Do work-related physical factors predict neck and upper limb symptoms in office workers?

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Abstract

The objective of this study was to examine the influence of physical exposure at work on neck and upper limb symptoms in office workers. Data were used from a prospective cohort study with a follow-up period of 3 years. Independent variables were observed and self-reported physical exposure at work. Outcome measures were neck/shoulder symptoms and elbow/wrist/hand symptoms. Data were analyzed with the generalized estimating equation (GEE) method, with adjustment for age, gender, psychosocial work characteristics and the outcome at baseline. Neck rotation was associated with neck/shoulder symptoms in the analyses with observed data as well as those with self-reported data. Neck extension was also statistically significantly associated with neck/shoulder symptoms, but only self-reported data were available. Neck flexion, self-reported wrist pronation, self-reported arm elevation, and self-reported duration of computer work, were not associated with symptoms. An indication was found of an adverse effect on neck/shoulder symptoms of long working days and on elbow/wrist/hand symptoms of self-reported wrist flexion and full-time work or longer compared to part-time work. It was concluded that only a limited number of work-related physical factors were related to neck and upper limb symptoms in office workers.

Keywords: *video observations, GEE-model, cohort study, office workers, computer use*

1. Introduction

Neck and upper limb symptoms are common in the working population. In the Netherlands, a recent survey showed that 28% of the working population had had neck/shoulder or elbow/wrist/hand symptoms in the previous 12 months [1]. Data from the European Foundation for the Improvement of Living and Working Conditions, based on fifteen European countries, showed that 25% reported that their work causes neck/shoulder pain, and 15% reported that their work causes arm pain. In a subpopulation of office workers these percentages were 20% and 9%, respectively [2].

Although it is not clear to what extent these symptoms are work-related, the high prevalence among workers compels preventive actions at the workplace. Accordingly, knowledge concerning the significance of risk factors is needed. Although there is a growing interest in psychosocial and personal risk factors for neck and upper limb symptoms, it is beyond doubt that work-related physical risk factors will remain an important issue in the investigation of the aetiology of neck and upper limb symptoms. The identification of relevant physical risk factors offers probably more opportunities for prevention than other factors.

Already several physical risk factors for neck and upper limb symptoms were studied. Repetitiveness, especially in combination with forceful exertions, is generally acknowledged as an important risk factor [3,4,5]. However, this mainly concerns industrial workers. The knowledge of risk factors in office workers is still limited, and additional high quality studies are still needed to identify and verify work-related physical risk factors for neck and upper limb symptoms in office workers.

The present study has the advantage of a longitudinal design and observed physical exposure next to self-reported data. The objective of this study is to determine the influence of physical exposure at work on neck and upper limb symptoms in an office population.

2. Methods

2.1. Study population

In 1994, the Study on Musculoskeletal disorders, Absenteeism, Stress and Health (SMASH), a prospective cohort study with a follow-up period of three years, was initiated among a working population in The Netherlands. The main purpose of this study was to determine risk factors for musculoskeletal disorders, with a focus on low back, neck and shoulder symptoms. The 34 participating companies were asked to select workers who had been employed in their current job for at least one year and who were working 24 hours per week or more. At baseline, 1,789 (87%) of the 2,064 workers invited to participate in SMASH filled in a questionnaire. After exclusion of workers who did not meet the selection criteria mentioned above and who did not have another paid job for a substantial amount of time, 1,742 were eligible for participation. Based on video-observations and worksite inspection, job titles were assigned according to the International Standard Classification of Occupations (ISCO 1988). For the present study, a selection was made of 398 office workers.

2.2. Data collection

After the baseline measurement there were three yearly follow-up measurements. In 1995, 1996 and 1997, a postal questionnaire was sent to the worker's home address. This questionnaire was similar to the baseline questionnaire and contained questions about individual characteristics, job characteristics and musculoskeletal symptoms. At baseline physical exposure was assessed using video observations according to a group based measurement strategy. Of each worker four video-recordings were made of 10-14 minutes during one day. All workers were classified into groups with similar tasks and a similar physical load, based on on-site inspection. The video-recordings of one fourth of the workers in each group were observed according to a standard protocol. All individuals within a group were assigned the mean values of the exposure variables, based on the individuals observed in that group.

2.3. Physical risk factors

Data on physical exposure at work were obtained using questionnaires as well as video observations. The questions were derived from the standardized Dutch Musculoskeletal Questionnaire [6] and were part of all yearly questionnaires. Workers were asked if they were occupied 'never', 'occasionally', 'often' or 'very often' with computer tasks. Flexion and rotation of the wrists as well as neck flexion and neck extension were assessed by asking whether they, yes or no, carried out these activities for a prolonged period of time. Data on working hours were only assessed at baseline.

From the video observations, data were obtained of neck flexion, neck rotation and arm elevation. Wrist postures were not assessed as no reliable measurement of these postures could be extracted from the video observations. Duration of computer work and neck extension were not registered. Neck flexion was divided into 20 degrees or more and 45 degrees or more. Neck rotation was defined as a rotation of 45 degrees or more and both flexion and rotation were expressed as the percentage of time subjects were working in this posture. Arm elevation, supported and unsupported, was divided into elevation of 30 to 60 degrees, elevation of 60 to 90 degrees and elevation for more than 90 degrees. However, postures of arm elevation for more than 60 degrees hardly occurred among office workers. Therefore, only arm elevation of 30 to 60 degrees was included in the analyses. Arm elevation was also expressed as the percentage of time subjects were working in this posture.

2.4. Psychosocial risk factors

Data on psychosocial work characteristics were assessed with a Dutch version of the Job Content Questionnaire (JCQ) [7], which measures all dimensions of the widely used Demand-Control-Support model [8]. These questions were included in all yearly measurements. Various items were combined to form dimensions of job demands, decision authority and social support of colleagues. The precise calculation of these dimensions, based on data from SMASH, has been described by de Jonge et al. [9].

2.5. Outcome measure

Data on symptoms were collected with an adapted version of the Nordic Questionnaire [10]. Workers were asked to rate the occurrence of pain in neck, shoulders, elbows, wrists or hands in the previous 12 months on a four-point scale (never, sometimes, regular, prolonged). Workers were identified as cases if they reported regular or prolonged pain in these regions during the previous 12 months. Combined outcome measures were made for neck/shoulder symptoms and elbow/wrist/hand symptoms. Before we combined these symptoms, we examined if the association at baseline with physical exposure was not different for neck symptoms and shoulder symptoms, and for elbow symptoms and wrist/hand symptoms.

2.6. Analysis

The effects of physical exposure at work were examined with the generalized estimating equation (GEE) method [11], using the Proc Genmod procedure in the statistical package SAS (version 9.1.2). A time lag of one measurement (= 1 year) was built into the model to relate the independent variables (physical exposure) at one point in time to the dependent variable (symptoms) in the following year, as assessed in the next measurement. The dependent variables were studied separately: neck/shoulder symptoms and elbow/wrist/hand symptoms. The independent variables were derived from the self-reported and observed data on physical exposure. Since data from the video observations were only available at baseline, we had to use baseline values as the independent variables in the analyses with observed exposure.

The continuous variables of the observed data were divided into tertiles, indicating low, medium and high values of exposure. Univariate analyses were carried out first. Then, multivariate analyses were carried out, with the covariates age, gender, the value of the outcome measure at the time of exposure measurement and the psychosocial work characteristics job demands, social support of co-workers and decision authority. It was examined if physical activity in leisure time had a confounding effect, but the inclusion of this variable in the model did not influence the results.

Additionally, it was examined if the effect of physical exposure changed after time. Therefore, models were analyzed containing a time variable, the respective exposure variables and the interaction terms of the exposure variables and time. A statistically significant interaction term would indicate a change over time in the relation between the exposure variable and the outcome measure.

3. Results

Table 1 shows the effects of physical exposure at work on neck/shoulder symptoms. Self-reported neck extension was identified as a statistically significant risk factor. Observed neck flexion was not associated with symptoms. The association between neck rotation and neck/shoulder symptoms was statistically significant with the self-reported variable. An even higher risk estimate was found in the analyses with observed neck rotation, although the association was only borderline statistically significant. The results also showed an effect of long working days. However, in the multivariate analyses this association was not statistically significant. Analyses of the interaction with time showed that the association between self-reported neck extension and neck/shoulder symptoms increased after time. There were no further significant results in the analyses with the models containing exposure*time variables, that indicated an increase or decrease in the relation of the exposure variables and neck/shoulder symptoms.

Table 1: Results of the GEE-analyses concerning the risk at neck/shoulder symptoms of physical exposure in office workers (n=398); self-reported exposure is presented in italic small print, statistically significant results are marked with *

		%[a]	(n)[a]	crude OR	(95% CI)	adj. OR[b]	(95% CI)
neck flexion >= 20° (% of time)							
	low (0-33%)	21	(82)	1.00		1.00	
	medium (33-38%)	44	(175)	1.01	(0.60-1.71)	0.92	(0.58-1.46)
	high (38-73%)	35	(139)	1.20	(0.70-2.05)	1.06	(0.65-1.72)
neck flexion >= 45° (% of time)							
	low (0-3%)	19	(74)	1.00		1.00	
	medium (3-4%)	43	(172)	1.05	(0.62-1.79)	0.95	(0.59-1.52)
	high (4-24%)	38	(150)	1.21	(0.70-2.08)	1.10	(0.67-1.80)
neck flexion	*no*	*25*	*(99)*	*1.00*		*1.00*	
(self-reported)	*yes*	*75*	*(299)*	*1.49**	*(1.09-2.02)*	*1.35*	*(0.92-1.99)*
neck extension	*no*	*96*	*(379)*	*1.00*		*1.00*	
(self-reported)	*yes*	*4*	*(16)*	*1.43*	*(0.78-2.61)*	*2.42**	*(1.22-4.80)*
neck rotation >= 45° (% of time)							
	low (2-13%)	46	(142)	1.00		1.00	
	medium (14%)	43	(172)	1.37	(0.87-2.16)	1.06	(0.70-1.60)
	high (14-45%)	21	(82)	2.60*	(1.54-4.40)	1.57	(0.99-2.50)
neck rotation	*no*	*50*	*(198)*	*1.00*		*1.00*	
(self-reported)	*yes*	*50*	*(200)*	*1.69**	*(1.29-2.21)*	*1.43**	*(1.02-2.01)*
arm elevation 30°- 60° (% of time)							
	low (9-32%)	37	(146)	1.00		1.00	
	medium (32-35%)	14	(55)	0.56	(0.29-1.07)	0.76	(0.42-1.38)
	high (36-65%)	49	(195)	0.70	(0.46-1.06)	0.81	(0.55-1.19)
computer work (self-reported)							
	seldom/never to now and then	*19*	*(74)*	*1.00*		*1.00*	
	rather often	*43*	*(170)*	*1.14*	*(0.84-1.54)*	*1.23*	*(0.81-1.85)*
	very often	*39*	*(154)*	*1.03*	*(0.70-1.52)*	*0.94*	*(0.60-1.48)*
working week	*< 40 hours*	*14*	*(54)*	*1.00*		*1.00*	
(self-reported)	*40 hours*	*73*	*(286)*	*0.68*	*(0.39-1.18)*	*0.89*	*(0.54-1.45)*
	> 40 hours	*13*	*(53)*	*0.97*	*(0.48-1.95)*	*1.04*	*(0.55-1.97)*
long working days	*< 8½ h per day*	*90*	*(343)*	*1.00*		*1.00*	
(self-reported)	*≥8½ h per day*	*10*	*(40)*	*1.81**	*(1.01-3.27)*	*1.57*	*(0.91-2.70)*

[a] percentages and number of workers at baseline
[b] Adjusted for the value of the outcome measure at the time of exposure, age, gender and psychosocial work characteristics

Table 2 shows the effects of physical exposure at work on elbow/wrist/hand symptoms. The univariate analyses resulted in a statistically significant association between wrist flexion and elbow/wrist/hand symptoms. This association was no longer statistically significant in the multivariate analyses. A self-reported full-time working week (= 40 hours) and a working week longer than 40 hours seems to be unfavorable compared to part-time work. However, the associations were not statistically significant. There were no statistically significant results in the analyses with the models containing exposure*time variables.

Table 2: Results of the GEE-analyses concerning the risk at elbow/wrist/hand symptoms of physical exposure in office workers (n=398); self-reported exposure is presented in italic small print, statistically significant results are marked with *

		%[a]	(n)[a]	crude OR	(95% CI)	adj. OR[b]	(95% CI)
wrist flexion	*no*	*67*	*(265)*	*1.00*		*1.00*	
	yes	*33*	*(132)*	*1.53**	*(1.01-2.33)*	*1.45*	*(0.92-2.30)*
wrist pronation	*no*	*84*	*(332)*	*1.00*		*1.00*	
	yes	*16*	*(64)*	*1.14*	*(0.64-2.04)*	*1.27*	*(0.69-2.34)*
arm elevation 30°- 60° (% of time)							
	low (9-32%)	37	(146)	1.00		1.00	
	medium (32-35%)	14	(55)	0.33	(0.15-0.73)	0.52	(0.25-1.11)
	high (36-65%)	49	(195)	0.57	(0.34-0.96)	0.82	(0.51-1.31)
computer work seldom/never to now and then		*19*	*(74)*	*1.00*		*1.00*	
(self-reported)	*rather often*	*43*	*(170)*	*1.22*	*(0.68-2.18)*	*1.29*	*(0.63-2.66)*
	very often	*39*	*(154)*	*1.42*	*(0.77-2.60)*	*1.42*	*(0.70-2.86)*
working week	*< 40 hours*	*14*	*(54)*	*1.00*		*1.00*	
(self-reported)	*40 hours*	*73*	*(286)*	*0.89*	*(0.44-1.79)*	*1.67*	*(0.90-3.11)*
	> 40 hours	*13*	*(53)*	*1.00*	*(0.41-2.41)*	*1.45*	*(0.62-3.37)*
long working days	*< 8½ h per day*	*90*	*(343)*	*1.00*		*1.00*	
(self-reported)	*≥8½ h per day*	*10*	*(40)*	*1.22*	*(0.71-2.11)*	*1.04*	*(0.45-2.41)*

[a] percentages and number of workers at baseline
[b] Adjusted for the value of the outcome measure at the time of exposure, age, gender and psychosocial work characteristics

4. Discussion

The results of analyses with observed and with self-reported data on physical exposure diverged. Several reasons could be given for these diverging results. Firstly, the analyses were not fully comparable as no data on observed physical exposure were available at follow-up. In the analyses with observed data, the relation of physical exposure at baseline and the outcome variables at all measurements was studied, irrespective of changes in exposure. The advantage of the analyses with self-reported data, is that changes in exposure were taken into account. Therefore, the odds ratios do not only account for the between-subjects relationship, but also for the within-subjects relationship. In other words, the odds ratios do not only represent the risks of subjects with higher scores on the exposure variables compared to subjects in the reference group, but also the risk of an increase in score over time within subjects [12].

Secondly, the use of self-reported data has drawbacks compared to observed data. One important disadvantage of analyses using self-reported data is the risk of an overestimation of the risks. Subjects with symptoms are probably more aware of possible disadvantageous postures or actions at work than subjects free of symptoms. The reason could be that they feel pain exerting these actions or remaining in these postures, or because they attribute their symptoms to more or less known risk factors. This might lead to differential misclassification. Although in the design of the present study the assessment of exposure was not at the same time as the assessment of symptoms, this problem might still occur, as subjects with symptoms had often also symptoms at the previous measurement, when the exposure was assessed.

Summarizing, the analyses with observed and self-reported data both have their pros and cons and are not entirely comparable. Therefore, each result should be judged on its own merit.

A group-based measurement strategy was used to asses data on physical exposure. The choice for this strategy opposed to an individual-based strategy is dependent on the estimation of variance in exposure between and within workers [13]. In general, individual-based strategies generate precise, though biased, estimates and group-based strategies generate less precise but essentially unbiased estimates [14]. Furthermore, the choice for a group-based strategy is usually based on reasons of efficiency. To prevent misclassification in a group-based measurement it is important to minimize the within-group variance and maximize the between-group variance. Grouping on the base of job-title is usually too crude. To minimize misclassification in the present study, groups were composed on the base of the estimation of the comparability of jobs during onsite inspections. As a consequence, it is not possible to measure individual differences within work groups. Furthermore, misclassification of exposure for individual workers still may have occurred due to differences between individuals within a group.

6. Conclusion

Neck rotation was identified as a risk factor for neck/shoulder symptoms. Neck extension was also statistically significantly associated with neck/shoulder symptoms, but only self-reported data were available. An indication was found of an adverse effect of long working days. None of the factors of physical exposure, examined in the present study, were identified as risk factors for elbow/wrist/hand symptoms, although an indication of an adverse effect was found of wrist flexion and of full-time work or longer compared to part-time work.

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