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Self-reported working conditions of VDU operators and associations with musculoskeletal symptoms: a cross-sectional study focussing on gender differences

Lena Karlqvist[a,*], Ewa Wigaeus Tornqvist[a], Mats Hagberg[b], Maud Hagman[a], Allan Toomingas[a]

[a] *National Institute for Working Life, SE-112 79 Stockholm, Sweden*
[b] *Department of Occupational Medicine, Gothenburg University, Gothenburg, Sweden*

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Abstract

The aim of the present study was to describe working conditions and the prevalence of musculoskeletal symptoms among male and female VDU operators, and to assess associations between work-related physical and psychosocial exposures and neck and upper limb symptoms by gender. The study population comprised a variety of occupations from both private and public sectors. Data on physical and psychosocial exposures were collected by questionnaires, as were data on musculoskeletal symptoms. Univariate associations between exposures and symptoms affecting the neck and upper limbs were estimated by calculating the prevalence ratios with 95% confidence intervals. We also assessed the potential excess odds ratio attributable to interaction between gender and, one by one, exposure variable. Women ($n = 785$) used the computer on average 3.9 h/day and men ($n = 498$) 3.6. Variation of different work tasks was lower among females than among males. Nineteen per cent of the women and 12% of the men did >3 h of continued computer work without breaks (>10 min) at least twice a week. Twice as many women as men experienced high job strain (high demands and low decision latitude). A higher proportion of women than men reported symptoms $\geqslant 3$ days the preceding month from the upper body, irrespective of body region. For many of the studied exposures the prevalence of symptoms in one or several body regions was increased with increasing exposure, indicating exposure-response relationships. *Duration of computer work* was associated with symptoms among both men and women. Only among men, *duration of work with a non-keyboard computer input device* was associated with symptoms. Only among women, *job strain* was associated with symptoms. *Time pressure* was associated with higher prevalence of symptoms among women. Among men, *time pressure* was associated with lower prevalence of symptoms. Thus, the associations differed between the genders. Women experienced higher prevalence of symptoms than men in all body regions and they were more often exposed to physical and psychosocial conditions that in previous studies have been considered harmful, than men.

Relevance to industry

Work-related exposures and the associations between these factors and musculoskeletal symptoms among VDU operators differed in some respect between men and women. This should be considered in intervention programs. The results from this study gives further support to the advice that *duration of computer work, time pressure* and *job strain*

*Corresponding author. Tel.: +46-8-619-68-17; fax: +46-8-619-68-05.
E-mail address: lena.karlqvist@niwl.se (L. Karlqvist).

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should be reduced in order to decrease the risk of muskuloskeletal disorders among professional computer workers.

Keywords: Ergonomics; Gender differences; Musculoskeletal symptoms; Physical exposures; Psychosocial exposures; VDU; Work-related exposures

1. Introduction

In recent years, the occurrence of work-related musculoskeletal disorders in the neck and upper limbs, such as finger extensor and flexor tendinitis, carpal tunnel syndrome and neck-shoulder myofascial pain, has increased dramatically and now account for nearly 70% of reported occupational illnesses in the USA (Bureau of Labour Statistics, 1996). Computer-intensive workplaces report a high prevalence and incidence of such disorders among the workers (Bergqvist et al., 1995; Faucette and Rempel, 1994; Punnett and Bergqvist, 1997; Tittiranonda et al., 1999). Among the working population in Sweden today, 68% of all men and 63% of all women use personal computers at work. Computerised work is likely to increase (SCB, 1999; Ekman et al., 2000). Of all reported work injuries due to musculoskeletal illness in Sweden, work with computer equipment was reported as the cause of the problems among 13% of the women and 4% of the men in 1998, compared with 6% and 1%, respectively, in 1992 (Wigaeus Tornqvist et al., 2001a).

Several epidemiological studies show that intensive computer work and factors related to work organisation, as well as physical and psychosocial exposures in computer work, are associated with increased risk of neck and upper extremity disorders (Tittiranonda et al., 1999; Ekman et al., 2000; Wigaeus Tornqvist et al., 2001a).

Studies of modern working conditions report substantial changes in work organisation and work content, concerning factors like downsizing, just-in-time jobs, time pressure, job demands and decision latitude (Aronsson, 1999; Härenstam et al., 2001). To a great extent this also concerns computerised modern work.

New technical devices are continuously being introduced to supplement the keyboard, such as the computer mouse, track-ball, computer pen, pointer, track-point, track-pad and even voice control. A good ergonomic design of the computer workstation is important to avoid musculoskeletal disorders (Sauter et al., 1991; Karlqvist, 1998; Aarås et al., 1999). The design is also important for comfort, productivity and quality of the VDU-produced work (Tittiranonda et al., 1999; Jensen et al., 2001).

Exposures relevant to the occurrence of musculoskeletal disorders include both physical workload and the organisation of work in general (Punnett and Herbert, 2000). There is scientific evidence of cause-and-effect relationships between repetitive motion, forceful work, and postural stress for disorders of the back and upper extremities (Bernard, 1997). The risk is particularly high when two or more of these job features are simultaneous and exert synergistic effects. Thus, primary prevention of musculoskeletal disorders in the workplace should include ergonomics programs that emphasize, e.g. the ergonomic design of workstations, equipment, tools, and work organisation to fit the capabilities and limitations of the human body (Hagberg et al., 1995; Westgaard and Winkel, 1997). Work organisation determines, e.g. work pace, repetitiveness, duration of exposures, and recovery time as well as psychosocial dimensions of the work environment such as decision latitude, psychosocial job demands, and social support from supervisors and among coworkers. High psychological work demands typically involve both rapid physical work pace and feelings of time pressure. Highly stereotyped finger motion patterns occur when a manual job both is monotonous and offers little decision autonomy (Punnett and Herbert, 2000).

Being a female is often described as a "risk factor" for many musculoskeletal disorders because prevalence in the general population and in large groups of employees have been reported to be twice as high among women compared to men

(Viikari-Juntura et al., 1991; de Zwart et al., 1997). As Punnett and Herbert (2000) point out, depending of the gender segregated labour market it is essential to distinguish between gender differences in *crude prevalence or risk* and differences in *the effects of occupational exposures* on musculoskeletal outcome. The associations of musculoskeletal disorders with gender and occupational ergonomic exposures should be assessed separately in order to determine whether women are at increased risk when exposed to the same ergonomic stressors as men.

The aim of the present study was to describe working conditions and the prevalence of musculoskeletal symptoms among male and female VDU operators, and to assess associations between work-related physical and psychosocial exposures, respectively, and neck and upper limb symptoms, and whether these associations differed between women and men.

2. Methods

2.1. Study design

The present study is the baseline of a prospective cohort study aiming at identifying risk and preventive factors for musculoskeletal disorders and impaired performance during work with a computer mouse and other input devices.

Information about symptoms, work organisation, work content, physical, psychosocial and individual factors during the preceding month was collected by questionnaire at baseline.

Together with the employers and the Occupational Health Care Centres of the different work sites, work groups or departments were selected to participate in the study. The questionnaire was distributed to all employees at the different work sites by ergonomists at the Occupational Health Care Centres. The ergonomists were also responsible for checking the questionnaires to be filled in, and for collecting them.

2.2. Study population

The present study included 1529 employees (634 men and 895 women) from 46 different work sites in Sweden. The work sites differed in size, the smallest including only seven persons and the largest 260. The study population represented both private and public sectors and included a variety of occupations. The questionnaire was answered by 498 men and 785 women, 79% and 88%, respectively of the total study population. The main reason for not participating was, e.g. that participants were not willing to do so (14%), and other reasons accounted for 2%. Altogether, there was not quite an even distribution of men and women since whole departments or work sites were included in the study. The mean age for the men was 42 years (range: 20–65) and for the women 45 years (range: 20–65). A higher proportion of men had higher education than high school, 55%, compared with 45% of the women.

Daily nicotine users were 31% of the men and 21% of the women. More women than men (20% and 13%, respectively) were smokers while more men used snuff. Physical training at least eight times per month and at least 30 min each time was performed by 37% of the men and 39% of the women.

2.3. Questionnaire

Parts of a questionnaire had earlier been validated and it was constructed with questions related to working conditions. In the present study we have focused on exposures like working hours, work content (variation of work tasks, hours/week of computer work, work with a non-keyboard input device and data/text entry), physical exposures (duration of sitting/standing and walking, periods of computer work without breaks and position of the non-keyboard input device on the work table) and psychosocial exposures (job demands in relation to competence, job strain and probability of meeting time limits and quality demands, as well as social support and support from a supervisor) and questions about comfort of the work environment. Also individual factors like civil status, age, educational level and life-style factors were included. Information about symptoms was collected by the questionnaire at baseline. The questions about musculoskeletal symptoms referred to the duration (days) of pain or aches (and numbness in the hands/fingers) in the neck, upper back, lower back, right and left shoulder, shoulder joint/upper arm, elbow/forearm, wrist and hand/fingers, respectively. The questionnaire was constructed with 88 questions altogether.

There was little internal loss of data, at the most 2%, and the loss was evenly distributed among the men and the women.

2.4. Data treatment and analysis

All analyses were made separately for men and women. We calculated the relative distribution (%) for discrete variables, and for continuous variables we calculated the mean, standard deviation and range.

Symptoms were defined as reporting pain or aches in any of the body regions asked about, or numbness in the fingers, $\geqslant 3$ days during the preceding month. Symptoms in the different body regions were compiled into four broader outcome categories: (a) neck and/or shoulders (neck/shoulders), (b) shoulder joints/upper arms (shoulder joint/upper arms), (c) elbows/forearms and/or wrists and/or hands/fingers (elbow/forearm/hands) and (d) upper and/or lower back (back), respectively.

The exposure conditions considered were generally categorised into three groups, one reference group with low or "optimal" exposure, one "medium high" and one "high" exposed group. The categorization was mainly taken from the alternatives (as the authors believed would not/would cause harmful effects) of each question in the inquiry. For a few questions (e.g. demand and control), based on index values, the median value was chosen as the cut-off point for low/high exposure. Job strain (high demands and low decision latitude) was based on these cut-off points for low/high exposures.

The exposure frequency and the prevalence of symptoms in each exposure category were calculated. The difference between female and male exposure frequency and prevalence of symptoms in each exposure category was expressed in difference between proportions with 95% confidence intervals (Gardner and Altman, 1989).

In the calculations of associations between exposures and symptoms the "high" and "medium high" exposed groups were pooled together to increase power. The exposures considered were: *duration of computer work, duration of work with a non-keyboard input device, duration of data/text entry, variation of work tasks, duration of computer work without breaks (>10 min), position of the non-keyboard input device, job strain (high demands and low decision latitude), demands in relation to competence (too high or too low), probability of meeting time limits and quality demands (time pressure), social support, support from a supervisor and age*. We estimated univariate associations between the respective exposures and symptoms affecting the neck/shoulders, shoulder joint/upper arms and elbow/forearm/hands by calculating the prevalence ratios (PRs) with 95% confidence intervals (95% CIs) in the SAS statistical software (SAS, 1999). Additionally, the associations between exposures and musculoskeletal symptoms that in the univariate analyses showed importance ($PR \geqslant 1.20$ or $PR \leqslant 0.83$), for men or women, have been tested in logistic procedure with interaction between gender and the respective exposure. We did not have enough data in this study to test all the exposures simultaneously. We assessed the potential excess odds ratio (OR) attributable to interaction, with unexposed men as reference group, by measuring departure from additivity of effect by the method proposed by Rothman and Greenland (1998). The expected OR for the combination of being female and exposed would be the OR for exposed men plus the OR for unexposed women minus the OR for unexposed men (reference group with $OR = 1.0$). An observed OR above the expected OR will show the relative excess OR due to interaction (interaction estimate: the observed OR minus the expected OR).

3. Results

3.1. Working conditions

3.1.1. Working hours and tasks

Ordinary working hours for the men were 39 (SD:3.9) h/week and 37 (SD:6.0) for the women.

Among the men, 69% worked overtime with an average of 4.1 (SD:4.2) h/week, and among the women, 63% with an average of 3.2 (SD:5.0) h/week. Computer work was the most common work task for both men and women, averaging 3.6 h/day and 3.9 h/day (Table 1). Only three men and five women had not done computer work during the last month. Dominating work tasks, besides computer work, lasting for at least 30 min/day, among the men were: deskwork (70% of the men), meetings/seminars and discussions with co-workers (48%) and phone calls (43%). Corresponding work tasks for the women were: deskwork (60% of the women) and phone calls (43%) (Table 1).

A higher proportion of women spent 2 h or more with computer work and women had lower variation of work tasks, lasting for at least 30 min, than men (Table 2, where also the prevalence of musculoskeletal symptoms is presented). A higher proportion of women reported more than 3 h of continued computer work, without breaks, at least twice a week (Table 2). Additionally, the computer work tasks differed more among men compared with women (Table 3). The most common computer work task was writing/independent text processing among both the men and the women, but more women (51%) did data/text entry, compared with men (38%) (Table 3). Twenty-six per cent of the men and 18% of the women had more than two types of computer work tasks which lasted for at least 30 min/day, difference: −8 (95% CI: −13 to −3)%. More of the women, 39% compared with 23% of the men, had worked with data/text entry at least 30 min/day during the preceding month, difference: 16 (95% CI: 9–24)%. More of the men, 61%, compared with 46% of the women, worked with writing, independent text processing ⩾30 min/day, difference: −15 (95% CI: −21 to −10)%. Men, compared to women, also

Table 1
The relative frequency (%) of men and women with different work tasks during the last month, and mean (*m*) percentage of work time with standard deviation (SD) spent on each task among those who had the task[a]

Work tasks	Men, $n = 498$			Women, $n = 785$		
	%	*m* (SD)	% ⩾0.5 h/day	%	*m* (SD)	% ⩾0.5 h/day
VDU work	99	44 (22)	98	99	51 (23)	99
Difference (95% CI)				0 (−1–1)		1 (−0.1–2)
Typing	2.4	4.3 (5.2)	0.2	12	4.1 (6.1)	1.3
Difference (95% CI)				*10 (7–12)*		*1 (0.2–2)*
Desk work	90	17 (12)	70	90	14 (12)	60
Difference (95% CI)				0 (−3–4)		*−10 (−16 to −5)*
Meetings/seminars	86	11 (10)	48	87	7.9 (7.2)	33
Difference (95% CI)				1 (−3–5)		*−15 (−21 to −9)*
Discussions with co-workers	88	9.1 (6.3)	48	88	6.7 (5.3)	30
Difference (95% CI)				0 (−4–4)		*−18 (−24 to −12)*
Phone calls	85	9.4 (9.0)	43	89	9.7 (8.9)	43
Difference (95% CI)				*4 (0.03–8)*		0 (−6–6)
Teaching	22	7.6 (7.3)	8	21	11 (12)	10
Difference (95% CI)				−1 (−1–4)		2 (−5–9)
Copying	78	5.8 (8.9)	13	85	4.9 (4.9)	16
Difference (95% CI)				*7 (3–12)*		3 (−1–8)
Coffee break	84	4.9 (4.1)	14	89	4.6 (2.6)	14
Difference (95% CI)				*5 (1–9)*		0 (−4–4)
“Other”[b]	23	23 (22)	17	23	19 (19)	15
Difference (95% CI)				0 (−5–5)		−2 (−11–6)

[a] Difference between the percentage of women and men with 95% confidence intervals (95% CI). Italic indicates significant differences between men and women.

[b] For the men: travel, customer contacts and visits, materials- and goods handling, installations, etc. For the women: patient contacts and visits, materials handling and information.

Table 2
The relative frequency (%) of male (M) and female (F) computer users exposed to the respective exposure variables, reported symptoms ⩾3 days during the preceding month in different body regions and differences between female and male computer users with 95% confidence intervals, $n_{\text{men}} = 498$, $n_{\text{women}} = 785$[a]

Exposure variables	Exposed	Symptoms (%)		
	% M/F	Neck/shoulders M/F diff (95% CI)	Shoulder joint/upper arms M/F diff (95% CI)	Elbow/forearm/hands M/F diff (95% CI)
Duration of computer work				
<2 h/day	23/15	*22/47 25 (14–38)*	19/26 7 (−4–18)	*12/31 19 (9–30)*
2–&lt4 h/day	33/35	*33/60 27 (18–36)*	*17/30 13 (5–21)*	*24/40 16 (8–25)*
⩾4 h/day	44/50	*35/61 26 (18–34)*	*16/36 20 (13–27)*	*23/42 19 (12–27)*
Exposure difference (95% CI), computer work ⩾2 h/day compared with less: *8 (4–13)*				
Duration of work with non-keyboard input device				
<0.5 h/day	26/29	*19/58 39 (29–48)*	*12/32 20 (12–29)*	*12/37 25 (17–34)*
0.5-<3 h/day	60/58	*37/60 23 (16–30)*	*20/32 12 (6–18)*	*24/40 16 (9–23)*
⩾3 h/day	14/13	*27/54 27 (13–41)*	*10/36 26 (15–38)*	*23/40 17 (4–31)*
Exposure difference (95% CI), non-keyboard input device ⩾0.5 h/day compared with less: −3 (−8–2)				
Duration of data/text entry				
<0.5 h/day	77/61	*29/57 28 (22–34)*	*17/31 14 (8–20)*	*20/36 16 (10–22)*
0.5–<3 h/day	16/26	*32/59 27 (14–39)*	*14/32 18 (8–28)*	*24/45 21 (9–33)*
⩾3 h/day	7/13	49/62 13 (−6–32)	23/36 13 (−8–30)	29/45 16 (−1–34)
Exposure differences (95% CI), data/text entry ⩾0.5 h/day compared with less: *16 (11–21)*				
Variation of work tasks				
⩾5 work tasks (⩾30 min)	27/20	*27/51 24 (13–34)*	*16/27 11 (1–20)*	*18/34 16 (6–26)*
>2–<5 work tasks (⩾30 min)	46/44	*30/58 28 (20–36)*	*16/31 15 (8–22)*	*20/36 16 (9–23)*
⩽2 work tasks (⩾30 min)	26/36	*38/61 23 (13–36)*	*20/37 16 (7–25)*	*27/46 19 (9–29)*
Exposure differences (95% CI), ⩽2 work tasks (⩾30 min) compared with more: *10 (5–15)*				
Duration of computer work without breaks (breaks >10 min)				
<2 h, daily to once in a while	39/38	*22/50 28 (20–36)*	*15/30 15 (8–22)*	*16/33 17 (10–24)*
Other combinations	49/43	*37/60 23 (15–31)*	*19/31 12 (5–19)*	*24/41 17 (9–25)*
>3 h at least twice a week	12/19	*37/71 34 (20–49)*	*15/39 24 (12–36)*	*22/49 27 (14–41)*
Exposure differences (95% CI), >3 h at least twice a week compared with less: *7 (3–11)*				
Position of a non-keyboard input device				
"Optimal"	33/22	*26/53 27 (17–37)*	*15/33 18 (9–27)*	*19/36 17 (8–26)*
"Non-optimal"	67/78	*34/60 26 (19–32)*	*18/32 14 (9–20)*	*22/41 19 (13–25)*
Exposure differences (95% CI), "non-optimal" position compared with "optimal" position: *11 (6–16)*				
Demands in relation to competence				
In accordance with competence	64/67	*27/57 30 (24–37)*	*18/33 15 (9–21)*	*18/38 20 (14–26)*
Lower than competence	26/20	*39/64 25 (13–36)*	*13/31 18 (9–27)*	*23/44 21 (10–31)*
Higher than competence	10/13	*35/60 25 (10–42)*	*17/29 12 (−2–25)*	*29/40 11 (−3–28)*
Exposure differences (95% CI), demands lower than competence compared with higher/in accordance: *−6 (−11 to −1)*				
Probability of meeting time limits and quality demands (time pressure)				
Good probability	69/68	*30/57 27 (21–33)*	*19/29 10 (4–16)*	*22/38 16 (10–22)*
Less good probability	21/22	*34/61 27 (15–39)*	*13/36 23 (13–33)*	*20/44 24 (13–35)*

Table 2 (*continued*)

Exposure variables	Exposed	Symptoms (%)		
	% M/F	Neck/shoulders M/F diff (95% CI)	Shoulder joint/upper arms M/F diff (95% CI)	Elbow/forearm/hands M/F diff (95% CI)
Low probability	10/10	*31/65 34 (19–52)*	*10/45 35 (21–49)*	*15/39 24 (10–39)*
Exposure differences (95% CI), low probability compared to less good/good probability: 0 (−3–3)				
Job strain (high demands, score 5–20, and low decision latitude, score 6–24)				
Low strain (<13+>19)	18/9	*26/47 21 (6–36)*	18/23 5 (−8–17)	18/24 6 (−7–19)
Medium high strain	79/85	*32/58 26 (20–32)*	*16/33 17 (12–22)*	*21/40 19 (13–24)*
High strain (⩾16+⩽15)	3/6	*50/78 28 (4–60)*	*17/42 25 (7–52)*	33/58 25 (−4–52)
Exposure differences (95% CI), high strain compared to medium high/low strain: *3 (1–5)*				
Anxiety about not being able to finish work in time				
Never	27/23	*28/55 27 (16–37)*	*15/25 10 (1–19)*	*23/38 15 (5–25)*
Occasionally	52/47	*29/53 24 (17–32)*	*17/30 13 (7–20)*	*19/36 17 (10–24)*
At least sometimes during the week	21/30	*40/69 29 (18–40)*	*19/43 24 (14–34)*	*22/47 25 (15–35)*
Exposure differences (95% CI), anxiety at least sometimes during the week compared to sometimes/never: *9 (5–14)*				
Variation between sitting/ standing at the computer				
At least once a day	8/13	40/57 17 (−1–35)	18/27 9 (−5–25)	*18/39 21 (7–37)*
Sometimes during the week	9/10	*25/65 40 (25–57)*	*16/41 25 (10–41)*	*23/55 32 (17–49)*
Never or seldom	83/77	*31/58 27 (21–33)*	*17/32 15 (10–20)*	*21/38 17 (11–23*
Exposure differences (95% CI), never or seldom compared to sometimes/at least once a day: *−6 (−10 to −1)*				
Overall comfort (score −44 to +44)				
High ⩾25	26/28	*23/47 24 (14–33)*	17/22 5 (−4–13)	*21/33 12 (3–22)*
Medium >2 <25	53/46	*29/59 30 (22–37)*	*16/32 16 (10–23)*	*19/38 19 (12–26)*
Low ⩽2 21/27	*43/66*	*23 (12–35)*	*19/42 23 (13–33)*	*27/48 21 (11–32)*
Exposure differences (95% CI), low overall comfort compared to medium/high: *6 (1–11)*				
Occupations where computer work tasks differ[b]				
Variations in work tasks	37/28	*31/58 27 (18–37)*	*19/30 11 (3–19)*	*20/38 18 (9–27)*
Mostly keyboarding	20/50	*36/58 22 (11–33)*	*15/35 20 (12–28)*	*28/41 13 (3–23)*
Mostly non-keyboard input devices	43/22	*29/59 30 (21–40)*	*15/29 14 (6–22)*	*18/37 19 (10–28)*
Exposure differences (95% CI), mostly keyboarding compared to less keyboarding: *30 (25–35)*				
Exposure differences (95% CI), mostly non-keyboard input devices compared to less: *−21 (−26 to −16)*				
Exercise				
Not at all	20/21	*30/61 31 (20–43)*	*14/34 20 (10–30)*	*22/41 19 (8–30)*
Average amount	43/40	*32/59 27 (19–35)*	*18/35 17 (9–24)*	*24/43 19 (11–27)*
A lot (⩾8times ⩾30 min, last month)	37/39	*30/56 26 (17–35)*	*17/29 12 (5–20)*	*17/35 18 (11–26)*
Exposure differences (95% CI), a lot compared to average/not at all: 2 (−3–7)				

[a] Italic indicates significant differences of exposures and symptoms between women and men.

[b] Mostly keyboarding: Administrators (personnel), handler, insurance officer, call-centre operator, medical secretary. Mostly non-keyboard input device: Administrator (project leader), graphics industry operator, engineer, support.

Table 3
The relative frequency (%) of men and women with different computer work tasks during the last month and mean (m) percentage of work time with standard deviation (SD) spent on each task among those who had the task[a]

Work tasks at the computer	Men, $n = 498$		Women, $n = 785$		Diff (95% CI)
	%	m (SD)	%	m (SD)	
Data/text input from original	38	37 (29)	51	48 (32)	*13 (7–19)*
Writing, independent text processing	78	42 (26)	68	40 (30)	*−10 (−15 to −5)*
Layout, graphic design	26	18 (21)	19	26 (32)	*−7 (−12 to −2)*
Construction, design	11	28 (24)	4.5	25 (25)	*−7 (−10 to −3)*
Accounts	21	16 (16)	17	27 (27)	−4 (−9–0.3)
Data analysis, statistics	23	20 (18)	16	15 (17)	*−7 (−12 to −3)*
Programming	15	25 (21)	6.4	22 (22)	*−9 (−12 to −5)*
Internal, external communication e-mail	67	18 (17)	66	13 (15)	−1 (−6–4)
Search for information, e.g. Internet	73	18 (20)	62	15 (18)	*−11 (−16 to −6)*
"Other"[b]	20	49 (34)	28	59 (35)	*8 (3–13)*

[a] Difference between the percentage of women and men with 95% confidence intervals (95%CI). Italic indicates significant differences between men and women.
[b] For the men: registration, order insertion, systems support, games/picture handling, etc. For the women: registration, order insertion, handling, switchboard operation, point code operation, timetabling, time reservation and tape recording.

used internal, external communication—e-mail—more (⩾30 min/day), 30% and 19%, respectively, difference: −11 (95% CI: −24 to −9)%, and searched for information, e.g. on the Internet, 25% versus 18%, difference: −7 (95% CI: −12 to −3)%.

Computers were also used at home by 70% of the men and 47% of the women. The mean duration of computer work at home was on average 6.1 (SD:10) h/month among the male users and 3.9 (SD:9.9) h/month among the female users. Computer use for other tasks than work, e.g. games, was 8.1 (SD:10) and 5.3 (SD:7.7) h/month, for men and women, respectively.

3.1.2. Ergonomic-physical conditions

During a normal working week men were sitting on average 84% of their work time and women 83%. Only 5% of the men and 4% of the women spent 60% or more of their work time in a standing/walking posture.

Besides the keyboard, the computer mouse was the most common computer input device and was used by more than 95% of the study group. Other input devices used were, e.g. track-ball, optical mouse, touch pad and computer pen, but none were used by more than 5%. Voice control was used by one single man.

When men and women marked their location of the computer mouse on the table when working, on a simulated drawing (Fig. 1), it showed that 67% of the men and 78% of the women worked with their computer mouse in a so-called "non-optimal" location (Table 2). "Non-optimal" location correspond to an area on the table outside the length of the forearm and/or outside shoulder width.

When the operators rated their physical work environment during computer work according to the comfort scale, −4 (very, very uncomfortable) to +4 (very, very comfortable), in general, the women experienced worse comfort than the men (Table 4). The largest differences were observed for location of the non-keyboard computer input device, climate, lighting, work postures and working space. Other problems for both men and women were noise and screening off the daylight.

An overall comfort scale was calculated. Low, medium high and high comfort was categorized from tertiles of the sum. A higher proportion of women experienced low overall comfort (Table 2).

3.1.3. Psychosocial conditions

Work demands lower than their competence (e.g. skill, experience) was rated by 26% of the men and 20% of the women, while 11% of the men and 13% of the women rated their work demands higher than their competence (Table 2).

High psychological demands were experienced by 21% of the men and 29% of the women, difference: 8 (95% CI: 3–13)%. More men experienced high decision latitude, 48% compared with 29% of the women, difference: −19 (95% CI: −24 to −14)%. Six per cent of the women and 3% of the men experienced high job strain (high demands and low decision latitude) (Table 2). However, 40% of the women, compared with 31% of the men, experienced a high level of support from the management, difference: 9 (95% CI: 4–14)%.

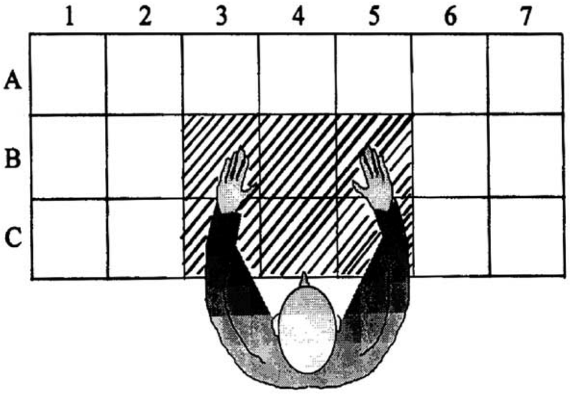

Fig. 1. "Optimal" area of location of the non-keyboard input device indicated by the striped area.

3.1.4. Musculoskeletal symptoms

3.1.4.1. Symptoms reported in the whole group of men and women. Musculoskeletal symptoms from one or more body regions were reported by 51% of the men and 72% of the women (Table 5). Neck and shoulder symptoms were most common among women, and neck and low back symptoms were most common among men (Table 5). Aggregated symptoms from: (a) neck/shoulders were 59% among women and 31% among men, (b) shoulder joint/upper arms 32% and 17%, respectively, (c) elbow/forearm/hands 40% and 21%, respectively and (d) back 38% and 27%, respectively.

For many of the studied exposures the prevalence of symptoms in one or several body regions was increased with increasing exposure, thus exposure-response relationships were indicated (Table 2). Females in categories with a lot of exercise, compared with less, had lower prevalence of symptoms in all body regions (Table 2).

3.1.4.2. Symptoms reported in different occupational groups of men and women. In almost all occupational groups the prevalence of symptoms was higher among women compared to men

Table 4
The relative frequency (%) of men and women who rated high ($\geqslant +2$ on the rating scale −4 to +4) and low ($\leqslant -2$ on the rating scale −4 to +4) comfort[a]

Comfort variables	Men, $n = 498$		Women, $n = 785$		
	High %	Low %	High %	Low %	Diff (95% CI)
Lighting (general)	67	7	65	13	*6 (3–9)*
Lighting (work table)	61	7	60	12	*5 (2–8)*
Screening off the day light	48	16	48	19	3 (−1–7)
Noise	52	17	49	16	−1 (−5–3)
Climate	51	17	43	24	*7 (2–11)*
Work chair	59	11	63	11	0 (−4–3)
Work posture	48	10	51	16	*6 (2–9)*
Work space	58	10	56	16	*6 (2–9)*
Location of the screen	58	7	60	9	2 (−1–5)
Location of the keyboard	56	8	60	10	2 (−1–5)
Location of the non-keyboard input device	53	10	53	18	*8 (4–12)*

[a] Differences between the percentage of women and men rating low comfort with 95% confidence intervals (95% CI). Italic indicates significant differences between women and men. See also Table 2.

Table 5
The relative frequency (%) of men and women who reported musculoskeletal symptoms from one or more body regions in the neck, shoulder, arm, hand and/or low back (and/or numbness in the hands) for at least 3 days during the last month[a]

Symptoms	Men, $n = 498$%	Women, $n = 785$%	M/F difference (95% CI)
Numbness in the hands	6	14	*8 (5–11)*
Neck	24	46	*22 (17–27)*
Shoulders	22	49	*27 (22–32)*
Shoulder joints/upper arms	17	32	*15 (10–20)*
Upper back	8	18	*10 (6–14)*
Elbows/forearms	13	22	*9 (5–13)*
Wrists	8	20	*12 (8–16)*
Hands/fingers	7	22	*15 (11–19)*
Low back	25	34	*9 (4–14)*
Any of the above symptom	51	72	*21 (16–26)*

[a] Differences between the percentage of women and men with 95% confidence intervals (95% CI). Italic indicates significant differences between women and men.

(Table 6). Gender differences were predominant among graphics industry operators, person responsible/investigator and researchers. The female call-centre operators had the highest prevalence of musculoskeletal symptoms in all body regions.

When comparing the largest occupational group among the men, 134 engineers, with the female group of 52 engineers, it was shown that the prevalence of symptoms was higher in neck/shoulders among the female group compared to the male group. When comparing the largest occupational group among the women, 149 insurance officers, with the male group of 20 insurance officers, the prevalence of symptoms was higher in both neck/shoulders and shoulder joint/upper arms in the female group, compared to the male group (Table 6).

3.1.5. Associations between work-related exposures and symptoms

3.1.5.1. Univariate analyses. Associations between exposures and symptoms were most pronounced for the neck/shoulder region followed by elbow/forearm/hands (Table 7). Long duration of computer work, >2 h/day compared with less, and long duration of computer work, >2 h without breaks, at least twice a week, was associated with neck/shoulder and elbow/forearm/hand symptoms both among men and women. Among men, but not among women, duration of work with a non-keyboard input device was associated with symptoms. Among women, but not among men, job strain was associated with symptoms (Table 7).

3.1.5.2. Logistic procedure. For all exposures tested, unexposed women showed a higher point estimate than exposed men (unexposed men always constitutes the reference group). Example: *duration of computer work and neck/shoulder symptoms*, exposed men OR 1.8 (95% CI:1.1–3.0), unexposed women OR 3.1 (95% CI:1.8–5.5), and exposed women OR 5.5 (95% CI:3.5–8.7) (Table 8).

The results showed a tendency for departure from additivity of effect for the combination of being female and exposed to the respective physical and psychosocial exposures tested except for *duration of work with non-keyboard input device* in neck/shoulders and elbow/forearm/hands and *duration of data/text entry* in neck/shoulders. An excess OR >1.0 was shown for associations between *duration of computer work, duration of computer work without breaks* and *job strain,* respectively, and neck/shoulder symptoms and for associations between *job strain* and shoulder joint/upper arm and elbow/forearm/hand symptoms, respectively (Table 8).

4. Discussion

The results from this study confirm associations between earlier suggested harmful exposures

Table 6
The prevalence (%) of musculoskeletal symptoms among males (M) and females (F) in the different occupations grouped in 15 categories[a]

Occupations	N (M/F)	Symptoms (%) (M/F) Neck/shoulders	Shoulder joint/upper arms	Elbow/forearm/hands
Administrator (personnel)	11/48	55/50	27/25	46/31
Difference (95% CI) %		−5 (−28–4)	−2 (−31–27)	−15 (−46–18)
Administrator (project leader)	21/35	33/57	19/40	14/40
Difference (95% CI) %		24 (−2–15)	21 (−2–44)	*26 (4–48)*
Call-centre operator	28/29	57/72	18/41	36/59
Difference (95% CI) %		15 (−0–40)	*23 (1–46)*	23 (−2–48)
Computer support	16/7	44/29	31/29	19/14
Difference (95% CI) %		−15 (−57–26)	−2 (−42–38)	−5 (−37–27)
Engineer	134/52	26/60	14/17	19/21
Difference (95% CI) %		*34 (18–48)*	3 (−9–15)	2 (−10–15)
Graphics industry operator	43/78	28/63	12/32	19/47
Difference (95% CI) %		*35 (18–52)*	*20 (6–35)*	*28 (13–45)*
Person responsible/investigator	42/96	19/60	10/37	14/42
Difference (95% CI) %		*41 (26–57)*	*27 (15–41)*	*28 (13–42)*
Insurance officer	20/149	30/52	15/33	35/40
Difference (95% CI) %		*22 (1–44)*	*18 (1–35)*	5 (−17–27)
Librarian	24/59	38/53	8/31	29/46
Difference (95% CI) %		15 (−1–38)	*23 (6–38)*	17 (−6–39)
Management, marketing	60/32	33/72	20/31	17/41
Difference (95% CI) %		*39 (19–58)*	11 (−8–30)	24 (−5–43)
Medical secretary	0/72	−/67	−/40	−/44
Messenger	37/16	14/63	16/38	16/38
Difference (95% CI) %		*49 (23–75)*	22 (−12–48)	22 (−5–48)
Occupational health personnel	7/32	43/31	29/6	43/22
Difference (95% CI) %		−12 (−52–28)	−23 (−57–12)	−21 (−60–18)
Receptionist	0/14	−/64	−/21	−/14
Researcher	55/66	36/67	24/41	18/44
Difference (95% CI) %		*31 (13–47)*	*17 (1–34)*	*26 (10–42)*

[a] Difference in symptoms between women and men with 95% confidence intervals (95% CI). Italic indicates significant differences.

among VDU operators and symptoms in the neck/shoulders, shoulder joint/upper arms and elbow/forearm/hands (Punnett and Bergqvist, 1997; Tittiranonda et al., 1999). Such harmful exposures include work organisational as well as physical and psychosocial exposures (Wells et al., 2001).

4.1. Working conditions and gender differences

The results from our study indicated that more women, compared to men, were exposed to organisational, physical and psychosocial working conditions that in previous studies have been recognised as harmful conditions. Men and women were found in different occupations, reflecting the gender segregated Swedish labour market (Westberg, 1998). Even in the same occupations, men and women had different work tasks with different durations and variations. Women had less variation of work tasks in general and less variation of computer work tasks than men. The average duration of computer work was also longer among women.

At least a few females were represented in all occupational groups, but there were no male representatives among receptionists or medical secretaries. Their educational background differed, 35% of the male study persons had university (more than 4 years of full-time study) as their highest education level, compared with 17% of the females.

Table 7
Prevalence ratios (PR) with 95% confidence intervals (CI) for symptoms ⩾3 days during the preceding month in the different body regions among male (M) and female (F) computer users, $n_{men} = 498$, $n_{women} = 785$

	Neck/shoulders		Shoulder joint/upper arms		Elbow/forearm/hands	
	M	F	M	F	M	F
Duration of computer work						
⩾2 h/day versus <2 h/day	**1.6 (1.1–2.3)**	**1.3 (1.1–1.6)**	0.9 (0.5–1.3)	1.3 (0.9–1.8)	**2.0 (1.2–3.4)**	**1.3 (1.0–1.8)**
Duration of work with a non-keyboard input device						
⩾0.5 h/day versus <0.5 h/day	**1.8 (1.3–2.7)**	1.0 (0.9–1.1)	1.5 (0.9–2.5)	1.0 (0.8–1.3)	**1.9 (1.2–3.2)**	1.1 (0.9–1.3)
Duration of data/text entry						
⩾0.5 h/day versus <0.5 h/day	**1.3 (1.0–1.7)**	1.0 (0.9–1.2)	1.0 (0.6–1.6)	1.1 (0.9–1.3)	1.3 (0.9–1.9)	**1.2 (1.0–1.5)**
Variation of work tasks						
<5 work tasks (⩾30 min) versus ⩾5 work tasks (⩾30 min)	1.2 (0.9–1.7)	**1.2 (1.0–1.4)**	1.1 (0.7–1.7)	1.3 (0.9–1.7)	1.2 (0.8–1.9)	**1.2 (1.0–1.6)**
Duration of computer work without breaks						
⩾2 h at least twice a week versus <2 h daily to once in a while	**1.7 (1.3–2.3)**	**1.3 (1.1–1.4)**	1.2 (0.8–1.8)	1.1 (0.9–1.4)	**1.5 (1.0–2.1)**	**1.3 (1.1–1.6)**
Position of the non-keyboard input device						
"Non-optimal" versus "Optimal"	**1.3 (1.0–1.7)**	**1.1 (1.0–1.3)**	1.2 (0.8–1.9)	1.0 (0.8–1.2)	1.2 (0.8–1.7)	1.1 (0.9–1.4)
Job strain (high demands and low decision latitude)						
Medium and high strain (⩾13 + ⩾19) versus low strain (<13 + >19)	1.2 (0.8–1.8)	**1.3 (1.0–1.6)**	0.9 (0.6–1.5)	**1.5 (1.0–2.3)**	1.2 (0.7–1.9)	**1.7 (1.1–2.6)**
Job demands in relation to competence						
Lower or higher than competence versus in accordance with competence	**1.4 (1.1–1.8)**	**1.1 (1.0–1.2)**	0.8 (0.5–1.2)	0.9 (0.7–1.1)	**1.4 (1.0–1.9)**	1.1 (0.9–1.3)
Time pressure						
Less good or low probability of meeting time limits and quality demands versus good probability	1.1 (0.8–1.4)	**1.1 (1.0–1.2)**	0.6 (0.4–1.0)	**1.3 (1.1–1.6)**	0.9 (0.6–1.3)	1.1 (0.9–1.3)
Social support (score 6–24)						
Medium or low (⩽20) versus high (>20)	0.9 (0.7–1.2)	1.1 (0.9–1.2)	0.9 (0.6–1.5)	1.2 (0.9–1.5)	1.3 (0.8–1.9)	1.1 (0.9–1.3)
Support from supervisor (score 8–40)						
Medium or low (⩽32) versus high (>32)	1.1 (0.8–1.4)	1.0 (0.9–1.2)	1.1 (0.7–1.6)	1.1 (0.9–1.3)	1.2 (0.8–1.8)	1.1 (0.9–1.3)
Age-group						
⩾35 years versus <35 years	0.9 (0.7–1.2)	1.0 (0.8–1.1)	1.0 (0.7–1.6)	**1.3 (1.0–1.7)**	1.1 (0.8–1.7)	1.1 (0.9–1.4)

Table 8
Odds ratios (OR) among unexposed women, exposed men and exposed women for all variables that in the univariate analyses showed importance, PR ⩾ 1.20 or PR ⩽ 0.83 (unexposed men always constitutes the reference group: OR = 1.0)

Exposure variables	OR (95% CI)		
	Neck/shoulders	Shoulder joint/upper arms	Elbow/forearm/hands
Duration of computer work			
Unexposed women	3.1 (1.8–5.5)		3.4 (1.7–6.7)
Exposed men	1.8 (1.1–3.0)		2.3 (1.3–4.2)
Exposed women	5.5 (3.5–8.7)		5.3 (3.0–9.4)
Interaction estimate	1.5		0.6
Duration of work with non-keyboard input device			
Unexposed women	5.2 (3.1–8.7)		4.1 (2.2–7.4)
Exposed men	2.3 (1.4–3.7)		2.2 (1.2–3.9)
Exposed women	6.2 (3.9–9.8)		5.0 (2.9–8.6)
Interaction estimate	−0.3		−0.3
Duration of data/text entry			
Unexposed women	3.3 (2.5–4.4)		2.4 (1.8–3.3)
Exposed men	1.4 (0.9–2.2)		1.4 (0.9–2.3)
Exposed women	3.6 (2.6–4.9)		3.4 (2.4–4.8)
Interaction estimate	−0.1		0.6
Variation of work tasks			
Unexposed women	2.0 (1.3–3.1)		1.7 (1.1–2.8)
Exposed men	0.9 (0.6–1.4)		1.0 (0.6–1.5)
Exposed women	2.8 (2.0–4.0)		2.3 (1.6–3.4)
Interaction estimate	0.9		0.6
Duration of computer work without breaks (breaks >10 min)			
Unexposed women	3.3 (2.2–4.9)		2.3 (1.5–3.5)
Exposed men	1.9 (1.3–2.8)		1.4 (0.9–2.2)
Exposed women	5.7 (3.9–8.2)		3.6 (2.4–5.3)
Interaction estimate	1.5		0.8
Position of a non-keyboard input device			
Unexposed women	3.0 (1.9–4.7)		
Exposed men	1.3 (0.9–2.0)		
Exposed women	3.9 (2.7–5.7)		
Interaction estimate	0.6		
Demands in relation to competence			
Unexposed women	3.5 (2.6–4.7)		2.8 (2.0–3.8)
Exposed men	1.6 (1.1–2.4)		1.5 (1.0–2.3)
Exposed women	4.4 (3.6–6.3)		3.3 (2.3–4.8)
Interaction estimate	0.3		0.1
Probability of meeting time limits and quality demands (time pressure)			
Unexposed women	2.0 (1.3–3.1)	1.8 (1.3–2.5)	
Exposed men	0.9 (0.6–1.4)	0.6 (0.3–1.0)	
Exposed women	2.8 (2.0–4.0)	2.7 (1.9–3.9)	
Interaction estimate	0.7	0.9	

Table 8 (*continued*)

Exposure variables	OR (95% CI)		
	Neck/shoulders	Shoulder joint/upper arms	Elbow/forearm/hands
Job strain (high demands and low decision latitude)			
Unexposed women	1.8 (1.0–3.4)	1.5 (0.7–3.2)	1.1 (0.6–2.1)
Exposed men	1.0 (0.6–1.5)	1.0 (0.6–1.7)	0.8 (0.5–1.3)
Exposed women	3.1 (2.1–4.6)	2.7 (1.6–4.3)	2.2 (1.4–3.4)
Interaction estimate	1.2	1.1	1.3
Age-group			
Unexposed women		1.8 (1.0–3.1)	
Exposed men		1.0 (0.6–1.7)	
Exposed women		2.6 (1.7–4.2)	
Interaction estimate		0.8	

Computer work tasks dominated among both men and women. However, women did this work task on average about half of their work time, while men spent on average 44% of their work time doing computer work. Men and women had a continuous sitting posture during VDU work and it might be assumed that this constrained sitting would lead to prolonged static contraction of the trapezius muscle, which may result in an overload of type 1 muscle fibres (Hägg, 1991). Several studies indicate that VDU work, especially monotonous data entry with limited rest breaks, may increase the risk of neck and upper extremity disorders (Punnett and Bergqvist, 1997; Aronsson et al., 1992; Bergqvist et al., 1995). In our study, where 51% of the women performed data/text entry during, on average, almost half of their computer work time and had frequent periods of long duration of computer work without breaks, there was an increased prevalence of symptoms in all body regions studied. Women also had low variation of general work tasks as well as variation of computer work tasks lasting for at least 30 min. During computer work, 67% of the men and 78% of the women worked with their computer mouse outside an "optimal" area of the worktable (Karlqvist et al., 1996). This gender difference may partly reflect anthropometric differences. Women also experienced worse comfort than men at the computer workstation and one of the largest differences between men and women was in the location of the non-keyboard computer input device. Earlier studies also indicated this finding (Karlqvist et al., 1995; Brunnberg and Karlqvist, 2000) and one reason for the different comfort ratings between men and women could be differences in anthropometry. The design of the keyboard (still often too long) will force the arm/hand to work far out from the body, especially for narrow-shouldered women. The workstation layout, as well as the individual working technique, influences postures and muscular load (Aarås et al., 1999; Gerr et al., 2000; Lindegård et al., 2001). Aarås and co-authors concluded that in VDU work, supporting the forearm in a neutral position when operating the mouse, significantly reduced the musculoskeletal pain in the upper part of the body. Gerr and co-authors showed that a large proportion of computer users do not work in so-called neutral postures, while Lindegård and co-authors concluded that newspaper editors, with a good working technique had a lower muscular load in the trapezius and forearm extensor muscles compared to editors with a poor working technique.

The results from this study also indicated a higher proportion of women with high job strain than men. High demands were experienced by 29% of the women, and 23% experienced low decision latitude. Only 1/5 of the men experienced high demands and 13% low decision latitude. This is in accordance with many other studies, which have found higher demands and lower decision latitude among women (Karasek and Theorell, 1990; Härenstam et al., 2001).

In summary, women were more often exposed in working conditions related to work tasks with low task variability and work-rest probabilities; this has also been observed in other studies (Kilbom and Messing, 1998; Härenstam et al., 2000).

4.2. Prevalence

The prevalence of musculoskeletal symptoms was higher among women than among men, in this study, in accordance with many other studies (Punnett and Bergqvist, 1997; Tittiranonda et al., 1999; de Zwart et al., 2001). This was evident also in almost all occupational groups. The female call-centre operators showed the highest prevalence of musculoskeletal symptoms. This group has been studied more in detail (Norman et al., 2001).

In an investigation by de Zwart and co-authors the association between gender and upper extremity musculoskeletal complaints, among the general working population and in various occupational groups, was analysed (de Zwart et al., 2001). Their results confirmed the presence of gender differences in upper extremity musculoskeletal complaints among the working population and in many occupational classes, with the female workers having the higher risk. Wigaeus Tornqvist and co-authors analysed the influence on neck- and shoulder disorders from physical and psychosocial exposure at work among men and women in a general Swedish population. They found, for example that the relative risk of seeking care due to neck- and shoulder disorders was only moderately increased by single specific physical and psychosocial working conditions, but the observed risk indicators differed between the genders (Wigaeus Tornqvist et al., 2001b).

4.3. Associations

Duration of computer work was a strong risk indicator for neck/shoulder- and elbow/forearm/hand symptoms among men and women in this study, as previously shown (Punnett and Bergqvist, 1997; Jensen et al., 2001). We expected that the high correlation between *duration of computer work* and *duration of work using non-keyboard computer input device* ($r = 0.56$ for men and $r = 0.42$ for women) would give similar results for duration of work using a non-keyboard computer input device as an indicator for neck/shoulder- and elbow/forearm/hand symptoms, as duration of computer work. However, this was the case for men, but not for women in our study. Earlier studies have shown that duration of work using a non-keyboard computer input device was only a strong indicator for shoulder joint/upper arm- and elbow/forearm/hand symptoms and not for neck/shoulder symptoms among men and women (Franzblau et al., 1993; Karlqvist et al., 1996; Jensen et al., 2001).

Long *duration of data/text entry* with limited rest breaks may increase the risk of neck and upper extremity disorders according to several studies (Punnett and Bergqvist, 1997; Aronsson et al., 1992; Bergqvist et al., 1995). The results from this study show the same tendency, where the exposure variable, *duration of computer work without breaks,* showed the strongest association with neck/shoulder and elbow/forearm/hand symptoms both among men and women. *Variation of work tasks,* however, indicates breaks from continuous computer work, and maybe variation in mental demands. Low variation of work tasks may increase the risk of neck and upper extremity disorders (Punnett and Bergqvist, 1997; Aronsson et al., 1992; Bergqvist et al., 1995). In the present study, associations between variation of work tasks and neck/shoulder- elbow/forearm/hand symptoms were observed among women. *Job strain*, high demands and low decision latitude, showed associations with symptoms in all three body regions (neck/shoulders, shoulder joint/upper arms and elbow/forearm/hands) among the women. Job strain has been shown to be moderately associated with neck and shoulder disorders in several studies (Hagberg et al., 1995; Bernard, 1997; Theorell, 1996). In a recent study by Wigaeus Tornqvist and co-authors associations between job strain, as well as interaction between VDU work and job strain, and symptoms in the neck/shoulders among women were seen, but not among men (Wigaeus Tornqvist et al., 2001b). In the present study, a risk indicator for shoulder joint/upper arm symptoms among women was *time pressure* whereas a preventive effect was indicated among men. This is hard to understand and should be further studied. Time pressure among men and women showed the same opposite effects in the study by Wigaeus Tornqvist and co-authors with increased relative risk (RR) for women and diminished RR for men in the neck/shoulder region (Wigaeus Tornqvist et al., 2001b).

For all exposures tested, unexposed women had a higher prevalence than exposed men in the lower exposure groups. This has been shown also in other studies (Leino et al., 1988; Punnett, 1997).

When we assessed the potential excess odds ratio attributable to interaction between gender and the respective exposure, the results showed a tendency for departure from additivity of effect for all except two exposures. In conclusion, the interaction analyses showed that to be a woman and exposed to several of the risk indicators observed (one by one) showed a tendency of higher OR than expected from additivity. Unfortunately, we did not have enough data in this study to test these tendencies when all exposures were encounted for simultaneously. That should be further encouraged.

The results from this study emphasize the importance of prevention in the workplace in order to reduce musculoskeletal symptoms. Ergonomic recommendations for management, from the results of this study, should include: reduction in duration of computer work; possibilities to take more breaks during computer work; especially for women, more variation of work tasks, size and design of the workstation and input devices according to operators' anthropometry and a work organisation with reduced job strain and time pressure.

4.4. Methodological considerations

One restriction in this study design is that it is not based upon a random sample of the Swedish labour market, but the sample is chosen to cover a wide range of different computer work tasks and intensity of computing. Another is the cross-sectional design of this part of the study, which limits the possibility to draw any conclusions about cause-effect relations. The associations observed will, however, later be analysed in relation to incidence of neck- and upper extremity disorders in order to gain more insight into cause-effect relations. Preliminary incidence data from the longitudinal analysis show a similar pattern (and magnitude of risks) as found in this cross-sectional study. A third restriction in this study is that the results are based on self-reported symptoms collected by questionnaire at baseline. Women reported more symptoms. However, data from the longitudinal analysis with medical examination of the musculoskeletal system indicated that the female computer users, compared with the males, were more frequently afflicted by symptoms and findings (Toomingas et al., 2001). Also in the study by Wigaeus Tornqvist and co-authors more female cases (those who sought care or treatment for neck or shoulder disorders), than male cases, received a confirmed diagnoses, 71% and 58%, respectively (Wigaeus Tornqvist et al., 2001a, b).

4.5. Conclusions

Many of the work-related physical and psychosocial exposures investigated were associated with musculoskeletal symptoms in VDU operators. The associations differed between the genders. Women experienced higher prevalence of symptoms than men in all body regions and they were more often exposed to physical and psychosocial conditions that in previous studies have been considered harmful, than men.

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