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Is there a gender difference in the effect of work-related physical and psychosocial risk factors on musculoskeletal symptoms and related sickness absence?

by Wendela E Hooftman, PhD,[1, 2] Allard J van der Beek, PhD,[1, 2] Paulien M Bongers, PhD,[2, 3] Willem van Mechelen, PhD [1, 2]

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Objectives The objective of this study was to determine whether there are gender differences in the effect of exposure to work-related physical and psychosocial risk factors on low back, neck, shoulder, or hand–arm symptoms and related sickness absence.

Methods Data of a prospective cohort (study on musculoskeletal disorders, absenteeism stress and health) with a follow-up period of three years were used. Questionnaires were used to assess exposure to risk factors and musculoskeletal symptoms. Sickness absence was registered continuously. Female-to-male gender ratios (GR) were calculated to determine whether there were any differences in the effect. A GR value >1.33 or <0.75 was regarded as relevant.

Results Except for the effect of bending the wrist and the neck backwards (GR 1.52–2.55), men generally had a higher risk of symptoms (GR range 0.50–0.68) with equal exposure. For sickness absence, a GR value of >1.33 was found for twisting the upper body, working in uncomfortable postures, twisting the wrist, bending the neck backwards, and coworker and supervisor support (GR range 1.66–2.63). For driving vehicles, hand–arm vibration, squeezing, working above shoulder level or below knee level, reaching, twisting the neck, job demands, and skill discretion, the GR value was <0.75. For job satisfaction, a GR value of 0.50 was found for absence due to back symptoms, while the GR value was 1.78 for sickness absence due to neck, shoulder, or hand–arm symptoms.

Conclusions Although women are expected to be more vulnerable to exposure to work-related risk factors, the results of this study showed that, in many cases, men are more vulnerable. This study could not explain the gender difference in musculoskeletal symptoms among workers.

Key terms absenteeism; back; gender; neck; upper extremity.

Many studies have reported gender differences in the prevalence of musculoskeletal symptoms (1–3). Most studies report higher prevalences among women (3–7). However, prevalences of back symptoms have been reported to be higher for men in some studies (4, 8). Similarly, gender differences have also been found for sickness absence due to musculoskeletal symptoms (9–12).

One explanation for these gender differences lies in the so-called "vulnerability hypothesis" (13, 14); similar exposure to the same risk factors might have a larger effect on women than men as a result of differences in biological [eg, hormones, physiology (15–18)] or psychological factors [eg, coping strategies (19)]. An earlier review (20) attempted to answer the question of whether there indeed are gender differences in vulnerability to work-related physical and psychosocial risk factors between men and women. Strong evidence of a gender difference was found for the effect of exposure to heavy lifting, hand–arm vibration, and awkward arm postures. However, women were found to be more vulnerable to

1 Department of Public & Occupational Health, EMGO Institute, VU University Medical Center, Amsterdam, Netherlands.
2 Body@Work, Research Centre Physical Activity, Work and Health, TNO VU University Medical Center, Amsterdam, Netherlands.
3 TNO Quality of Life, Work and Employment, Hoofddorp, Netherlands.

Reprint requests to: Allard van der Beek, EMGO Institute, Van der Boechorststraat 7, NL-1081 BT Amsterdam, Netherlands. [E-mail: a.vanderbeek@ vumc.nl]

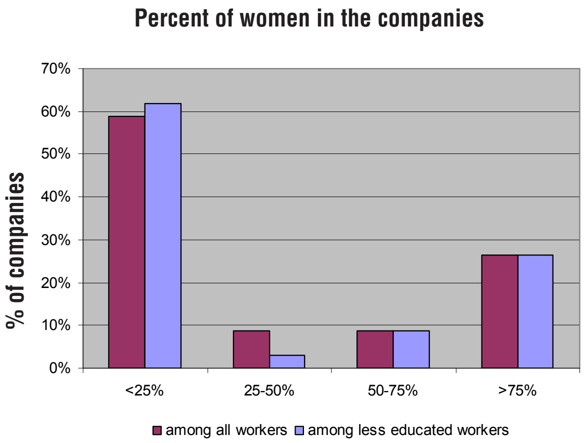

Figure 1. Percentage of companies employing <25%, 25-50%, 50-75%, or >75% female workers, for all workers and less educated workers.

exposure only for the relation between awkward arm postures and neck–shoulder symptoms, while men were more vulnerable to the two other exposures. No evidence for a gender difference was found for the effect of social support. Due to a lack of high-quality studies, there was inconclusive evidence for the remaining risk factors. Most of the studies assessed in the review focused on symptoms as the outcome measure, although sickness absence was assessed in two studies, one on back symptoms and the other on neck–shoulder symptoms.

Therefore, the objective of our study was to determine whether there are gender differences in the effect of exposure to work-related physical and psychosocial risk factors on low back, neck, shoulder, or hand–arm symptoms and related sickness absence. The hypothesis was that, given the gender differences in musculoskeletal symptoms, men may show equal or greater effects of exposure to work-related risk factors in back pain and women may show more effects of exposure to work-related risk factors on musculoskeletal symptoms in other parts of the body.

Study population and methods

This study employed data from the study on musculoskeletal disorders, absenteeism stress and health (SMASH). Nearly 1800 employees in 34 companies participated in this longitudinal study, which focused on the determination of risk factors for musculoskeletal symptoms. At baseline (1994) and during three annual follow-up measurements ("waves"), participants completed questionnaires on exposures and symptoms. Companies continuously registered data on sickness absence. A more-detailed description of the study can be found elsewhere (21, 22).

Population

At baseline, 87% of the workers (N=1789) filled out the questionnaire, 92% of whom also filled out at least one follow-up questionnaire. Workers who, at baseline, worked <20 hours a week (N=40), were employed in their current job for <1 year (N=37), had a second job (N=100), had a permanent disability pension or were on sickness benefit (N=34), were excluded from the current analyses. The companies were selected to incorporate different types of work and a wide range of exposures, and included (among others) care work in daycare centers, assembly-line work in a cookie factory, production work in a pharmaceutical company, computer programming in offices, and grinding and welding in a metal parts factory.

Figure 1 shows that, in the majority of the companies, less than 25% of the workers in the sample were female although in about 25% of the companies, more than 75% of the workers were female. A similar pattern was found among less-educated workers.

For the current analyses, workers with missing data on relevant variables in two or more out of four "waves" were excluded, leaving the final number of workers in the analyses at 1259 (low–back symptoms), 1222 (neck and shoulder symptoms), and 1263 (hand–arm symptoms). Since sickness absence was not registered by all of the companies. According to table 1, the number of workers for absence was lower, namely, 762 (low back-related absence) and 748 (neck-, shoulder-, arm-, or hand-related absence).

Symptoms

Musculoskeletal pain was assessed using an adaptation of the Nordic questionnaire (23). Workers were asked whether they had experienced pain or discomfort in the past 12 months in their back, neck, shoulders, elbows, or hands–wrists on a four-point scale as follows: "no, never", "yes, sometimes", "yes, regular", or "yes, prolonged". The responses for elbow and hand–wrist symptoms were combined into one measure for hand–arm symptoms. Cases were defined as the workers who reported regular or prolonged symptoms in the past 12 months.

Sickness absence

The companies supplied the date of the first and last day of, and reason for, each episode of sickness absence. An occupational physician coded the reasons for absence according to a modified Dutch code of the International

Table 1. Description of the study population (N=1578). (SD = standard deviation)

	Men (N=1096)		Women (N=482)		Missing
	N	%	N	%	N
Age, mean (SD) [a, b]	36.6	8.4	33.1	9.2	0
Education [b]					15
No education or primary school	146	13.4	26	5.5	
Lower secondary of vocational school	480	44.1	154	32.4	
Intermediate secondary or vocational school	266	24.4	179	37.7	
Higher secondary or vocational school	103	9.5	53	11.2	
University	93	8.5	63	13.3	
Years employed, mean (SD) [b]	10.7	8.3	7.0	5.4	0
Hours working, mean (SD) [b]	39.2	3.7	35.2	6.4	24
Symptoms					
Low back (N=1259)					
Baseline	306	34.8	137	36.5	4
Follow-up 1	236	27.9	113	31.0	47
Follow-up 2	246	29.6	116	32.6	73
Follow-up 3	219	26.7	95	27.5	92
Neck (N=1222)					
Baseline [b]	143	17.0	146	39.0	8
Follow-up 1 [b]	110	13.6	118	33.0	53
Follow-up 2 [b]	119	14.9	112	31.3	67
Follow-up 3 [b]	91	11.5	85	24.6	83
Shoulder (N=1222)					
Baseline [b]	134	15.9	138	37.0	6
Follow-up 1 [b]	108	13.5	101	28.3	64
Follow up 2 [b]	105	13.3	95	26.9	79
Follow up 3 [b]	102	12.9	84	24.5	90
Arm-hand (N=1263)					
Baseline [c]	120	13.7	69	18.3	11
Follow up 1 [c]	87	10.5	57	15.8	71
Follow up 2 [b]	95	11.6	71	20.0	91
Follow up 3	91	11.1	52	15.0	94
Sickness absence					
Low back (N=762)					
Baseline	50	9.9	12	7.2	89
Follow up 1	52	10.3	14	8.3	86
Follow up 2	59	11.5	12	7.5	90
Follow up 3 [b]	57	11.7	3	1.7	96
Neck-shoulder-arm-hand (N=748)					
Baseline	22	4.5	9	5.4	89
Follow up 1	25	5.0	10	6.0	84
Follow up 2	17	3.4	8	5.0	89
Follow up 3 [c]	18	3.8	14	7.9	91

[a] For age, education and working hours, numbers are for the complete baseline population (N=1578); for symptoms and sickness absence the numbers are for the populations used in the respective analyses.
[b] Significant difference between men and women at P=0.00.
[c] Significant difference between men and women at P=0.05.

Classification of Diseases. From these data, information was gathered on the occurrence of sickness absence. Since few people were absent due to neck or shoulder symptoms, we combined absences due to these symptoms with absences due to hand–arm symptoms. Cases were defined as workers who were absent from work for at least three days due to back or neck, shoulder, or hand–arm symptoms.

Risk factors

Exposure to physical risk factors was assessed using the Dutch Musculoskeletal Questionnaire (24, 25). Questions on how often activities were performed (eg, "How often do you have to lift loads of more than 5 kg?") were asked on a four-point scale as follows: "never", "occasionally", "often", or "very often". Questions on neck and wrist postures (eg, "Do you often have to work with your neck bent?") were asked on a dichotomous scale ("yes" or "no").

Exposure to work-related psychosocial risk factors was assessed using the Dutch translation of Karasek's job content questionnaire. Individual questions were later combined into the dimensions according to Karasek (ie, job demands, job control, and social support) (26). Furthermore, a single question was asked about job satisfaction. Finally, several questions were set about exposure to psychosocial risk factors in private life (27).

Statistics

Since the SMASH cohort consisted of samples of workers nested within companies, a multilevel analysis seemed appropriate. However, when multilevel analyses were performed on the SMASH dataset, the estimations obtained from did not differ from those obtained using statistical techniques that did not model this nested structure. In other words, the level of companies did not explain the variance in the SMASH cohort. Although it might be argued that multilevel analyses are still the better option because they are "safer", we preferred to use generalized estimation equations for the analyses. An important advantage of such analyses is that data from persons with missing data on one or two of the follow-up measurements are not excluded from the analyses. Hence we decided that the advantage of multilevel analyses (analyzing the nested sample) was smaller than its disadvantage (excluding workers with missing data). Therefore, logistic generalized estimation equations analyses with a one-year time lag were carried out to estimate the odds ratio for exposure and sickness absence due to low-back, neck, shoulder, and hand–arm symptoms. Separate analyses were made for the men and women. All of the analyses were performed with Stata, version 7.0 for Windows (Stata Corporation LP, College Station, TX, USA).

In the multivariate analyses, various symptoms at the baseline were considered to be confounders, including age, education, nationality, years of employment, workhours, workdays, physical exposure (at work and in private life), and psychosocial exposure (at work and in private life). However, we limited the number of potential confounders on the basis of theory or the literature, since not all the risk factors were relevant to every outcome measure. An overview of the confounders for each body region that were considered in the analyses can be found in table 2. First, univariate analyses were performed to test the relation between the individual potential confounders and the outcome variables. Variables related to the outcome with a P–value of >0.25 were not considered as confounders for either men or women. Furthermore, to prevent collinearity, variables associated with individual risk factors with a correlation of >0.5 were not included as confounders. Second, the remaining confounders were individually entered into the univariate models. Variables that changed the univariate odds ratio by >10% for men or women were included in the multivariate model.

In order to determine the difference in the effect of exposure between the men and women, we calculated gender ratios (GR) values as described by Altman & Bland (28). In this procedure, a ratio of odds ratio is calculated (the odds ratio for the women divided by that for the men), which shows the interaction with gender. GR values >1.33 (women having a higher risk) and <0.75 (men having a higher risk) were regarded as relevant gender differences.

Results

Symptoms

Tables 3–5 show the multivariate odds ratio for the men and women separately; in figure 2, the relevant GR values, along with their confidence intervals, are shown for symptoms. For most of the risk factors (16 out of 22), we found no relevant GR value (ie, they were 0.75–1.33). The relation between lifting loads of >25 kg and low-back symptoms was larger for the men than for the women (GR 0.67). Working below knee level was a stronger risk for the men for shoulder (GR 0.63), as well as hand–arm symptoms (GR 0.68). For both neck and hand–arm symptoms, we found a relevant GR value of 0.50 for the effect of bending the neck forwards. For twisting the neck, a GR value of 0.69 was found for the relation with shoulder symptoms. Bending the neck backwards, on the other hand, was a larger risk factor for the women for both neck and for hand–arm symptoms

Table 2. Overview of confounders considered for each symptom region

	Low back	Neck and shoulder	Hand or arm
Socio-demographic [a]			
Age [b]	√	√	√
Education [b]	√	√	√
Dutch nationality [b]	√	√	√
Body mass index	√	√	√
Number of family members [b]	√	√	√
Smoker [b, c]	√	√	√
Alcoholic beverages a week [b]	√	√	√
Healthy eating [b]	√	√	√
Strenuous activity in private life [b, c, d, e]	√	√	√
Work duration			
Years employed [b]	√	√	√
Working days a week [b]	√	√	√
Hours working [b]	√	√	√
Work-related physical risk factors			
Lift loads >5kg [b, c, d, e]	√	.	.
Lift loads >25kg [b, c, d, e]	√	.	.
Flexion/rotation of the upper part of the body [b, c, d, e]	√	.	.
Uncomfortable working postures [b, c, d, e]	√	.	.
Driving a vehicle [b]	√	.	.
Repeated movements with hands or arms [b]	.	√	√
Force exertion with hands [b]	.	√	.
Hand-arm vibration [b]	.	√	√
Working with hands above shoulder level [b, c, d, e]	.	√	.
Working with the hands below knee level [b, c, d, e]	.	√	.
Reaching [b]	.	√	.
Squeeze firmly with the hands [b]	.	.	√
Often bend the neck or keep the neck bent forwards [b, c, d, e]	.	√	.
Often bend the neck or keep the neck bent backwards [b, c, d, e]	.	√	.
Often twist the neck or keep the neck twisted [b, c, d, e]	.	√	.
Often bend the wrist or keep the wrist bent [b, c, d, e]	.	.	√
Often twist the wrist or keep the wrist twisted [b, c, d, e]	.	.	√
Work-related psychosocial risk factors			
Skill discretion [b, c, d, e]	√	√	√
Psychological demands [b, c, d, e]	√	√	√
Coworker support [b, c, d, e]	√	√	√
Supervisor support [b, c, d, e]	√	√	√
Job satisfaction [b, c, d, e]	√	√	√
Physical risk factors in private life			
Lift loads >5 kg [b, c, d, e]	√	.	.
Lift loads >25 kg [b, c, d, e]	√	.	.
Flexion/rotation of the upper part of the body [b, c, d, e]	√	.	.
Uncomfortable working postures [b, c, d, e]	√	.	.
Driving a vehicle [b]	√	.	.
Repeated movements with hands or arms [b]	.	√	√
Force exertion with hands [b]	.	√	.
Hand-arm vibration [b]	.	√	√
Working with hands above shoulder level [b, c, d, e]	.	√	.
Working with the hands below knee level [b, c, d, e]	.	√	.
Reaching [b]	.	√	.
Squeeze firmly with the hands [b]	.	.	√
Psychosocial risk factors in private life			
Work influence personal life [b, c, e]	√	√	√
Personal life influences work [b, c, e]	√	√	√
Disassociate from work [b, c, e]	√	√	√
Able to relax at home [b, c, e]	√	√	√
Busy home environment [b, c, e]	√	√	√
Club membership [b, c, e]	√	√	√
Visiting friends frequently [b, c, e]	√	√	√
Delegate home responsibilities [b, c, e]	√	√	√
Life events [b, c, d, e]	√	√	√

[a] Measured at: [b] = baseline, [d] =follow up 1, [e] = follow up 2, [c] = follow up 3.

Table 3. Results of the multivariate analyses for low back and neck symptoms. Figures in **boldface** are significant at P=0.05, figures in *italics* have a relevant gender ratio (GR<0.75 or GR>1.33). (OR = odds ratio, 95% CI = 95% confidence interval)

Symptoms [a]	Low back				Neck			
	Men		Women		Men		Women	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Work-related physical risk factors [b]								
Lift loads >5 kg [c, d, e, f]	**1.15**	**1.05–1.27**	1.06	0.93–1.22	.	..	.	..
Lift loads >25 kg [c, d, e, f]	***1.26***	***1.11–1.42***	*0.84*	*0.67–1.06* [1]	.	..	.	..
Flexion/rotation of the upper part of the body [c, d, e, f]	**1.22**	**1.11–1.34**	**1.21**	**1.05–1.38**	.	..	.	..
Uncomfortable working postures [c, d, e, f]	**1.41**	**1.24–1.60**	**1.48**	**1.22–1.80** [1, 2]	.	..	.	..
Driving a vehicle [c]	**1.16**	**1.01–1.33**	1.23	0.84–1.79 [2]	.	..	.	..
Repeated movements with hands or arms [c]	.	..	.	..	1.11	0.99–1.25	**1.26**	**1.09–1.45**
Hand-arm vibration [c]	.	..	.	..	1.07	0.89–1.28	0.87	0.62–1.23 [1, 2]
Often bend the wrist or keep the wrist bent [c, d, e, f]	.	..	.	..	.	..	.	..
Often twist the wrist or keep the wrist twisted [c, d, e, f]	.	..	.	..	.	..	.	..
Squeeze firmly with the hands [c]	.	..	.	..	.	..	.	..
Working with hands above shoulder level [c, d, e, f]	.	..	.	..	1.13	0.96–1.32	0.97	0.83–1.13
Working with the hands below knee level [c, d, e, f]	.	..	.	..	1.16	0.94–1.43	0.92	0.71–1.20 [1, 2, 6]
Reaching [c]	.	..	.	..	1.20	0.97–1.47	1.18	0.92–1.52
Force exertion with hands [c]	.	..	.	..	1.06	0.92–1.22	0.99	0.87–1.13
Often bend the neck or keep the neck bent forwards [c, d, e, f]	.	..	.	..	***2.07***	***2.86–1.49***	*1.04*	*1.52–0.71* [1, 2]
Often bend the neck or keep the neck bent backwards [c, d, e, f]	.	..	.	..	0.92	0.59–1.44	0.72	0.38–1.39 [1, 2, 3, 4]
Often twist the neck or keep the neck twisted [c, d, e, f]	.	..	.	..	1.42	0.95–2.13	**1.79**	**1.21–2.66** [1, 2, 4, 5]
Work-related psychosocial risk factors								
Psychological demands [c, d, e, f]	**1.28**	**1.05–1.56**	1.34	0.97–1.85 [1, 2]	**1.45**	**1.10–1.91**	**1.18**	**1.13–1.58** [1, 2]
Skill discretion [c, d, e, f]	**1.29**	**1.09–1.52**	1.06	0.82–1.36	1.16	0.87–1.54	1.34	0.99–1.82 [1, 2]
Coworker support [c, d, e, f]	**1.28**	**1.05–1.57**	1.29	0.92–1.79 [2]	**1.37**	**1.13–1.67**	1.12	0.95–1.32 [1, 2]
Supervisor support [c, d, e, f]	**1.26**	**1.06–1.51**	**1.41**	**1.07–1.87** [2]	**1.70**	**1.30–2.23**	**1.43**	**1.02–2.02**
Job satisfaction [c, d, e, f]	**1.17**	**1.02–1.33**	1.12	0.90–1.39	1.20	0.98–1.48	1.13	0.85–1.51 [1, 2]

[a] Adjusted for: [1] work-home interference, [2] home-work interference, [3] twisting the neck, [4] bending the neck forwards, [5] baseline neck symptoms, [6] baseline shoulder symptoms.
[b] Measured at: [c] = baseline, [d] = follow-up 1, [e] = follow-up 2, [f] = follow-up 3.

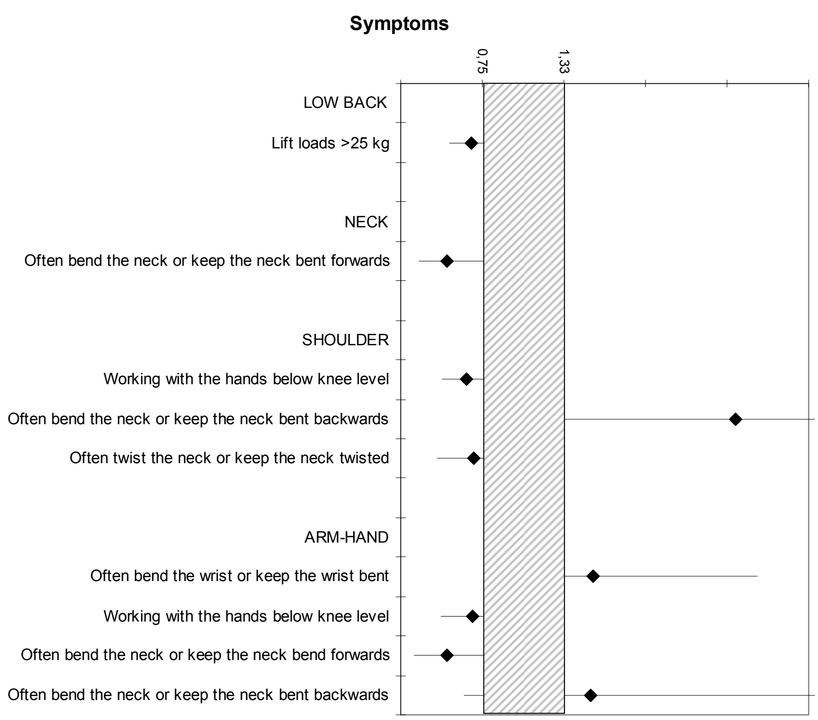

Figure 2. Results of the relevant gender differences (gender ratio [GR] <0.75 or GR>1.33 for musculoskeletal symptoms.

Table 4. Results of the multivariate analyses for shoulder and arm-hand symptoms. Figures in **boldface** are significant at P=0.05, figures in *italics* have a relevant gender ratio (GR<0.75 or GR>1.33). (OR = odds ratio, 95% CI = 95% confidence interval)

Symptoms [a]	Shoulder				Arm-hand			
	Men		Women		Men		Women	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Work-related physical risk factors [b]								
Lift loads >5 kg [c, d, e, f]	.	..	.	..	.	..	.	..
Lift loads >25 kg [c, d, e, f]	.	..	.	..	.	..	.	..
Flexion/rotation of the upper part of the body [c, d, e, f]	.	..	.	..	.	..	.	..
Uncomfortable working postures [c, d, e, f]	.	..	.	..	.	..	.	..
Driving a vehicle [c]	.	..	.	..	.	..	.	..
Repeated movements with hands or arms [c]	1.12	0.98–1.27	**1.21**	**1.05–1.39**	**1.12**	**1.00–1.25**	**1.25**	**1.05–1.48**
Hand-arm vibration [c]	1.05	0.88–1.25	0.85	0.62–1.16	**1.20**	**1.02–1.41**	1.05	0.71–1.55
Often bend the wrist or keep the wrist bent [c, d, e, f]	.	..	.	..	*1.40*	*0.97–2.02*	***2.15***	***1.39–3.32*** [1, 2, 9]
Often twist the wrist or keep the wrist twisted [c, d, e, f]	.	..	.	..	1.15	0.81–1.63	1.32	0.85–2.05 [1, 2, 9]
Squeeze firmly with the hands [c]	.	..	.	..	**1.26**	**1.10–1.45**	1.18	0.99–1.41
Working with hands above shoulder level [c, d, e, f]	**1.30**	**1.12–1.52**	**1.24**	**1.05–1.47**	0.96	0.75–1.22	0.79	0.57–1.09 [1, 2, 9]
Working with the hands below knee level [c, d, e, f]	*1.17*	*0.97–1.41*	***0.74***	***0.58–0.96*** [1, 2]	*1.05*	*0.88–1.24*	*0.71*	*0.50–1.02* [1, 2]
Reaching [c]	**1.28**	**1.05–1.56**	**1.53**	**1.20–1.96**	1.20	0.98–1.46	1.03	0.77–1.36
Force exertion with hands [c]	**1.19**	**1.03–1.38**	1.00	0.86–1.16	**1.20**	**1.04–1.38**	0.89	0.75–1.06
Often bend the neck or keep the neck bent forwards [c, d, e, f]	1.27	1.68–0.96	1.04	1.34–0.80 [3, 7]	*1.21*	*0.85–1.73*	*0.61*	*0.35–1.04* [1, 2, 10]
Often bend the neck or keep the neck bent backwards [c, d, e, f]	***0.60***	***0.37–0.99***	***1.54***	***0.78–3.04*** [1, 2, 3, 4, 5, 6, 8]	*1.03*	*0.64–1.67*	*1.58*	*0.74–3.38* [1, 2, 9, 11]
Often twist the neck or keep the neck twisted [c, d, e, f]	***1.44***	***1.05–1.97***	*0.99*	*0.70–1.39* [1, 2, 4]	1.15	0.79–1.65	1.14	0.76–1.71 [1, 2, 10]
Work-related psychosocial risk factors								
Psychological demands [c, d, e, f]	**1.58**	**1.19–2.11**	1.22	0.90–1.67 [1, 2]	1.14	0.90–1.45	1.23	0.91–1.65
Skill discretion [c, d, e, f]	1.19	0.90–1.58	**1.52**	**1.10–2.11** [1, 2]	1.06	0.82–1.36	0.96	0.71–1.28
Coworker support [c, d, e, f]	**1.41**	**1.07–1.85**	1.26	0.89–1.78 [1, 2]	1.30	0.95–1.76	1.07	0.73–1.57 [2]
Supervisor support [c, d, e, f]	**1.40**	**1.07–1.82**	1.29	0.98–1.70 [1, 2]	1.27	1.02–1.57	0.97	0.74–1.25
Job satisfaction [c, d, e, f]	0.94	0.76–1.18	0.99	0.74–1.33 [1]	1.19	0.98–1.43	1.12	0.86–1.44

[a] Adjusted for: [1] work-home interference, [2] home-work interference, [3] twisting the neck, [4] bending the neck forwards, [5] working above shoulder level, [6] force exertion with hands, [7] job satisfaction, [8] baseline shoulder symptoms, [9] squeeze firmly with the hands, [10] bending the wrist, [11] baseline arm-hand symptoms.

[b] Measured at: [c] = baseline, [d] = follow-up 1, [e] = follow-up 2, [f] = follow-up 3.

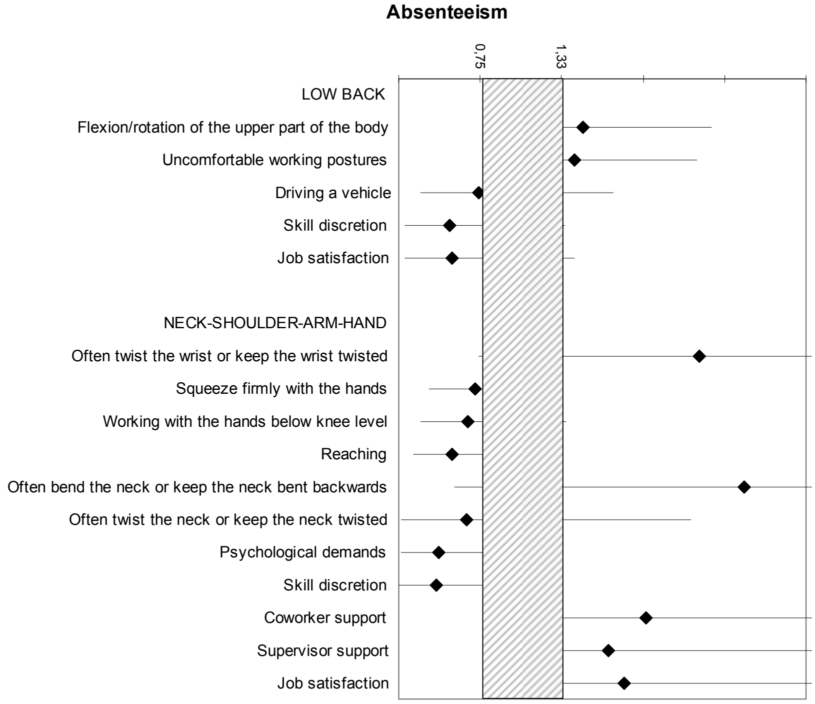

Figure 3. Results of the relevant gender differences (gender ratio [GR] <0.75 or GR>1.33 for absence due to musculoskeletal symptoms.

Table 5. Results of the multivariate analyses for absence due to low back and neck-shoulder. Figures in **boldface** are significant at P=0.05, figures in *italics* have a relevant gender ratio (GR<0.75 or GR>1.33). (OR = odds ratio, 95% CI = 95% confidence interval)

Absence [a]	Low back				Neck-shoulder			
	Men		Women		Men		Women	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Work-related physical risk factors [b]								
Lift loads >5 kg [c, d, e, f]	**1.26**	**1.07–1.49**	1.24	0.81–1.88 [9]	.	..	.	..
Lift loads >25 kg [c, d, e, f]	1.05	0.85–1.31	0.99	0.49–2.01 [8, 9, 10]	.	..	.	..
Flexion/rotation of the upper part of the body [c, d, e, f]	*1.11*	*0.90–1.37*	***1.65***	***1.07–2.55*** [1, 9]	.	..	.	..
Uncomfortable working postures [c, d, e, f]	***1.26***	***1.02–1.56***	***1.79***	***1.17–2.75*** [1, 9]	.	..	.	..
Driving a vehicle [c]	*1.21*	*0.96–1.52*	*0.90*	*0.40–1.99* [9, 11, 15]	.	..	.	..
Repeated movements with hands or arms [c]	.	..	.	..	1.10	0.85–1.44	0.86	0.53–1.39 [3, 4, 6, 9, 16]
Hand-arm vibration [c]	.	..	.	..	1.18	0.87–1.60	0.88	0.39–2.00 [2, 3, 4, 17, 18]
Often bend the wrist or keep the wrist bent [c, d, e, f]	.	..	.	..	0.80	0.37–1.73	0.81	0.30–2.22 [3, 4, 6, 17, 18, 19]
Often twist the wrist or keep the wrist twisted [c, d, e, f]	.	..	.	..	*0.88*	*0.40–1.91*	*2.02*	*0.88–4.67* [3, 4, 6, 17, 18, 19]
Squeeze firmly with the hands [c]	.	..	.	..	***1.74***	***1.25–2.42***	*1.24*	*0.74–2.07* [16, 20]
Working with hands above shoulder level [c, d, e, f]	.	..	.	..	**1.61**	**1.08–2.39**	1.21	0.77–1.90 [9, 16, 20]
Working with the hands below knee level [c, d, e, f]	.	..	.	..	*1.35*	*0.94–1.95*	*0.89*	*0.48–1.66* [9, 16]
Reaching [c]	.	..	.	..	***1.58***	***1.08–2.31***	*0.86*	*0.48–1.54* [5, 9, 16]
Force exertion with hands [c]	.	..	.	..	**1.56**	**1.20–2.02**	**1.50**	**1.07–2.11**
Often bend the neck or keep the neck bent forwards [c, d, e, f]	.	..	.	..	0.89	0.46–1.72	1.11	0.32–3.81 [3, 4, 6, 16, 18]
Often bend the neck or keep the neck bent backwards [c, d, e, f]	.	..	.	..	*0.89*	*0.40–1.98*	*2.33*	*0.63–8.66* [3, 6, 9, 16, 17, 18]
Often twist the neck or keep the neck twisted [c, d, e, f]	.	..	.	..	*1.66*	*0.77–3.60*	*1.09*	*0.42–2.85* [3, 6, 7, 16, 17]
Work-related psychosocial risk factors								
Psychological demands [c, d, e, f]	1.01	0.75–1.36	0.98	0.47–2.06 [11]	*1.23*	*0.70–2.19*	*0.56*	*0.28–1.15* [3, 4, 6, 16, 18]
Skill discretion [c, d, e, f]	*1.31*	*0.96–1.78*	0.70	0.29–1.68 [8, 11, 12, 13, 15]	*1.04*	*0.61–1.76*	*0.46*	*0.21–1.00* [3, 6, 9, 16, 17, 18]
Coworker support [c, d, e, f]	**1.42**	**1.00–2.03**	1.84	0.97–3.47 [15]	*0.48*	*0.26–0.86*	*0.92*	*0.46–1.86* [3, 6, 7, 16, 17]
Supervisor support [c, d, e, f]	1.11	0.80–1.53	0.89	0.43–1.86 [8, 14, 15]	*0.86*	*0.54–1.35*	*1.42*	*0.79–2.57* [20]
Job satisfaction [c, d, e, f]	**1.31**	**1.03–1.67**	0.72	0.28–1.81 [8]	*1.28*	*0.88–1.86*	*2.27*	*1.27–4.07* [6, 9, 20]

[a] Adjusted for: [1] home-work interference, [2] bending the neck forwards, [3] working above shoulder level, [4] force exertion with hands, [5] job satisfaction, [6] squeeze firmly with the hands, [7] bending the wrist, [8] coworker support, [9] education, [10] flexion/rotation of the upper part of the body, [11] lift loads >5kg, [12] working days, [13] working hours, [14] busy home environment, [15] baseline low back absence, [16] twisting the wrist, [17] working below knee level, [18] reaching, [19] repeated movements with hands or arms, [20] baseline neck-shoulder-arm-hand absence.

[b] Measured at: [c] = baseline, [d] = follow-up 1, [e] = follow-up 2, [f] = follow-up 3.

(GR 2.55 and 1.52, respectively). Finally, bending the wrist was a larger risk factor for hand–arm symptoms for the women (GR 1.54).

Sickness absence

Figure 3 shows the relevant GR value for sickness absence. We found no relevant gender ratio for 8 out of 22 risk factors. The effect of driving vehicles (GR 0.74) and low skill discretion (GR 0.53) on sickness absence due to low-back symptoms was larger for the men than the women. On the other hand, bending and twisting the upper body (GR 1.48) and working in uncomfortable postures (GR 1.42) were larger risk factors for the women. For sickness absence due to neck, shoulder, hand, and arm symptoms, relevant gender differences of <0.75 (GR range 0.44–0.71) were found for: (i) squeezing (GR 0.71), (ii) working below knee level (GR 0.66), (iii) reaching (GR 0.55), (iv) twisting the neck (GR 0.65), (v) high job demands (GR 0.46) and (vi) low-skill discretion (GR 0.44). The effect of exposure was larger for the women for: (i) twisting the wrist (GR 2.31), (ii) bending the neck backwards (GR 2.63), and (iii) low coworker (GR 1.93) or supervisor support (GR 1.66). For low job satisfaction, the results were inconsistent with a GR value of 0.55 for sickness absence due to symptoms of the lower back, and a GR value of 1.78 for sickness absence due to neck, shoulder, arm, and hand symptoms.

Discussion

We expected the women to be more vulnerable and the effect of exposure to be larger in general for female participants. For musculoskeletal symptoms, we found a relevant gender difference for at least one symptom region for 6 of 22 risk factors; the women had a higher risk in only two cases. In an earlier systematic review (20), strong evidence for gender differences was only found for three risk factors, for which two men had the higher risk. For the remaining risk factors, we found either inconclusive evidence or no evidence for a difference. Our results seem similar to those of the review, but were in the same direction only for lifting and low-back symptoms. In the review, strong evidence was found for women having a higher risk of neck–shoulder symptoms due to exposure to awkward arm postures, while, in our study, a GR value of 0.63 was found for shoulder symptoms due to working with the hands below knee level. Furthermore, we found no gender difference for the effect of hand–arm vibration, while, in the review, it was concluded that there was strong evidence that men have a higher risk of neck–shoulder symptoms due to exposure to hand–arm vibration.

If we combine the results of our study with the results of the review, there still is strong evidence that the effect of lifting is larger for men than for women. However, the evidence for a gender difference in the effect of hand–arm vibration on arm posture becomes inconclusive. For the remaining risk factors, there was either no evidence for a difference or inconclusive evidence.

For sickness absence, we found a relevant gender difference for 14 of the 22 risk factors. For six risk factors, the women had the higher risk; for seven risk factors the men had the higher risk; and for one risk factor the results were inconsistent for the different symptom regions. The review included only two studies on sickness absence; therefore, it is difficult to compare results. It should be noted that, for sickness absence, we found much more gender differences than for symptoms. This difference seems to be predominantly caused by psychosocial risk factors. We found absolutely no gender differences in the effect of psychosocial risk factors on symptoms. However, for sickness absence, we found a relevant gender difference for at least one symptom region for all of the psychosocial risk factors. Low supervisor or coworker support seemed to have a larger effect on women, while high demands or low-skill discretion seemed to have a larger effect on men. The results for job satisfaction were ambiguous.

Following the work of Leino-Arjas (29), we used cutoff points of 0.75 and 1.33 to determine relevant gender differences. The aforementioned review (20) used different cutoff points, namely, 0.75 and 1.25. Therefore, in our study, it was harder to find a work-related risk factor that implied a larger risk for the women than in the review. We found three GR values between 1.25 and 1.33: (i) GR 1.26 for bending the neck forwards and neck symptoms, (ii) GR 1.28 for skill discretion and shoulder symptoms, and (iii) 1.29 for coworker support and the absence of low-back pain. Had these GR values been interpreted as relevant, it would have clouded our results since, except for supervisory support, they point in a direction opposite to that of the GR value we had considered relevant thus far.

Similarly, if the review's cutoff points were altered to 1.33, the conclusion would change for the relation between kneeling–squatting and lower-extremity complaints from "inconclusive" to "no evidence" for a gender difference. For the remaining risk factors, the review conclusions would not change, as most of the results were already inconclusive.

Limitations of the study

A limitation of the study was that both exposure and outcome were based on self-reports. If either the men or the women had systematically under- or over-reported, the results could have been biased. We asked workers to rate both their exposure and symptoms on a four-point scale ("never", "occasionally", "often", or "very often" for exposure and "no, never", "yes, sometimes", "yes, regular", and "yes, prolonged" for symptoms). This poses two possible problems.

First, do men and women interpret these terms in the same way? Men and women have been found to differ in symptom description. For example, Ekman et al (30) found that men and women with chronic heart failure choose different descriptors of breathlessness when they have to describe their symptoms. Similarly, Vodopiutz et al (31) found that men with chest pain describe their pain concretely, while women use a more diffuse description of chest pain. However, these results only show that women use different words than men; they do not use more (or less) severe descriptors. Furthermore, exposure reporting may be influenced by anxiety about, as well as experience with, a risk factor (32). On average, women seem to be more concerned about health matters than men (33) and, therefore, could be expected to over-report their exposure. This phenomenon was indeed found by Hansson et al (34), but was contradicted by Leijon et al (35). Since the results of these studies do not consistently show that either men or women over-report their symptoms, we find it unlikely that our results can be explained completely by a gender difference in reporting about exposure.

Second, women in the Netherlands work part-time more often than men. Therefore, even though the terms may have the same meaning for both genders, the weekly cumulative work exposure for women would still in fact be lower. In the Dutch population, about 90% of the men work at least five days a week compared with 63% of Dutch women. Therefore, if men and women report equal exposure, the cumulative exposure of men, in fact, may be higher. An equal mechanism could be caused by intraclass confounding, meaning that within an exposure category, men and women may experience different exposures (eg, men lifting >25 kg may be lifting weights heavier than women who lift >25 kg) or because women who bend their necks may do it for longer periods than men. Therefore, if the effect of exposure on men and women were equal, we may find a larger effect on men. However, since we found no gender difference for most of the risk factors, a larger effect on men than on women cannot completely explain our results.

Explaining gender differences

For most of the risk factors, we found no relevant gender differences. If we did find a difference, it more often meant that the men had a higher risk. Therefore, our results do not provide convincing evidence that the vulnerability hypothesis is the basis for the excess of musculoskeletal symptoms at some body sites among women. The question of what explains this excess remains unanswered.

Another explanation for the gender differences in sickness absence due to musculoskeletal symptoms is the exposure hypothesis, which implies that women may simply be more exposed to some risk factors than men. Both at work and at home, the division of labor seems to run at least partly along gender lines, resulting in different jobs and tasks for men and women. Such a difference may lead to different and possibly higher exposure for women. However, gender differences in musculoskeletal symptoms have also been found between men and women within the same occupational class (36) and with the same tasks (37). Furthermore, it has been shown that the gender difference in musculoskeletal symptoms and related sickness absence did not disappear after correction for a wide variety of both physical and psychosocial risk factors at work as well as at home (Unpublished data: Hooftman WE, van der Beek AJ, Bongers PM, et al. Gender differences in the prevalence of musculoskeletal symptoms are not caused by exposure differences).

Moreover, even if men and women perform the same tasks, gender differences in exposures to work-related risk factors may occur due to gender differences in task performance. When the task performance of men and women was studied in a laboratory situation, the men and women were found to perform the same task differently, the result being differences in external (18, 38–41), as well as internal (18, 42–45), exposures. However, when task performance was studied at the workplace (eg, with video recordings), no significant differences in external exposure were found (46, 47). This finding supports the results of Hooftman et al (Unpublished data: Hooftman WE, van der Beek AJ, van de Wal BG, Burdorf A, Knol DL, Bongers PM, et al. Equal task, equal exposure? Are men and women with the same tasks equally exposed to physical risk factors for work-related musculoskeletal disorders?), who found no significant gender differences in exposure to awkward postures among men and women doing the same tasks. It thus seems as if men and women perform specific isolated tasks in a slightly different way, but, in the larger picture of "a day's work", these differences may become obsolete.

A third possibility is that men and women differ in their experience of pain. Many laboratory studies have been performed to examine gender differences in pain perception. Women were found to have a lower pain threshold, independent of the exact stimulus, for example, thermal stimuli (hot and cold) (48–50), electrocutaneous stimulation (51), and pressure (52). This difference in pain perception has been attributed to the influence of sex hormones (53) and gender role expectations (54). Ellermeier & Westphal (52) used pupil reactions to measure pain intensity resulting from a high-pressure stimulus. Pupil reactions are related to pain but are unlikely to be biased by attitude or culture and, therefore, can be considered to be an objective measure of pain. Their results showed that women did not only report more pain, but also showed more pupil dilation. This finding indicates that part of the gender difference in pain is due to the fact that women indeed feel more pain. However, the reporting of pain also seems to be influenced by social expectations. Robinson and his colleagues have examined the influence of gender role expectations on pain. They found that women are viewed as more willing to report pain (55) and that, while women have a lower pain threshold, lower tolerance to pain, and lower temporal summation of pain, these differences between men and women could be (partly) explained by gender role expectations (56). It was also shown that pain-rating behavior could be influenced and that, when a gender-specific expectation of pain tolerance was given before the test, there were no longer significant gender differences in pain tolerance (56). Combined with the results of Ellermeier & Westphal (52), these findings show that women not only detect pain at an earlier stage, but are also more willing to report a stimulus as being painful. For our present study, this finding may imply that women simply more often report (relatively small) symptoms that are unrelated to exposure, while men report the more severe symptoms caused by exposure.

However, if this were the case, it could be argued that the gender difference in musculoskeletal pain would be higher for symptoms than for more objective end points, but it does not appear to be so. Punnett & Herbert (13) showed that some of the largest gender differences have been found in studies with relatively restrictive case definitions. In our study, we found more gender differences for sickness absence than for symptoms. Therefore, the extent to which gender differences in pain experience explain the gender differences in musculoskeletal symptoms remains unclear.

It should also be noted that sickness absence is influenced more by factors than symptoms. The possibility of working with symptoms (ie, being absent or not) depends on the severity of the symptoms and the type of work performed (ie, the need to be absent). It may also be influenced by the motivation to work (ie, the desire to be absent), the attitudes of managers and coworkers towards working with symptoms, and the extent to which a healthcare system allows sickness absence due to a specific symptom (ie, the opportunity to be absent). In the Netherlands, rules and regulations regarding sickness absenteeism are promulgated at a national level. Although theoretically this practice should imply that men and women are treated equally, independent of the company for which they work, it does not exclude the possibility of gender differences in informal rules and the motivation to work. Results from Sweden have shown that there are clear relations between gender and sickness absence (57); this may be the case in the Netherlands as well. For example, women with children may be forced to use their sickness absence days when their children are ill. Furthermore, Hooftman et al (58) showed that women (but not men) with musculoskeletal symptoms are likely to call in sick if they feel that their home situation is being negatively affected by attempts to keep working while suffering from physical complaints.

In conclusion, as the results of our study show that, in many cases, men are more vulnerable, we could not explain the female excess of musculoskeletal symptoms among the workers. It is recommended that further studies be carried out, both epidemiologic and laboratory-based, to gain more insight into whether gender differences in pain experience can explain the differences in musculoskeletal symptoms. Furthermore, it is important to understand how the influence of possible differences in the need, desire, and opportunity to be absent explain gender differences in sickness absenteeism due to musculoskeletal symptoms.

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