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Abstract ***Objectives***: This study analysed the association between gender and upper extremity musculoskeletal complaints, among the general working population and in various occupational groups. The hypothesis was tested whether the higher risk for women in the general working population for these complaints could partly be explained by differences in the distribution of men and women in occupations with different risks for the onset of upper extremity musculoskeletal complaints. ***Methods***: The data for this study came from cross-sectional questionnaire data from 16,874 employees categorised in 21 different occupational classes. Associations between gender and complaints of the upper extremities were analysed for the total study sample and for each occupational class separately. An adjustment was made for the variable 'occupational class' in the final model in order to study the impact of occupational gender segregation on gender differences in upper extremity complaints in the working population. ***Results***: In the total study sample, significantly higher risks of complaints of the neck, shoulder, elbow, and wrist among the women were observed. Within many occupational classes, women reported significantly higher risks than did men, in particular for complaints of the neck and shoulder. Adjustment for occupational class showed increased risks for female workers for complaints of the neck, shoulder, elbow, and wrist, hence, rejecting our hypothesis on occupational gender segregation as an explanation for the higher risks for upper extremity complaints among women in the general working population. ***Conclusions***: This study confirmed the presence of gender differences in upper extremity musculoskeletal complaints among the working population and in many occupational classes, with female workers having the higher risk. The results, however, do not lend support to a differential occupational exposure theory as an explanation for the higher risks for these complaints among women in the general working population. Careful consideration of gender influence in ergonomic epidemiological studies is recommended.

Key words Gender · Occupational exposure · Musculoskeletal complaints · Upper extremities · Questionnaire study

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Introduction

During the past decade, upper extremity musculoskeletal disorders (UEMSD) have become one of the most significant and costly health problems among the working population world-wide (Feuerstein et al. 1998; Muggleton et al. 1999; Silverstein et al. 1998). Alternative terms for these disorders are: repetitive strain injuries (RSI), cumulative trauma disorders (CTD), and occupational cervobrachial disorders (OCD) (Rosecrance and Cook 1998). Several extensive reviews have been published lately on the epidemiological evidence of work-related risk factors in the development of these types of disorder (Bernard 1997; Derebery 1998; Muggleton et al. 1999, Rosecrance and Cook 1998; Sluiter et al. 2000; Viikari-Juntura and Silverstein 1999; Winkel and Westgaard 1992). Most of the papers concluded that occupational exposure to factors such as highly repetitive work tasks, excessive forces, awkward working postures, and hand-arm vibration are associated with the onset of UEMSD.

The individual factor of gender has frequently been treated as a potential confounder or effect modifier in ergonomic epidemiological studies (Bernard 1997). Over the past years, elevated risks of complaints of the upper extremities among female workers have been reported in

various occupational groups, e.g. among car assembly workers (Zetterberg and Öfverholm 1999), newspaper employees (Bernard et al. 1994), salespeople (Skov et al. 1996), fish industry workers (Chiang et al. 1993; Nordander et al. 1999), and office workers (Bergqvist et al. 1995). In large-scale studies of the general working population in different countries, the higher risk for women of the onset of these types of complaint have also been consistently observed (De Zwart et al. 1997a; Ekberg et al. 1995; Feuerstein et al. 1998; Franklin et al. 1991; Linton 1990; Tanaka et al. 1995). The explanations for these gender differences, however, are still poorly understood.

Recently, Kilbom and Messing (1998) discussed potential reasons for the higher musculoskeletal morbidity rates among female workers. The first explanation that was hypothesised were the biological differences between sexes in, e.g. body size, muscular capacity, aerobic capacity, and hormonal conditions, thought to make women more susceptible to the onset of musculoskeletal disorders. Secondly, outside of work, female workers may be more often exposed to risk factors for these types of disorder during household and child care activities than are men. Thirdly, gender-related differences may be related to information bias, as women may be more likely to express or report health problems. Fourthly, within the same occupation, the assigned tasks between both sexes may differ, as well as the psychosocial work environment. Furthermore, work stations and applied tools at the work place may be inappropriate for women, as most of them have been designed on the basis of anthropometric data for men. Finally, women and men may be segregated into different jobs with different working conditions and thus consequently are exposed to different occupational risk factors.

This last-named differential occupational exposure theory has often been mentioned as one of the most plausible explanations for gender differences in health statistics among the general working population. Consistent evidence for this hypothesis concerning gender differences in musculoskeletal complaints, however, is still lacking.

The objectives of this study are twofold: firstly, to analyse the association between gender and upper extremity musculoskeletal complaints among the general working population and in various occupational groups. Secondly, to test the hypothesis whether the higher risk in women in the general working population for these types of complaint can be explained partly by differences in the distribution of male and female workers in occupations with different risks for the onset of upper extremity musculoskeletal complaints.

Methods

Subjects

The data for this study on complaints of the upper extremities came from cross-sectional questionnaire data on working conditions and health, from a database concerning 48,690 active male and female workers from the Netherlands. All questionnaires were gathered by a regional occupational health service (OHS) in the eastern part of the country between 1982 and 1993, as part of periodic occupational health surveys (POHS). For almost three decades, employees in the Netherlands have been invited by their OHS to participate in a POHS with intervals of approximately 4 years. The surveys are carried out company-wide on a voluntary basis. Reported participation rates vary around 70–90% (Weel et al. 2000). A POHS consists of a standardised physical examination and a self-administered questionnaire. The survey primarily aims at identification of adverse working conditions and work-related diseases (Weel et al. 2000).

In case workers participated more than once in a POHS between 1982 and 1993, data from only the first questionnaire were used. Excluded from analyses were all employees: serving in the armed forces ($n = 1{,}325$), those with a mental or physical disability, working in sheltered workplaces ($n = 2{,}861$), those with ages deviating from the range 15–64 years ($n = 18$), and those with missing values on any of the items included in the analyses ($n = 433$). In the remaining group of 44,053 subjects, occupational classes were constructed by grouping workers by their occupational titles in order to increase statistical power. This grouping procedure was based on the Dutch classification of occupations. This national classification system is derived from the international standard classification of occupations in which occupations with similar work demands are grouped into occupational classes (ILO 1969). Because of statistical considerations, we selected for the final analysis data from occupational classes that had a minimum number of 50 subjects in each gender group. In total, 16,874 subjects were selected of whom 66.9% were men and 33.1% were women. Mean age of the men was 38.0 years (range 17–64) and of the women was 32.9 years (range 16–64). The sample included employees from 21 occupational classes representing a broad variation in work tasks and work demands (see Table 1).

Questionnaire data

The self-administered questionnaire, that has been used for almost three decades in POHS (Weel et al. 2000) and in several epidemiological studies (Broersen et al. 1996; De Zwart et al. 1997a,b; 1997c), included 55 items about subjective work demands and working conditions and 117 items about subjective health complaints. For the analysis, data were selected from questions referring to current job title, age, gender, civil status, and finally complaints of the upper extremities. Subjective complaints of the upper extremities were estimated through the questions: (1) Do you regularly have pain or stiffness in the neck? (yes/no); (2) Do you regularly have pain or stiffness in the shoulder? (yes/no); (3) Do you regularly have pain or stiffness in the elbow? (yes/no); and (4) Do you regularly have pain or stiffness in the wrist? (yes/no).

Data analysis

Cox's proportional hazards regression analyses with a constant risk period were performed for the estimation of crude and adjusted prevalence ratios and 95% confidence intervals as effect measures of the association between gender and complaints of the upper extremities (Breslow 1974; Thompson et al. 1998). Men were selected as reference population. Demographic confounders age (four groups ≤29, 30–39, 40–49, ≥50 years) and civil status (two groups: single, and married/living together) were included in the adjusted analyses, regardless of the level of significance. Moreover, we performed descriptive analyses of the prevalences of complaints to identify high and low risk occupations by gender.

To study the impact of differences in gender distribution in occupational classes on the association between gender and upper extremity complaints in the general working population, we added the variable 'occupational class' as a confounder to a model in which age and civil status were already included. This was done for

Table 1 Numbers of men and women within each of the 21 occupational classes (relative gender distribution within each class between brackets)

Occupational class[a]	Men	Women
Laboratory workers	300 (83.6%)	59 (16.4%)
Authors, journalists and related creative artists	158 (73.1%)	58 (26.9%)
Social workers	259 (57.0%)	195 (43.0%)
Managers and directors	1,958 (96.2%)	77 (3.8%)
Bookkeepers and accountants	564 (61.4%)	354 (38.6%)
Administrative workers	1,787 (53.7%)	1,543 (46.3%)
Cashiers, tellers and bank employers	273 (62.3%)	165 (37.7%)
Professional nurses, midwives and related medical and paramedical workers	210 (19.4%)	875 (80.6%)
Teachers (pre-) primary and special education	287 (41.6%)	403 (58.4%)
Teachers secondary and higher education	395 (80.0%)	99 (20.0%)
Salespeople and shop assistants	116 (58.9%)	81 (41.1%)
Restaurant services workers	72 (28.9%)	177 (71.1%)
Housekeeping services and personal care workers	76 (25.8%)	219 (74.2%)
Cleaners and building caretakers	162 (22.1%)	572 (77.9%)
Textile industry workers	182 (69.5%)	80 (30.5%)
Food and beverage industry workers	958 (84.0%)	182 (16.0%)
Assemblers of metal products	463 (88.4%)	61 (11.6%)
Assemblers of electrical products	254 (83.0%)	52 (17.0%)
Printers and related workers	505 (84.7%)	91 (15.3%)
Production and related workers not elsewhere classified	276 (82.6%)	58 (17.4%)
Material handling and related equipment operators, dockers and freight handlers	2,028 (91.4%)	190 (8.6%)
Total	11,283 (66.9%)	5,591 (33.1%)

[a] According to ILO classification (1969)

all four complaints of the upper extremities separately. We then studied the change in prevalence ratios after entering the variable of occupational class in the model. Under the hypothesis that women are dominant in high-risk jobs, a decline in the prevalence ratios towards 1,0 was expected. Finally, we carried out likelihood ratio tests to examine the difference in the log likelihood between the model with and without occupational class included. All data were managed and analysed with SPSS version 7.5 (SPSS, Chicago, Ill., USA). Tests were considered statistically significant if $P < 0.05$.

Results

Working population

Highest prevalence rates of subjective complaints of the upper extremities among male and female workers in the total study sample were reported for the neck and shoulder, varying between 10.7% and 17.7% (Table 2). Women reported higher morbidity rates in both regions of the upper body than did men. Rather low prevalence rates were observed for complaints of the elbow and wrist, all less than 4%. After being adjusted for age and civil status, prevalence ratios from Cox's proportional hazards regression models showed higher risks among the women for complaints of the neck (prevalence ratio (PR) = 1.90, 95% confidence interval (95% CI) 1.75–2.08), shoulder (PR = 1.43, 95% CI 1.30–1.57), elbow (PR = 1.23, 95% CI 1.02–1.47), and wrist (PR = 1.31, 95% CI 1.09–1.58).

Occupational classes

The prevalences of neck complaints for women exceeded that for the men in all occupational classes, except for laboratory workers (Table 3). In 14 out of 21 classes,

Table 2 Gender-specific numbers and prevalences of complaints of the upper extremities, and crude and adjusted prevalence ratios (males reference population) with 95% confidence intervals (95% CI) and *P* values for total study sample ($n = 16{,}874$) (*PR* prevalence ratios)

Part of body	Subjects	Complaints (%)	Crude PR	Adjusted PR[a]	95% CI	*P* value
Neck						
Men	11,283	1,212 (10.7)	1.00	1.00	–	
Women	5,591	987 (17.7)	1.64	1.90	1.75–2.08	<0.001
Shoulder						
Men	11,283	1,220 (10.8)	1.00	1.00	–	
Women	5,591	732 (13.1)	1.21	1.43	1.30–1.57	<0.001
Elbow						
Men	11,283	393 (3.5)	1.00	1.00	–	
Women	5,591	177 (3.2)	0.91	1.23	1.02–1.47	0.027
Wrist						
Men	11,283	321 (2.8)	1.00	1.00	–	
Women	5,591	184 (3.3)	1.16	1.31	1.09–1.58	0.005

[a] Adjusted for age and civil status

Table 3 Gender-specific prevalences of complaints of the neck and shoulder and adjusted prevalence ratios (males reference population, adjusted for age and civil status) with 95% confidence intervals (95% CI) and *P* values stratified for occupational class (*PR* prevalence ratios)

Occupational class	Neck					Shoulder				
	Complaints (%)		PR	95% CI	*P* value	Complaints (%)		PR	95% CI	*P* value
	Men	Women				Men	Women			
1. Laboratory workers	7.7	5.1	0.86	0.25–2.99	0.817	7.0	10.2	2.05	0.77–5.48	0.152
2. Authors, journalists and related creative artists	12.7	15.5	1.22	0.53–2.80	0.646	8.9	12.1	2.29	0.83–6.35	0.111
3. Social workers	13.1	20.5	1.57	0.96–2.57	0.071	10.0	9.7	1.09	0.58–2.05	0.786
4. Managers and directors	10.9	19.5	2.29	1.33–3.96	0.003	9.9	11.7	1.70	0.86–3.39	0.129
5. Bookkeepers and accountants	7.6	14.4	2.24	1.46–3.45	< 0.001	7.1	8.8	1.49	0.91–2.45	0.113
6. Administrative workers	9.6	15.7	1.96	1.60–2.41	< 0.001	6.7	10.3	1.98	1.54–2.53	< 0.001
7. Cashiers, tellers and bank employers	9.5	21.2	2.18	1.21–3.90	0.009	9.2	11.5	1.51	0.76–2.99	0.241
8. Professional nurses, midwives and related medical and paramedical workers	11.4	12.5	1.40	0.89–2.20	0.147	8.6	9.0	1.28	0.76–2.17	0.355
9. Teachers (pre-) primary and special education	10.8	22.8	2.13	1.40–3.26	0.001	9.4	17.6	2.07	1.31–3.27	0.002
10. Teachers secondary and higher education	16.7	38.4	2.52	1.68–3.79	< 0.001	16.7	24.2	1.58	0.98–2.55	0.059
11. Salespeople and shop assistants	6.0	27.2	4.78	1.95–11.74	0.001	9.5	14.8	2.01	0.83–4.86	0.122
12. Restaurant services workers	8.3	19.8	2.49	1.04–5.96	0.040	15.3	13.0	0.96	0.46–1.98	0.910
13. Housekeeping services and personal care workers	10.5	16.0	1.81	0.83–3.94	0.138	6.6	12.8	2.41	0.92–6.33	0.074
14. Cleaners and building caretakers	14.2	18.4	1.32	0.84–2.08	0.224	11.1	15.6	1.44	0.87–2.39	0.161
15. Textile industry workers	13.2	20.0	2.57	1.23–5.37	0.012	10.4	12.5	1.71	0.69–4.22	0.245
16. Food and beverage industry workers	10.6	23.6	2.42	1.68–3.49	< 0.001	17.2	34.1	2.13	1.58–2.88	< 0.001
17. Assemblers of metal products	8.6	16.4	2.06	1.01–4.23	0.048	12.5	18.0	1.62	0.83–3.15	0.154
18. Assemblers of electronic products	1.8	30.8	3.07	1.63–5.76	0.001	13.0	23.1	2.32	1.18–4.59	0.015
19. Printers and related workers	12.3	24.2	2.76	1.66–4.61	< 0.001	10.9	13.2	1.69	0.88–3.24	0.113
20. Production and related workers not elsewhere classified	11.2	5.5	1.44	0.68–3.07	0.338	12.7	15.5	1.32	0.63–2.77	0.464
21. Material handling and related equipment operators, dockers and freight handlers	11.2	21.1	2.21	1.56–3.13	< 0.001	12.8	21.1	2.04	1.45–2.88	< 0.001

significantly higher risks were found for women after we adjusted for age and civil status. A pronounced variety between occupational classes was observed in PRs among the female workers in particular, ranging from 5.1% to 38.4%. For women, laboratory workers were identified as an occupational class with a relatively low prevalence, whereas teachers in secondary and higher education and assemblers of electronic products were identified as occupations with a high prevalence. Among the men, less variety was observed, ranging from 6.0% to 16.7%. Here, salesmen and shop assistants, bookkeepers and accountants, and laboratory workers were found to show low prevalences, whereas a relatively high prevalence was reported for teachers in secondary and higher education.

For prevalences of complaints of the shoulder, similar results were reported. In 19 occupational classes higher rates were observed for female employees compared with their male colleagues. After adjustment, the female status was found to be a significant risk factor for shoulder complaints in five occupational classes. Among the female workers prevalences ranged from 8.8% to 34.1%. Bookkeepers and accountants, and nurses reported the lowest prevalences for shoulder complaints. Highest prevalence was found among food and beverage industry workers. Among the men, prevalences varied from 6.6% to 17.2%. Housekeeping services and personal care, administration and laboratory work were found to be jobs with low prevalences, whereas the food and beverage industry and teaching in secondary and higher education were found to be jobs with relatively high prevalences.

In ten classes, prevalences of complaints of the elbow in men exceeded that of the women, this in sharp contrast to the results reported for the neck and shoulder (Table 4). Only for teachers in pre- and primary as well as in special education was a significant association found with gender, with the female workers having the higher risk. Moreover, a small variation in prevalences between the various classes was observed among the men (1.3% to 6.5%) as well as the women (0% to 9.1%). In female employees, lowest prevalences were reported for authors, printers, and bookkeepers and accountants, whereas relatively high prevalences were reported for teachers in secondary and higher education, assemblers of electronic products and cleaners and building caretakers. Among the male employees, lowest prevalences were reported for the occupational classes of laboratory workers, authors, and bookkeepers and accountants. Relatively high prevalences were reported among assemblers of metal and electronic products and teachers in secondary and higher education.

Prevalences of complaints of the wrist were higher for women in 15 occupational classes compared with men. Female employees tended to have higher adjusted risks than men for symptoms of the wrist among food and beverage industry workers, assemblers of electronic products, and material handling and related workers. Similar to elbow complaints, limited variation in prevalences was reported between all classes for male (0.9% to 5.5%) and female (0% to 13.7%) workers. For women, low prevalences were found in production and production-related workers, bookkeepers and accountants, and textile industry workers. Relatively high prevalences were reported in food and beverage industry workers and assemblers of electronic products. For men, low prevalences were found in bookkeepers and accountants, salesmen and shop assistants, and restaurant service workers. Relatively high prevalences were found in textile industry workers, production and production-related workers, and housekeeping services and personal care workers.

In contrast to the female status, within none of the occupational classes was the male status associated with a significantly higher risk for one of the complaints of the upper extremities under study.

Gender segregation

In our study, men and women were found to be segregated into different occupational classes (Table 1). Moreover, descriptive gender-specific analyses showed a wide variety in prevalences of upper extremity complaints between occupational classes. To evaluate whether some of the risk differences between male and female workers in the total study sample could be explained by this gender segregation in working conditions, hypothesising that women are dominant in high risk occupations, we examined PRs unadjusted and adjusted for occupational class (Table 5). Controlling for occupational class in the analyses resulted in an increase in the PR for the association between gender and all four types of complaint separately instead of the hypothesised decline, hence, rejecting our proposed hypothesis. Likelihood ratio tests reported significant improvements of all four models after inclusion of the confounder occupational class ($P < 0.001$).

Discussion

The findings of this study showed an association of gender with complaints of the upper extremities among the general working population as well as in many occupational classes, with female workers consistently showing the higher risk. At the level of occupational class, the gender differences in morbidity rates were found to be more pronounced for the neck and shoulder compared with the elbow and wrist. Moreover, a wide variety in prevalences of upper extremity complaints between occupational classes was found for each gender group. Furthermore, our results could not confirm the frequently stated hypothesis that the higher risk for women for upper extremity complaints in the general working population can be attributed to gender segregation in occupations, with women dominant in high risk jobs.

Table 4 Gender-specific prevalences of complaints of the elbow and wrist, and adjusted prevalence ratios (males reference population, adjusted for age and civil status) with 95% confidence intervals (95% CI) and *P* values stratified for occupational class (*PR* prevalence ratios)

Occupational class	Elbow					Wrist				
	Complaints (%)		PR	95% CI	*P* value	Complaints (%)		PR	95% CI	*P* value
	Men	Women				Men	Women			
1. Laboratory workers	1.3	1.7	1.36	0.14–13.17	0.790	1.7	3.4	2.01	0.37–11.10	0.422
2. Authors, journalists and related creative artists	1.3	0.0	–	–	–	1.9	1.7	1.09	0.07–17.37	0.953
3. Social workers	2.3	3.1	1.07	0.32–3.59	0.914	3.1	2.6	0.69	0.21–2.29	0.543
4. Managers and directors	3.9	5.2	1.99	0.71–5.60	0.193	2.1	2.6	1.38	0.32–6.03	0.668
5. Bookkeepers and accountants	1.4	1.4	1.92	0.61–6.04	0.263	0.9	1.1	1.77	0.46–6.85	0.407
6. Administrative workers	1.7	1.6	1.38	0.78–2.42	0.270	1.8	2.0	1.48	0.89–2.48	0.132
7. Cashiers, tellers and bank employers	3.3	3.0	1.75	0.54–5.74	0.354	1.8	2.4	2.13	0.50–9.08	0.308
8. Professional nurses, midwives and related medical and paramedical workers	2.4	2.1	1.30	0.47–3.54	0.613	1.9	2.3	1.44	0.48–4.31	0.515
9. Teachers (pre-) primary and special education	2.8	5.2	2.44	1.06–5.61	0.036	2.8	2.5	1.17	0.45–3.06	0.749
10. Teachers secondary and higher education	5.1	9.1	2.05	0.92–4.59	0.804	2.8	6.1	2.38	0.85–6.61	0.097
11. Salespeople and shop assistants	2.6	3.7	2.30	0.41–12.81	0.341	0.9	3.7	8.40	0.81–87.00	0.075
12. Restaurant services workers	4.2	6.2	1.57	0.43–5.74	0.495	1.4	5.6	4.40	0.56–34.64	0.160
13. Housekeeping services and personal care workers	2.6	2.7	1.61	0.32–8.02	0.560	5.3	6.4	1.47	0.47–4.57	0.508
14. Cleaners and building caretakers	3.1	7.2	2.34	0.92–5.94	0.073	1.9	4.0	2.28	0.68–7.59	0.181
15. Textile industry workers	4.4	3.8	2.38	0.41–13.99	0.336	5.5	1.3	0.49	0.06–4.20	0.513
16. Food and beverage industry workers	4.4	3.8	1.09	0.48–2.46	0.837	4.4	13.7	2.77	1.67–4.60	< 0.001
17. Assemblers of metal products	6.5	1.6	0.30	0.04–2.26	0.245	4.3	4.9	1.01	0.29–3.47	0.989
18. Assemblers of electronic products	5.5	7.7	2.01	0.64–6.30	0.232	3.9	11.5	5.05	1.80–14.17	0.002
19. Printers and related workers	4.2	1.1	0.49	0.06–3.77	0.495	4.2	2.2	0.75	0.17–3.31	0.705
20. Production and related workers not elsewhere classified	3.6	1.7	0.54	0.07–4.25	0.555	5.4	0.0	–	–	–
21. Material handling and related equipment operators, dockers and freight handlers	4.3	3.2	1.04	0.45–2.41	0.919	3.5	6.3	1.95	1.04–3.66	0.038

Table 5 Prevalence ratios (males reference population) of complaints of the upper extremities by gender, with 95% confidence intervals (95% CI), *P* values and likelihood ratio test statistics (*PR* prevalence ratios)

Part of body	Model 1[a]	95% CI	*P* value	Model 2[b]	95% CI	*P* value	Likelihood ratio test[c] *P* value
	PR			PR			
Neck							
Men	1.00	–	–	1.00	–	–	–
Women	1.90	1.75–2.08	< 0.001	2.10	1.89–2.33	< 0.001	< 0.001
Shoulder							
Men	1.00	–	–	1.00	–	–	–
Women	1.43	1.30–1.57	< 0.001	1.79	1.60–2.00	< 0.001	< 0.001
Elbow							
Men	1.00	–	–	1.00	–	–	–
Women	1.23	1.02–1.47	0.027	1.45	1.16–1.81	0.001	< 0.001
Wrist							
Men	1.00	–	–	1.00	–	–	–
Women	1.31	1.09–1.58	0.005	1.68	1.35–2.11	< 0.001	< 0.001

[a] Adjusted for age and civil status
[b] Adjusted for age, civil status and occupational class
[c] Comparing the difference in the log likelihood between model 1 and model 2

Study limitations

Before we discuss the results, there are some potential limitations to the study that need to be acknowledged. The cross-sectional nature of this study limits causal inference between study variables, because working conditions were measured at the same time as subjective health complaints. Secondly, job titles and occupational classes were used in this study as surrogates for occupational exposure, as no other reliable exposure data were present. In general, this method is considered to be a rather crude manner of exposure assessment. Firstly, use of job titles can mask variability in tasks and task performance between individuals in the same job (Messing et al. 1994). Secondly, within occupational classes, variability in tasks between jobs within the same occupational class is likely. These factors may have biased some of the work-relatedness of the reported gender differences in complaints. However, despite these limitations, the use of these exposure measures have been proven to generate valuable information on associations between work and individual characteristics and upper extremity symptoms, in particular when data is analysed at group level from large and heterogeneous occupational populations (De Zwart et al. 1997a, Franklin et al. 1991, Hagberg and Wegman 1987, Tanaka et al. 1995).

Generalisation of results

Selected employees represented 25% of all occupational classes at national level. The study sample was characterised by a large variation in occupations, representing a broad range in physical as well as mental work tasks. Moreover, extreme differences in risks of complaints of the upper extremities could be observed between occupational classes, comparable with earlier findings (Hagberg and Wegman 1987). Further, typical male and female classes were present in the sample, as also has been reported in the general working population (Westberg 1998). The total proportion of women in the sample (33.1%) showed satisfactory correspondence with that reported in the general working population in The Netherlands during the years 1987–1990, varying between 36.0% and 38.0% (CBS 1991). Hence, generalisation of the results of this study seems justified.

Gender differences in upper extremity complaints

The results on gender differences in prevalences of upper extremity complaints as reported by this study are consistent with those found by others, reporting elevated risks for women within occupations (Bergqvist et al. 1995, Bernard et al. 1994, Chiang et al. 1993, Nordander et al. 1999, Skov et al. 1996, Zetterberg and Öfverholm 1999) as well as among the general working population (De Zwart et al. 1997a, Ekberg et al. 1995, Feuerstein et al. 1998, Franklin et al. 1991, Linton 1990, Tanaka et al. 1995). These gender differences among employees have also been observed for other types of musculoskeletal symptoms such as back complaints (Dempsey et al. 1997), although less marked than for upper extremity complaints (Punnett and Herbert 1999). Moreover, also among the general population, gender differences in morbidity such as musculoskeletal complaints are a widely known phenomenon (Gijsbers van Wijk and Kolk 1997).

Gender segregation

Judging by the increasing PRs in our study after being adjusted for occupational class, it seems that men not women are dominating jobs with high risk for the onset of complaints of the upper extremities, rejecting our

earlier stated hypothesis. Only a limited number of studies are available with which to compare our results. An American study among workers in an electricity utility company, representing 4000 job titles, also observed increasing risks of work-related injuries for women, after being adjusted for occupational category (Kelsh and Sahl 1996). In contrast, Silverstein et al. (1987) reported no gender differences in the risk of carpal tunnel syndrome among industrial workers in 39 different jobs when occupational exposure factors were controlled.

Other explanations for gender differences

Several likely work-related and non-work-related explanations for the gender distribution of upper extremity complaints as found in this study can be presented. First, female workers may be thought of as more vulnerable compared with men due to biological differences that may interact with workplace characteristics to affect health (Messing and Kilbom 1998). This differential vulnerability hypothesis suggests that although employed men and women may be exposed to similar levels of, e.g. physical work demands, different relative work loads may be experienced due to gender differences in, e.g. maximal physical work capacities. Further, within many working situations, the work stations and applied tools may be inappropriate for female workers, as most of them have been designed for men, without taking account of anthropometric differences between the sexes (Morse and Hinds 1993). For example, according to data by Karlqvist et al. (1998), women reported more awkward wrist and arm postures than men during computer work which was argued to be related with their smaller shoulder-widths. Besides differences in capacities and anthropometry, it has been suggested that the higher risks for women may also be explained by hormonal gender difference related to the female reproductive system, e.g. menstrual cycle, use of oral contraceptives, pregnancy, childbirth, and menopause (Chiang et al. 1993, Kilbom and Messing 1998, Messing and Kilbom 1998). However, the precise mechanism behind the potential association between hormonal factors and musculoskeletal disorders still has to be explored.

Although times are rapidly changing, the distribution of family roles still differs greatly between men and women (Lundberg et al. 1994). More often women apply for part-time jobs, allowing them to carry out household tasks and to take care of the children and partner (Messing et al. 1998). These differences may therefore be part of the explanation for the findings, as they result in gender differences in the total exposure time to risk factors in paid and domestic work. Moreover, they strongly reduce the opportunities for workers to recovery physically after a working day. It is often assumed that lack of recovery time may trigger or cause a pathological process that finally manifests itself as a (work-related) musculoskeletal disorder (Kuorinka and Forcier 1995).

Higher rates of physical symptoms among women have not only been observed in occupational populations (Gijsbers van Wijk and Kolk 1997), a strong argument for a non-work-related explanation. One often referred to is a fundamental difference in the way men and women experience and report symptoms of poor health. It is often hypothesised that women report more discomfort in studies, but when examined, are less likely than men to have a clinical diagnosis. Previous research has yielded mixed results regarding this hypothesis. Among women, a lower pain-pressure threshold in the hand has been reported, suggesting that symptoms are triggered more easily than in men (Brennum et al. 1989, Byström et al. 1995). However, the study of visual display workers by Bergqvist et al. (1995), reported a stronger correlation between subjective discomfort and clinical diagnosis of musculoskeletal disorders for female compared with male workers. Similar finding were described in a Dutch review study, reporting no gender differences or an overrating of symptoms of physical health disorders among men compared with objectively diagnosed clinical signs (Gijsbers van Wijk and Kolk 1997). Our study also produced no supporting results for this hypothesis, as differential effects of gender differences were observed by body part. If gender differences were caused by a general higher rate of symptom-reporting among women, similar gender effects would have been expected between body parts.

Within the same occupation, identical working conditions might be expected between male and female workers. However, research data suggest that this is not always the case. Recently, Nordander et al. (1999) reported clear gender differences in physical exposure and psychosocial work environment among workers with the same job title in the fish industry. This finding was explained by gender differences observed in the content of the work tasks. Similar results about gender segregation in work tasks within the same job have been reported in other studies, often reporting women to be more exposed to highly repetitive movements, static postures, and monotonous tasks than are men (Fransson-Hall et al. 1995, Mergler et al. 1987, Messing et al. 1994, Messing et al. 1998). In fact, within the study of Mergler et al. (1987), gender differences in musculoskeletal complaints between workers with the same occupational title disappeared after adjustment for the particular tasks performed. Gender differences in psychosocial work environment as reported within the same job, or gender differences in the way of coping with psychosocial factors, may also attribute to the higher risk for women of complaints of the upper extremities. An association between the psychosocial work environment and these symptoms has often been reported (Bernard 1997, Bernard et al. 1994, Hales et al. 1994, Muggleton et al. 1999, Rosecrance and Cook 1998). The precise role played by these psychosocial conditions needs more study with a gender sensitive approach, including conditions at work, in the domestic setting, and interactions between them (Kilbom and Messing 1998).

In our study, gender differences in upper extremity complaints, with women consequently reporting the higher number, were found in a wide variety of occupational classes, in particular for complaints of the neck and shoulder. This suggests that gender differences in musculoskeletal disorders are independent of the type of occupation, a strong argument for one of the non-work-related explanations mentioned earlier. On the other hand, the theory of gender segregation in work tasks among employees in the same job may also still be a plausible explanation for our findings. However, whether this phenomenon is independent of the type of occupation is questionable.

Conclusions

In conclusion, this study confirmed the presence of gender differences in upper extremity musculoskeletal complaints among the working populations as well as within several occupational classes, with women reporting the higher numbers of symptoms. The results, however, do not lend support for a differential occupational exposure theory as an explanation for gender differences in upper extremity complaints among the general working population. Gender differences in health presumably can be regarded as a multicausal phenomenon. Potentially, it can be attributed to differences in work-related and non-work-related factors between sexes. Therefore, understanding the origin behind gender differences in upper extremity complaints and in musculoskeletal complaints in general, warrants further studies with a multifactorial approach. Meanwhile, it is obvious that the significant differences between male and female workers, for risk of these complaints, argue for a careful consideration of gender influence in ergonomic epidemiological studies.

References

Bergqvist U, Wolgast E, Nilsson B, Voss M (1995) Musculoskeletal disorders among visual display terminal workers: individual, ergonomic, and work organizational factors. Ergonomics 38: 763–776

Bernard BP (1997) Musculoskeletal disorders and workplace factors: a critical review of epidemiological evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back. NIOSH, US. Department of Health and Human Services, Cincinnati, USA

Bernard B, Sauter S, Fine L, Petersen M, Hales T (1994) Job task and psychosocial risk factors for work-related musculoskeletal disorders among newspaper employees. Scand J Work Environ Health 20: 417–426

Brennum J, Kjeldsen M, Jensen K, Jensen TS (1989) Measurements of human pressure-pain thresholds on fingers and toes. Pain 38: 211–217

Breslow NE (1974) Covariance analysis of censored survival data. Biometrics 30: 89–99

Broersen JPJ, De Zwart BCH, Van Dijk FJH, Meijman TF, Van Veldhoven M (1996) Health complaints and working conditions experienced in relation to work and age. Occup Environ Health 53: 51–57

Byström S, Hall C, Welander T, Kilbom Å (1995) Clinical disorders and pressure-pain thresholds of the forearm-hand among automobile assembly line workers. J Hand Surg 20: 782–790

CBS (Centraal Bureau voor de statistiek) (1991) Enquête beroepsbevolking 1990. CBS, Voorburg Heerlen

Chiang H-C, Ko Y-C, Chen S-S, Yu H-S, Wu T-N, Chang P-Y (1993) Prevalence of shoulder and upper-limb disorders among workers in the fish-processing industry. Scand J Work Environ Health 19: 126–131

Dempsey PG, Burdorf A, Webster BS (1997) The influence of personal variables on work-related low-back disorders and implications for future research. J Occup Environ Medicine 39: 748–759

Derebery VJ (1998) Determining the cause of upper extremity complaints in the workplace. State of the Art Reviews Occup Med 13: 569–582

De Zwart BCH, Broersen JPJ, Frings-Dresen MHW, Van Dijk FJH (1997a) Musculoskeletal complaints in the Netherlands in relation to age, gender and physically demanding work. Int Arch Occup Environ Health 70: 352–360

De Zwart BCH, Broersen JPJ, Frings-Dresen MHW, Van Dijk FJH (1997b) Repeated survey on changes in musculoskeletal complaints relative to age and work demands. Occup Environ Med 54: 793–799

De Zwart BCH, Broersen JPJ, Van der Beek AJ, Frings-Dresen MHW, Van Dijk FJH (1997c) Selection related to musculoskeletal complaints among employees. Occup Environ Med 54: 800–806

Ekberg K, Karlsson M, Axelson O (1995) Cross-sectional study of risk factors for symptoms in the neck and shoulder area. Ergonomics 38: 971–980

Feuerstein M, Miller VL, Burrell LM, Berger R (1998) Occupational upper extremity disorders in the federal workforce: prevalence, health care expenditures, and patterns of work disability. J Occup Environ Med 40: 546–555

Franklin GM, Haug J, Heyer N, Checkoway H, Peck N (1991) Occupational carpal tunnel syndrome in Washington State 1984–1988. Am J Public Health 81: 741–746

Fransson-Hall C, Byström S, Kilbom Å (1995) Self-reported physical exposure and musculoskeletal symptoms of the forearm-hand among automobile assembly-line workers. J Occup Environ Med 37: 1136–1144

Gijsbers van Wijk CMT, Kolk AM (1997) Sex differences in physical symptoms: the contribution of symptom perception theory. Soc Sci Med 45: 231–246

Hagberg M, Wegman DH (1987) Prevalence rates and odds ratios of shoulder-neck diseases in different occupational groups. Br J Ind Med 44: 602–610

Hales TR, Sauter SL, Peterson MR, Fine LJ, Putz-Anderson V, Schleifer LR, Ochs TT, Bernard BP (1994) Musculoskeletal disorders among visual display terminal users in a telecommunication company. Ergonomics 37: 1603–1621

ILO (International Labour Office) (1969) International standard classification of occupations: revised edn. ILO, Geneva

Karlqvist LK, Bernmark E, Ekenvall L, Hagberg M, Isaksson A, Rosto T (1998) Computer mouse position as a determinant of posture, muscular load and perceived exertion. Scand J Work Environ Health 24: 245: 62–73

Kelsh MA, Sahl JD (1996) Sex differences in work-related injury rates among electric utility workers. Am J Epidemiol 143: 1050–1058

Kilbom Å, Messing K (1998) Work-related musculoskeletal disorders. In: Kilbom Å, Messing K (eds) Women's health at work. National Institute of Working Life, Solna, pp 203–227

Kuorinka I, Forcier L (1995) Work related musculoskeletal disorders (WMSDs): a reference book for prevention. Taylor & Francis, London Bristol

Linton S (1990) Risk factors for neck and back pain in a working population in Sweden. Work and Stress 4: 41–49

Lundberg U, Mårdberg B, Frankenhaeuser M (1994) The total workload of male and female white collar workers as related to

age, occupational level, and number of children. Scand J Psychol 35: 315–327
Mergler D, Brabant C, Vézina N, Messing K (1987) The weaker sex? Men in women's working conditions report similar health symptoms. J Occup Medicine 29: 417–421
Messing K, Kilbom Å (1998) Identifying biological specificities of relevance to work-related health. In: Kilbom Å, Messing K (eds) Women's health at work. National Institute of Working Life, Solna, pp 99–118
Messing K, Dumais L, Courville J, Seifert AM, Boucher M (1994) Evaluation of exposure data from men and women with the same job title. J Occup Med 36: 913–917
Messing K, Tissot F, Saurel-Cubizolles M-J, Kaminski M, Bourgine M (1998) Sex as a variable can be a surrogate for some working conditions: factors associated with sickness absence. J Occup Environ Med 40: 250–260
Morse LH, Hinds LJ (1993) Women and ergonomics. State of the Art Reviews Occup Med 8: 721–731
Muggleton JM, Allen R, Chappell PH (1999) Hand and arm injuries associated with repetitive manual work in industry: a review of disorders, risk factors and preventive measures. Ergonomics 42: 714–739
Nordander C, Ohlsson K, Balogh I, Rylander L, Pålsson B, Skerfving S (1999) Fish processing work: the impact of two sex dependent exposure profiles on musculoskeletal health. Occup Environ Med 56: 256–264
Punnett L, Herbert R (1999) Work-related musculoskeletal disorders: is there a gender differential, and if so, what does it mean? In: Goldman MB, Hatch M (eds) Women and health. Academic Press, San Diego, pp 474–491
Rosecrance JC, Cook TM (1998) Upper extremity musculoskeletal disorders: occupational association and a model for prevention. Cent Eur J Occup Environ Med 4: 214–231
Silverstein BA, Fine LJ, Armstrong TJ (1987) Occupational factors and carpal tunnel syndrome. Am J Ind Med 11: 343–358
Silverstein B, Welp E, Nelson N, Kalat J (1998) Claims incidence of work-related disorders of the upper extremities in Washington State, 1987–1995. Am J Public Health 88: 1827–1833
Skov T, Borg V, Ørhede E (1996) Psychosocial and physical risk factors for musculoskeletal disorders of the neck, shoulders, and lower back in salespeople. Occup Environ Med 53: 351–356
Sluiter JK, Rest KM, Frings-Dresen MHW (2000) Criteria document for evaluation of the work-relatedness of upper extremity musculoskeletal disorders. Coronel Institute for Occupational and Environmental Health, University of Amsterdam, Amsterdam/SALTSA, Stockholm, Sweden
Tanaka S, Wild DK, Seligman PJ, Halperin WE, Behrens VJ, Putz-Anderson V (1995) Prevalence and work-relatedness of self-reported carpal tunnel syndrome among US workers: analysis of the occupational health supplement data of 1988 National Health Interview Survey. Am J Ind Med 27: 451–470
Thompson ML, Myers JE, Kriebel D (1998) Prevalence odds ratio or prevalence ratio in the analysis of cross sectional data: what is to be done? Occup Environ Med 55: 272–277
Viikari-Juntura E, Silverstein B (1999) Role of physical load factors in carpal tunnel syndrome. Scand J Work Environ Health 25: 163–185
Weel ANH, Broersen JPJ, Van Dijk FJH (2000) Questionnaire surveys on health and working conditions: development of an instrument for risk assessment in companies. Int Arch Occup Environ Health 73: 47–55
Westberg H (1998) Where are women in today's workplace? In: Kilbom Å, Messing K (eds) Women's health at work. National Institute of Working Life, Solna, pp 27–57
Winkel J, Westgaard R (1992) Occupational and individual risk factors for shoulder-neck complaints: part II – the scientific basis (literature review) for the guide. Int J Ind Ergon 10: 85–104
Zetterberg C, Öfverholm T (1999) Carpal tunnel syndrome and other wrist/hand symptoms and signs in male and female car assembly workers. Int J Ind Ergon 23: 193–204