within the scope of the first stage of the National Programme "Improvement of safety and working conditions" partly supported in 2008-2010—within the scope of state services—by the Ministry of Labour and Social Policy. The Central Institute for Labour Protection – National Research Institute is the Programme's main co-ordinator.

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The aim of the study was to assess the prevalence and intensity of musculoskeletal pain in workers who used portable computers in their work on a regular basis and to determine the influence of working conditions and duration of work with a portable computer.

2. METHODS

2.1. Study Group

The study covered workers who regularly used portable computers in their everyday occupational duties. Employees of enterprises of different sizes and sectors were considered for the study. The biggest group was composed of representatives of trade companies (16.7%), white collar workers (14.7%) and personnel or financial and related sectors (12.3%). A questionnaire was used in the study, which took place from June to August 2008. The Committee for Ethics of Scientific Research of the Central Institute for Labour Protection – National Research Institute (CIOP-PIB) approved of the study.

2.2. Methods

The questionnaire consisted of three parts. Part 1 contained questions on general demographic (gender, age and education) and anthropometric (height and weight) data. Part 2 contained questions on working conditions and duration of work with a portable computer, e.g., work experience total and relating to computer work, average daily time of using the computer at work and at home, location of computer, seat and armrest adjustment and external devices such as a keyboard or docking station.

Part 3, prepared on the basis of the Nordic questionnaire, covered the prevalence of musculoskeletal pain [11]. Musculoskeletal problems experienced in the past months in the head, neck, shoulders, elbows, hands/wrists, the upper and lower back were considered. Additionally, for the purpose of the study, the questionnaire was supplemented with a visual analogue scale (VAS) to determine the intensity of pain.

2.3. Statistical Analysis

Statistical analysis was done with STATISTICA version 6.0. For descriptive analysis, mean values and standard deviations (quantitative variables) as well as frequency and intensity (qualitative variables) were calculated. To determine the relationship between the intensity of musculoskeletal pain and occupational and non-occupational factors, Pearson correlation, Spearman rank correlation, Mann-Whitney *U* test and ANOVA analyses were done.

The following factors were adopted as independent variables:

- non-occupational factors: age (in years), body weight (in kilograms), height (in centimetres), education, gender;
- occupational factors: frequency of using a portable computer (every day, a few times a week, occasionally), work with a portable computer on weekdays (in hours), work with a portable computer on days off (in hours), total work experience (in years), work experience with a portable computer (in years), use of a separate keyboard, use of a docking station, location of the computer (on a desk, on a table, on a computer desk with an adjustable keyboard drawer, other solutions), chair adjustment (height, seat and backrest angle), armrest adjustment (height, angle, none possible), chair with or without five wheels.

3. RESULTS

3.1. General Characteristics of the Respondents and Their Work Setting

Three hundred respondents who used a portable computer in their work took part in the study; 131 (43.7%) of them were women. Table 1 shows information on the respondents' age, years of work experience total and at work with a portable computer. The average age of the respondents was 31.3 (*SD* 9.2; range: 19–66 years), 54.6% were under 30, while only 17% were over 40 years old. The average work experience was 4.22 years (*SD* 1.8). The biggest groups of respondents comprised persons with 2–5 years (22%) and 5–10 years (18%) of work

TABLE 1. Age and Duration of Work Experience in the Study Group

Variable (years)	N	%
Age		
≤24	79	26.3
25–29	85	28.3
30–34	58	19.3
35–39	27	9.0
40–44	10	3.3
45–50	23	7.7
>50	18	6.0
Total work experience		
0.5–2	97	32.3
>2–5	65	21.7
>5–10	54	18.0
>10–20	48	16.0
>20	36	12.0
Work experience with portable computer		
≤0.5	88	29.3
0.6–1	65	21.7
>1–2	65	21.7
>2	82	27.3

experience. The average duration of work with a computer was 3.41 years (*SD* 1.28). Over 27% of respondents had an average experience of work with a portable computer exceeding 2 years. About 65% of respondents had university level education, 34% secondary and only 1% basic vocational education.

The findings of the study showed that ~70% of respondents considered a portable computer their main work tool. An analysis of collected data indicated that 67% of respondents worked with a portable computer every day, including 50% of respondents who used it at work at least 5h a day. About 70% of respondents used a portable computer also at home and ~77% also on days off. About 67% of respondents placed a portable computer on a normal desk or even on a table and only 6% on a computer desk equipped with a separate keyboard drawer. Table 2 presents additional information on workload and conditions of work with a portable computer.

TABLE 2. Workload and Conditions of Work With a Portable Computer

		Participants	
Variable		N	%
Frequency of computer use at work	every day	200	66.67
	a few times a week	55	18.33
	occasionally	44	14.67
Number of work hours using a portable computer at weekdays	<2	48	16.00
	2–4	97	32.33
	5–6	45	15.00
	>6	106	35.33
Number of work hours using a portable computer on days off	0	67	23.30
	≤1	105	35.00
	2–4	89	29.70
	5–6	19	6.30
	>6	6	2.00
Location of computer at work	desk	189	63.00
	table	26	15.33
	computer desk with adjustable keyboard drawer	18	6.00
	other	33	11.00
Use of a separate keyboard	yes	66	22.67
	no	232	77.33
Chair with adjustable...	seat height	202	40.64
	seat inclination	101	20.32
	backrest height	84	16.90
	backrest inclination	110	22.13
Chair with 5 wheels	yes	210	73.00
	no	81	27.00
Chair with adjustable armrests	height	41	13.67
	angle	14	4.67
	neither	144	48.00

3.2. Musculoskeletal Complaints

Operators of portable computers most often complained of the following musculoskeletal problems: headache, neck pain and low-back pain. Headache was reported by 126 persons (~42%), more frequently by women (55%) than by men (30%, p = .00), low-back pain was reported by 115 persons (38%) (women 48%, men 30%, p = .24). Neck pain occurred in 105 persons (35%) (women 38%, men 32%, p = .41). Sixty-four respondents (21%) complained of leg pain (women 28%, men 15%, p = .67). Hand or wrist pain occurred in 50 respondents (16.7%); in both cases it occurred more often in men (hand pain: women 2%, men 4%; wrist pain: women 13%, men 19%). Thirty-five respondents (12%) complained of upper-back pain (women 16%, men 8%, p = .18). Shoulder pain occurred in 32 respondents (11%), equally often in men (12%) and in women (9%) (p = .38). Fourteen respondents (4.7%) complained of arm pain (men 6%, women 3%, p = .78), the same percentage of men and women declared forearm pain (3%).

Table 3 presents mean values of the intensity and frequency of musculoskeletal complaints in the past month (determined with a VAS scale). The mean intensity of pain in the past month among computer operators was highest in the upper-back (45.9 mmVAS), low-back (40.7 mmVAS) and shoulder areas (37.9 mmVAS). The mean frequency of complaints was highest in the upper-back (52.6 mmVAS), low-back (50.0 mmVAS), neck (45.7 mmVAS) and forearm areas (45 mmVAS).

An analysis of the relationship between occupational and non-occupational factors and musculoskeletal complaints in the past month showed that age had a statistically significant influence on pain intensity in the neck area (r = .20; p = .04), shoulder area (r = .35; p = .05) and hand/wrist area (r = .38; p = .01). Work experience with a portable computer had a statistically significant influence on the intensity of low-back pain (r = –.19; p = .04). Moreover, a higher mean intensity of shoulder pain in the last month (F = 39; p = .013) was observed among those portable computer users who did not use a separate keyboard in their work. The relationship between the other occupational and non-occupational factors and the intensity of musculoskeletal pain was statistically insignificant.

TABLE 3. Mean Intensity and Frequency During the Day of Musculoskeletal Complaints in Different Body Parts in the Past Month (on a 100-mm VAS scale) in Users of Portable Computers (*N*)

			Intensity				Frequency	
Body Part	***N***	**%**	***M* (*SD*)**	**Range**	***N***	**%**	***M* (*SD*)**	**Range**
Head	126	42.0	29.6 (16.9)	3–74	127	42.3	39.7 (21.3)	3–99
Neck	105	35.0	37.3 (17.5)	3–75	104	34.7	45.7 (20.9)	4–97
Shoulder	32	10.7	37.9 (17.3)	9–84	32	10.7	39.1 (18.8)	9–81
Arm	14	4.7	30.6 (14.4)	12–53	14	4.7	40.9 (23.8)	12–90
Forearm/hand	9	3.0	23.8 (13.4)	6–49	9	3.0	45.0 (25.3)	13–91
Hand/wrist	50	16.7	34.5 (16.8)	6–81	51	17.0	42.4 (23.6)	3–96
Upper back	35	11.7	45.9 (19.6)	10–97	35	11.7	52.6 (21.2)	7–91
Lower back	115	38.3	40.7 (16.5)	7–87	115	38.3	50.0 (21.2)	7–97
Leg	64	21.3	34.4 (16.7)	7–97	64	21.3	43.5 (23.5)	1–97

Notes. VAS—visual analogue scale.

4. DISCUSSION

The results of the study have supported the supposition that workers have changed the original usage of portable computers. Apart from the group who used laptops only occasionally when working outside their office, many workers used laptops as their primary work tool also at their stationary office workstations. Over 65% of respondents worked with laptops every day and ~50% more than 5 h a day. Work time was additionally increased by using the computer for occupational purposes on days off work.

It is alarming that most respondents placed their portable computer on a normal desk or even on a small table without any equipment that might improve their working conditions. No respondents used a docking station and 77% did not have an additional keyboard. Over 27% of respondents did not have chairs equipped with five wheels. Sixty-three percent had chairs equipped with armrests; however, 48% had chairs that could not be adjusted. Only 19% of respondents could adjust the height or angle of the armrests.

In an analysis of data on the prevalence of workplace-related health problems published by the European Agency for Safety and Health at Work, musculoskeletal complaints turned out to be among the most frequent problems in the European Union [12], with computer work a risk factor.

The findings of the study have shown that headaches, neck pain, low-back and lower limb pain are common in operators of portable computers. These findings are in step with those obtained in a study on computer workstations safety and ergonomics Ergotest which covered 8 306 questionnaire studies conducted in 2008 and resulted in the second edition of a prosocial educational campaign Ergotest. Analyses of the questionnaires show that work-related health complaints most often concerned back and neck pain (88%), wrist pain (63%) and lower leg pain and swelling (40%) [13].

Musculoskeletal complaints during computer work, including portable computer, are caused by prolonged awkward body posture. The most common bad working postures observed in computer operators are forward bending/inclination of the back and head as well as excessive wrist extension [14, 15, 16]. The latter is especially important because bad wrist posture during work tasks is recognized as a risk factor in hand and wrist pain [17, 18, 5, 19]. In turn, excessive forward bending of the head and the resulting static muscle tension is mentioned as a risk factor in neck pain [20, 21, 22, 23]. In addition, the findings of other studies suggest that head position bent forward may cause spinal headaches [24, 25].

An analysis of the relationship between non-occupational and occupational factors and pain intensity has shown that age is the factor that has the greatest influence on the intensity of pain in the area of the neck ($r = .20$; $p = .04$), shoulders ($r = .35$; $p = .05$), and hands/wrists ($r = .38$; $p = .01$) in men. Women complained of headache of greater intensity than men ($p = .00$). The length of work experience correlated positively with the intensity of pain in the neck ($r = .21$; $p = .03$).

These findings are in line with those of other authors. According to many authors, female gender is a greater risk factor in complaints in all parts of the musculoskeletal system, independent of the work/job type [18, 26]. According to Ekman, Andersson, Hagberg, et al. also among computer operators women have more musculoskeletal complaints (OR 11.9; 95% CI 2.9–50.0) [27]. Many factors in the literature explain this relationship. The most frequent ones are additional load due to housekeeping and child care and anthropometric body dimensions [28, 29]. Similarly, the relationship between the length of work experience and musculoskeletal complaints is recognized. There is much evidence that the length of work experience of computer operators, which usually positively correlates with their age, is a risk factor in musculoskeletal complaints [30, 31, 32].

An analysis of the relationship between occupational and non-occupational factors and pain resulted in still another very interesting practical observation. It was found that the users of portable computers who did not use a separate keyboard in their work reported a higher average intensity of shoulder pain in the past month.

It is hoped that the findings of the study will help in developing guidelines for OSH specialists and for the users of portable computers in shaping proper working conditions.

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