

Ergonomics Aspects of Work with Computers

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Abstract—This paper is based on a large questionnaire study. The paper presents how all participants and subgroups (upper- and lower-level white-collar workers) answered the question, “Have you had an ache, pain, or numbness, which you associate with desktop computer use, in the different body parts during the last 12 months?” 14.6% of participants (19.4% of women and 8.2% of men) reported that they had often or very often physical symptoms in the neck. Even if our results cannot prove a causal relation of symptoms with computer use, show that workers believe that computer use can influence their wellbeing: this is important when devising treatment modalities to decrease these physical symptoms.

Keywords—Ergonomics, work, computer, symptoms.

I. INTRODUCTION

IN recent decades, the use of computers and laptops has increased. At the same time, computer work is widely perceived as a new risk factor for musculoskeletal disorders (MSDs). In European countries, the MSDs have become more frequently diagnosed occupational diseases [1].

Associations between computer work and MSDs have been researched in several studies [2]–[6]. Based on the literature [2]–[6], for example, the 12-month prevalence rates of musculoskeletal pain (MSP) in the neck is 55–69% and in the back 31–54%. In addition, other risk factors for MSPs have been reported: demographic (gender, age) and other personal characteristics (height, smoking, tendency to somatize), and also psychosocial, organizational, and physical aspects of work [2], [7]–[11]. Rempel et al. [12] and Esmaeilzadeh et al. [13] reported that a poor body posture and ergonomic design of the workstation can contribute to the occurrence of work-related musculoskeletal disorders in the upper extremity [12], [13].

Yang et al. [14] studied work-related risk factors for neck pain in the US working population. They concluded that their study adds to the evidence that an individual’s occupation and work hours affect workers’ risk for neck pain. Palmer et al. [15] studied the prevalence and occupational associations of neck pain in the British population. They found that construction workers, followed by nurses and armed services members were shown to have higher prevalence for neck pain [15].

The use of personal computers, other technical equipment, such as portable computers, notebooks, cell phones, and, more recently, also tablets, e-readers and smartphones, has increased, which has resulted in new human–computer interactions. For this reason, we performed a study of possible influences of new

technical equipment on the health of the working-age population in 2002. The questionnaire was divided into six sections: (1) background information, such as age, gender, marital status, education, occupation, and home county; (2) the familiarity and mapping the use of given technical devices at leisure and at work, (3) physical loading and ergonomics; (4) psychological welfare; (5) accidents and close-call situations; and (6) an open-ended question: “Other observations concerning technology and health.” The details of the questionnaire have been reported earlier [16], [17].

The aim of this paper is to present how all respondents and subgroups (upper- and lower-level white-collar workers) answered the question, “Have you had an ache, pain, or numbness, which you associate with desktop computer use, in the following body parts during the last 12 months?” and compare background information, such as gender and the physical symptoms of different groups.

II. METHODS

A. Study Population and Questionnaire

A questionnaire was sent to 15,000 Finns. As the study focused on the working age population, only people aged 18–65 were included. Names and addresses were obtained randomly from the Finnish Population Register Centre. The study design was approved by the local Ethical Committee (Pirkanmaa Health District, Finland, decision R02099).

This paper concentrates on all participants and their answers to Question 14, “Have you had an ache, pain, or numbness, which you associate with desktop computer use, in the following body parts during the last 12 months”:

- 14a. in wrists and fingers
- 14b. in elbows and forearms
- 14c. in neck
- 14d. in shoulders
- 14e. in hips and lower back
- 14f. in feet.

The options for Question 14 were, “cannot say,” “not at all,” “sometimes,” “quite often,” “often and very often.”

B. Statistical Analyses

The statistical analysis was performed using IBM SPSS Statistics version 23 software. To compare differences of background information, such as gender and the physical symptoms of different groups (upper-level white-collar workers and lower-level white-collar workers), we used independent samples Mann-Whitney U-test analyses.

In the statistical work, we used the following analyses: (1) comparison of answers to Question 14 between female and male participants (Analysis I); (2) comparison of answers to Question 14 between upper-level white-collar workers and

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lower-level white-collar workers (Analysis II); (3) comparison of answers to Question 14 between female and male upper-level white-collar workers (Analysis III); (4) comparison of answers to Question 14 between female and male lower-level white-collar workers (Analysis IV).

III. RESULTS

We received responses 6121 persons (the response percent 41 %). To Question 14, we obtained the following number of responses: 14a, (in wrists and fingers) 5885; 14b, (in elbows and forearms) 5879; 14c, (in neck) 5893; 14d, (in shoulders) 5866; 14e, (in hips and lower back), 5877; and 14f, (in feet) 5872. Figs. 1-3 show the “yes” responses of all, female, and male participants to Question 14. “Yes” responses included answers “often” and “very often.”

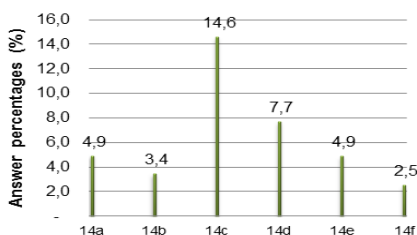


Fig. 1 “Yes” responses of all participants

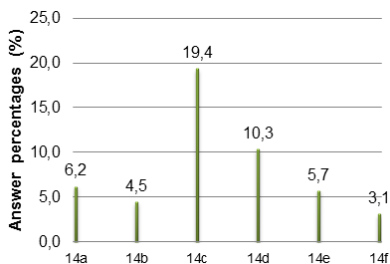


Fig. 2 “Yes” responses of all female participants

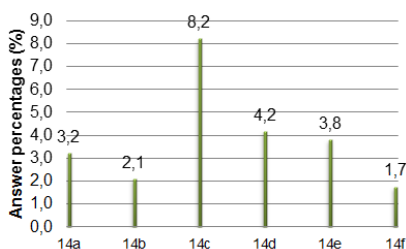


Fig. 3 “Yes” responses of all male participants

We received responses from 1121 upper-level white-collar workers and from 1425 lower-level white-collar workers. Figs. 4, 5, and 6 show the “yes” responses of all upper-level white-collar workers, female upper-level white-collar workers, and male upper-level white-collar workers to Question 14.

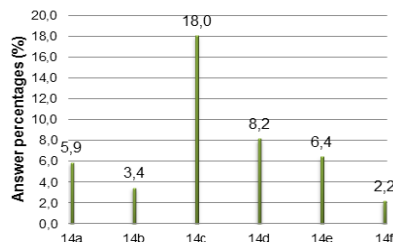


Fig. 4 “Yes” responses of all upper-level white-collar workers

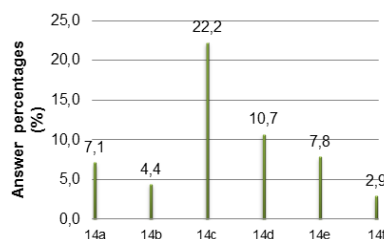


Fig. 5 “Yes” responses of female upper-level white-collar workers

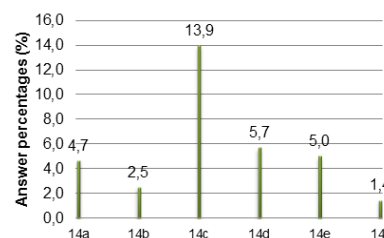


Fig. 6 “Yes” responses of male upper-level white-collar workers

Figs. 7-9 show the “yes” responses of all upper-level white-collar workers, female lower-level white-collar workers, and male upper-level white-collar workers to Question 14.

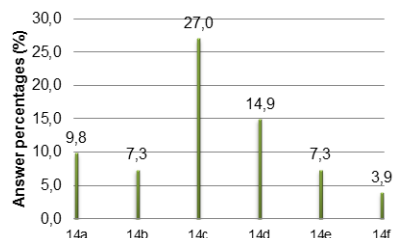


Fig. 7 “Yes” responses of all lower-level white-collar workers

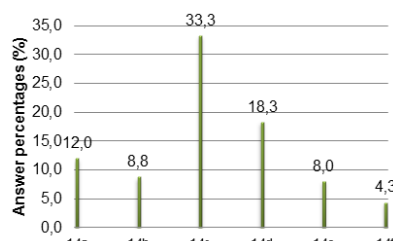


Fig. 8 “Yes” responses of female lower-level white-collar workers

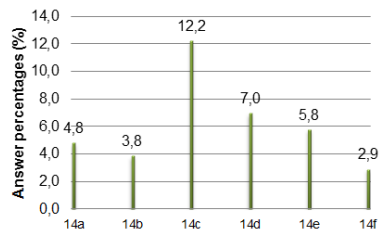


Fig. 9 “Yes” responses of male lower-level white-collar workers

Table I shows the results of Analysis I (comparison between female and male participants) using the answers to Question 14, “Have you had an ache, pain, or numbness, which you associate with desktop computer use, in the following body parts during the last 12 months?” (with independent samples Mann-Whitney U-test analyses).

TABLE I
RESULTS OF ANALYSIS I

Symptoms	Asymp. Sig.(2-tailed)
14a. in wrists and fingers	<0.001*
14b. in elbows and forearms	<0.001*
14c. in neck	<0.001*
14d. in shoulders	<0.001*
14e. in hips and lower back	<0.001*
14f. in feet.	<0.001*

* significant at $p < 0.05$

Table II shows the results of Analysis II (comparison between upper-level white-collar workers and lower-level white-collar workers), using the answers to Question 14, “Have you had an ache, pain, or numbness, which you associate with desktop computer use, in the following body parts during the last 12 months?” (with independent samples Mann-Whitney U-test analyses).

TABLE II
RESULTS OF ANALYSIS II

Symptoms	Asymp. Sig.(2-tailed)
14a. in wrists and fingers	<0.001*
14b. in elbows and forearms	<0.001*
14c. in neck	<0.001*
14d. in shoulders	<0.001*
14e. in hips and lower back	<0.001*
14f. in feet.	<0.001*

* significant at $p < 0.05$

Table III shows the results of Analysis III (comparison female and male upper-level white-collar workers), using the answers to Question 14, “Have you had an ache, pain, or numbness, which you associate with desktop computer use, in the following body parts during the last 12 months?” (with independent samples Mann-Whitney U-test analyses).

Table IV shows the results of Analysis IV (comparison between female and male lower-level white-collar workers), using the answers to Question 14, “Have you had an ache, pain, or numbness, which you associate with desktop computer use, in the following body parts during the last 12 months?” (with independent samples Mann-Whitney U-test analyses).

TABLE III
RESULTS OF ANALYSIS III

Symptoms	Asymp. Sig.(2-tailed)
14a. in wrists and fingers	0.855
14b. in elbows and forearms	0.774
14c. in neck	<0.001*
14d. in shoulders	0.068
14e. in hips and lower back	0.270
14f. in feet.	0.252

* significant at $p < 0.05$

TABLE IV
RESULTS OF ANALYSIS IV

Symptoms	Asymp. Sig.(2-tailed)
14a. in wrists and fingers	<0.001*
14b. in elbows and forearms	<0.001*
14c. in neck	<0.001*
14d. in shoulders	<0.001*
14e. in hips and lower back	0.002*
14f. in feet.	0.006*

* significant at $p < 0.05$

IV. DISCUSSION

The focus of this paper was the question, “Have you had an ache, pain, or numbness, which you associate with desktop computer use, in the following body parts during the last 12 months?”, which included the assumptions that the use of computers can influence physical symptoms. The question could lead the participants to think that the use of computers could possibly increase their symptoms. This limitation is important to take into account when analyzing of results.

Figs. 1-7 show that participants associated most symptoms in the neck with desktop computer use. However we did not perform statistical analyses between different symptoms; therefore, we cannot say if the differences are significant. We have reported the results of neck symptoms in our earlier article [18].

The statistical analyses show that there were significant differences in the answers between female and male participants and in the group of lower-level white-collar workers. However, in the group of upper-level white-collar workers, there were significant differences between women and men only on Question 14c (symptoms in neck). Female participants reported more symptoms than male participants.

Nowadays white-collar workers use computers, Smartphones, and other mobile devices very often. They typically also sit much of the day, which can also influence to their well-being.

The smartphone health effects have been also studied [18], [19]. Kim [19] has studied the influence of neck pain on cervical movement in the sagittal plane during smartphone use. He concluded that his findings suggest that young adults with mild neck pain (MNP) are more careful and more frequently utilize a neutral neck posture than young adults without MNP when using a smartphone while sitting. Park et al. [20] also investigated the effects of heavy smartphone use on the cervical angle, pain threshold of neck muscles, and depression. They

found that heavy smartphone use may produce considerable stresses on the cervical spine, and then it is possible that the pain threshold of the muscles around the neck. They also described that smartphones could also cause negative effects on a person's psychological status, such as depression. [20]

Experienced symptoms in the neck and shoulders should be relieved, for example, by looking for preventive medical inspections, by better solutions for keyboards, displays, and working postures. Also computer programs should be used so that reading is as easy as possible by, for example, larger fonts. Regular breaks during working and analyzing sedentary behavior are means to self-awareness actions.

In the future, it is important to consider that physical symptoms of workers who use heavy desktop computers, laptops, smartphones or other mobile devices can be partly or fully caused by their use of computers. It is also useful and important to develop computer ergonomics.

V. CONCLUSION

In our questionnaire study, a significant proportion of participants (about 15%) reported that they had often or very often an ache, pain, or numbness in the neck, which they associated with desktop computer use, during the last 12 months. The symptoms were more frequent in women: the proportion was more than double compared to men: 19% vs. 8% respectively. The prevalence of symptoms was higher in lower-level white-collar workers: 27% vs. 18% in upper-level white-collar workers; in both groups the prevalence confirmed higher in women. Similar results were obtained also in shoulders, but with a lower overall prevalence: 8% (10 and 4% respectively in women and men). These results are based on a subjective evaluation of the correlation of symptoms to the use of computers, accordingly do not prove a causal relation with computer use, but show on a large sample that persons, especially lower-level white-collar women workers, believe that computer use can influence their wellbeing: this belief should be included among factors to be considered in future studies.

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