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High physical and psychosocial load at work and sickness absence due to neck pain

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Objectives This study investigates the relationship between physical and psychosocial load at work and sickness absence due to neck pain.

Methods A prospective cohort study with a follow-up period of 3 years (1994–1998) was performed among a working population. At the beginning of the study, physical load at work was quantified by means of video recordings. Work-related psychosocial variables were measured by means of the Job Content Questionnaire. The frequency of sickness absence due to neck pain with a minimal duration of 3 days was assessed on the basis of company registrations during the follow-up period. Altogether 758 workers were included in the analyses. Possible confounding by individual characteristics, physical load, and psychosocial load was studied.

Results Work-related neck flexion and neck rotation, low decision authority, and medium skill discretion showed statistically significant increased risks for sickness absence due to neck pain (adjusted rate ratios ranging from 1.6 to 4.2). High quantitative job demands, low skill discretion, and low job security showed nonsignificant increased risks for sickness absence due to neck pain (adjusted rate ratios of 2.0, 1.6 and 1.7, respectively). Work-related sitting, conflicting job demands, supervisor support, and co-worker support did not increase sickness absence due to neck pain.

Conclusions Work-related neck flexion, neck rotation, low decision authority, and medium skill discretion are risk factors for sickness absence due to neck pain. There are indications that high job demands, low skill discretion, and low job security are also risk factors for sickness absence due to neck pain.

Key terms cervical spine, longitudinal, risk factors, prospective cohort study, sick leave, work-related.

Neck pain is a major health problem in modern society. One-year prevalences of neck pain in occupational settings have shown values varying from 6% to 76%, with higher values for female workers (1). In The Netherlands, a 1-year prevalence figure of 31.4% was found in 1998 (2). Data on sickness absence due to neck pain are scarce. In their longitudinal study, Burdorf et al (3) reported that the proportion of workers that experienced at least one period of sickness absence due to neck or shoulder pain during a follow-up period of two years was 17%. Waersted & Westgaard (4) reported that, for full-time workers, long-term sickness absence due to

neck and upper-limb disorders was 2.2% of the total number of days employed, and, for part-time workers, the corresponding value was 1.8%. Neither study looked at neck-specific sickness absence exclusively. Borghouts et al (5) estimated the total costs of neck pain in The Netherlands in 1996 to be USD 868 million. The total number of sick days related to neck pain was estimated to be 1.4 million, with a total cost of USD 185.4 million.

Neck pain is assumed to be of multifactorial origin, with the implication that several risk factors can contribute to its development. According to the results of

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two systematic reviews on physical and psychosocial risk factors for neck pain, there seems to be evidence that neck flexion and sitting are physical risk factors for neck pain, whereas high quantitative job demands, low authority over decisions, low skill discretion, and poor social support by colleagues are important work-related psychosocial risk factors for neck pain (6, 7). Whether these and other work-related variables are also related to sickness absence due to neck pain is unclear, because literature on the relationship between work-related physical and psychosocial variables and sickness absence due to neck pain is scarce.

In their literature review, Ganster & Schaubroeck (8) formulated recommendations regarding future research in the field of work stress and employee health. They recommended longitudinal designs and the use of "hard" outcome measures.

In our present study, we investigated what level of physical exposure (ie, neck flexion, neck rotation, and sitting) and what level of psychosocial exposure (ie, quantitative job demands, conflicting job demands, skill discretion, decision authority, supervisor support, co-worker support, and job security) leads to an increased risk of sickness absence due to neck pain. Data from a prospective cohort study in an occupational setting were used. Company-registered sickness absence information was used as the outcome measure.

Subjects and methods

In 1994, a study on musculoskeletal disorders, absenteeism, stress and health (SMASH), a large prospective cohort study with a follow-up period of 3 years, was initiated among a working population. The main purpose of SMASH was to determine risk factors for musculoskeletal disorders, with focus on back, neck, and shoulder disorders. Approximately 1800 male and female workers from 34 companies participated in SMASH. The participating companies were located throughout The Netherlands, and they included various industrial and service branches, which resulted in a study population of workers with a wide range of physical and mental workloads. Extensive information on SMASH can be found elsewhere (9–13).

Study population

Altogether 1789 of the 2064 workers who were invited to participate in SMASH filled out the questionnaire at the beginning of the study (87%). In order to be included in this particular analysis, participants had to meet the following criteria at the beginning of the study: (i) no other paid job for any substantial amount of time, (ii) no work disability payment due to neck pain in the

previous 12 months, (iii) at least 20 hours of work a week, (iv) at least 1 year in current job, (v) no sickness absence due to neck pain in the 3 months prior to the beginning of the study, (vi) registration of sickness absence covered at least a period of half a year after the time the baseline measurements took place. After these selection criteria were applied, 1025 workers were eligible for inclusion in the analysis.

Work-related physical variables

At the beginning of the study, work-related physical load was quantified by means of video recordings and force measurements at the workplace and subsequent observation and analysis of these video recordings. Four 10- or 14-minute video recordings of each participant were taken randomly during a workday. All the participants were assigned to groups of workers with similar tasks, based on onsite inspection of the work. Video recordings of one-fourth of the workers in each of these groups of workers were subsequently observed and analyzed for relevant measures. Multimoment video observations (every 15 seconds) were made of head inclination (in three categories: 0–20, 20–45 and >45 degrees out of the neutral position) and head rotation (in two categories: 0–45 and >45 degrees out of the neutral position). Continuous video observations were made of work in a sitting position. Based on these observations, the following four work-related physical variables were calculated: (i) the percentage of the worktime with the neck flexed a minimum of 20 degrees, (ii) the percentage of the worktime with the neck flexed a minimum of 45 degrees, (iii) the percentage of the worktime with the neck rotated a minimum of 45 degrees, and (iv) the percentage of the worktime sitting. The mean values were calculated for these physical variables on the basis of the observed video tapes of workers within each group. Each worker within a group was then allocated the mean value for each of the four previously mentioned physical variables.

Work-related psychosocial variables

At the beginning of the study, information on work-related psychosocial variables was collected by means of the Job Content Questionnaire (14). This questionnaire measures the dimensions of the widely used demand-control-support model (15, 16). On a 4-point scale (totally disagree, disagree, agree, totally agree) workers were asked to assess certain aspects of their work. Various items of the questionnaire were combined into dimensions as proposed by Karasek (15) [ie, quantitative job demands (5 items), skill discretion (5 items), decision authority (3 items), supervisor support (4 items), and co-worker support (4 items)]. The construction of these dimensions for the data from SMASH has been described by De Jonge et al (13). Single items

of the questionnaire were used for assessing job security ("I feel secure about my job") and conflicting job demands ("I don't get conflicting assignments from others").

Registration of sickness absence due to neck pain

Sickness absence was registered in a standardized way from the beginning of the study until December 1997. The participating companies registered the exact date of the onset and end of each period of sickness absence and wrote down the reasons for it. The occupational health physician of the occupational health service of each company checked the reasons for sickness absence and added, if possible, the diagnosis code to each period of sickness absence, using the GDS code system (17). This code system is an adapted Dutch version of the International Classification of Diseases (ICD) (18). From the registration, information was derived on the frequency of sickness absence due to neck pain with a minimal duration of 3 days. Table 1 presents the codes that were defined as neck-specific reasons for sickness absence. In addition, the duration of the registration period was calculated in person-months.

Potential confounders

Potential confounders were measured at the beginning of the study. Information on other work-related physical factors was derived from the video recordings and from a self-administered questionnaire (19). Furthermore, by means of a questionnaire, data were collected on nonwork-related physical factors (19, 20) and individual characteristics (21, 22). The work-related physical and psychosocial variables were also considered to be potential confounders for each other. The potential confounders are listed in the appendix.

Table 1. Gedifferentieerd diagnosecode-systeem (GDS codes) that were defined to be neck-specific reasons for sickness absence.

| Code | Description of code |
|-------|--|
| 722.0 | Discopathy, multiple sites, of which the neck region is one, no root symptoms |
| 722.1 | Discopathy, cervical, no root symptoms |
| 722.3 | Discopathy, multiple sites, of which the neck region is one, radiating pain, no herniated disc |
| 722.4 | Discopathy, cervical, radiating pain, no herniated disc |
| 722.6 | Herniated disc, multiple sites, of which the neck region is one, with or without root symptoms |
| 722.7 | Herniated disc, cervical, with or without root symptoms |
| 722.9 | Discopathy, not described further |
| 723.1 | Neck pain, neck myalgia (no spine abnormalities) |
| 723.2 | Brachialgia, accompanied by neck pain |

Statistics

The Poisson regression technique was used to model the relationship between work-related physical and psychosocial variables and the frequency of sickness absence due to neck pain with a minimal duration of 3 days (hereafter referred to as sickness absence due to neck pain), and it resulted in the calculation of a rate ratio (RR) and its corresponding 95% confidence interval (95% CI) (23). The analyses were performed with the SAS statistical package (24).

The work-related physical variables derived from the video recordings were divided into several small categories. Categories showing similar effect estimates were combined into broader categories and resulted in the following categorization of the four work-related physical variables: the percentage of worktime with the neck flexed a minimum of 20 degrees in three categories (<30% of the worktime, 30–40% of the worktime, >40% of the worktime); the percentage of worktime with the neck flexed a minimum of 45 degrees in two categories (<5% of the worktime, >5% of the worktime); the percentage of worktime with the neck rotated a minimum of 45 degrees in two categories (<25% of the worktime, >25% of the worktime); the percentage of worktime sitting in four categories (<1% of the worktime, 1–50% of the worktime, 50–95% of the worktime, >95% of the worktime).

A comparable strategy was used to categorize the work-related psychosocial dimensions quantitative job demands, decision authority, skill discretion, co-worker support, and supervisor support, which were all divided into three categories (low, medium, high). The two work-related psychosocial variables job security and conflicting job demands were divided into two categories [agree (totally), disagree (totally)].

First, univariate analyses of the relationship between each of the work-related physical and psychosocial variables and the frequency of sickness absence due to neck pain were performed. Second, univariate analyses were performed to test the relationship between each potential confounder and the frequency of sickness absence due to neck pain. Potential confounders associated with sickness absence due to neck pain with a P-value of <0.25 were considered probable confounders (25). Third, for potential confounders with a univariate P-value of <0.25, the actual confounding effect on the estimated rate ratio of each work-related physical and psychosocial variable was examined. Therefore, the estimated rate ratio for each work-related physical and psychosocial variable resulting from an analysis in which one work-related physical or psychosocial variable and one confounder were combined was compared with the crude rate ratio of this work-related physical or psychosocial variable. If the change in this rate ratio

was $\geq 10\%$, the potential confounder was considered to be a real confounder in this dataset. By checking the correlations, we verified the interrelationships between the work-related physical and psychosocial variables and the confounders to avoid colinearity. Finally, in the last step of the analysis, a multivariate model was constructed for each work-related physical and psychosocial variable, and in this model all the confounders determined during the previous steps of the analysis were included. Age and gender were selected a priori as confounders and included in all multivariate analyses.

Finally, the effect was studied of neck pain at the beginning of the study on the relationship between work-related physical and psychosocial variables and sickness absence due to neck pain. For this purpose, the variable "regular or prolonged neck pain in the 12 months prior to the beginning of the study" was univariately related to sickness absence due to neck pain, and the variable was added to each multivariate model.

A total of 1025 subjects met the inclusion criteria. For 267 subjects (26%) data on reasons for sickness absence due to neck pain were incomplete.

In the group of workers with missing data on the reasons for sickness absence, fewer worked with the neck flexed >20 degrees, or with the neck rotated >45 degrees, for a high percentage of their worktime ($P < 0.05$). In addition fewer workers in the group with missing data were sitting for a high percentage of their worktime ($P < 0.05$). In contrast, relatively more workers among those with missing data worked with their neck flexed >45 degrees for a high percentage of their worktime ($P < 0.05$).

No difference was found in the distributions of the work-related psychosocial variables quantitative job demands, conflicting job demands, and co-worker support between those included in this study and those with missing data on the reasons for sickness absence. For the other work-related psychosocial variables (ie, decision authority, skill discretion, supervisor support and job security) a statistically significant difference ($P < 0.05$) was found between the two groups. In the group of workers with missing data, the percentage of workers in the high-risk categories was higher.

Results

Descriptive information on the study population

Of the 758 workers included in this analysis, 567 (74.8%) were men. The mean age of the study population was 36.3 (SD 8.8) years. The mean duration of employment in the current job was 7.8 (SD 7.7) years, and the mean number of workhours per week was 38.9

(SD 4.2) hours. The baseline distribution of the work-related physical and psychosocial variables is presented in table 2.

During the follow-up period, a total of 36 workers (4.7%) had been absent from work due to neck pain,

Table 2. Distribution of the work-related physical and psychosocial variables at the beginning of the study.

| Variable | Distribution | |
|--|--------------|------|
| | N | % |
| Percentage of worktime with neck flexed ≥ 20 degrees | | |
| < 30% | 230 | 31.6 |
| 30–40% | 270 | 37.1 |
| > 40% | 227 | 31.2 |
| Percentage of the worktime with neck flexed ≥ 45 degrees | | |
| < 5% | 600 | 82.5 |
| > 5% | 127 | 17.5 |
| Percentage of the worktime with neck rotated ≥ 45 degrees | | |
| < 25% | 602 | 82.8 |
| > 25% | 125 | 17.2 |
| Percentage of the worktime in a sitting position | | |
| < 1% | 152 | 20.9 |
| 1–50% | 243 | 33.4 |
| 50–95% | 274 | 37.3 |
| > 95% | 58 | 8.0 |
| Quantitative job demands (mean 13.0, SD 2.3, range 5–20) | | |
| Low (score < 14) | 464 | 61.9 |
| Medium (score 14–17) | 232 | 30.9 |
| High (score > 17) | 54 | 7.2 |
| Conflicting job demands | | |
| Disagree (totally) | 493 | 66.0 |
| Agree (totally) | 254 | 34.0 |
| Decision authority (mean 8.3, SD 1.7, range 3–12) | | |
| High (score > 8) | 338 | 45.7 |
| Medium (score 7–8) | 290 | 38.3 |
| Low (score < 7) | 111 | 15.0 |
| Skill discretion (mean 14.6, SD 2.6, range 5–20) | | |
| High (score > 14) | 432 | 57.5 |
| Medium (score 14) | 113 | 15.0 |
| Low (score < 14) | 206 | 27.4 |
| Co-worker support (mean 12.0, SD 1.6, range 4–16) | | |
| High (score > 14) | 69 | 9.2 |
| Medium (score 11–14) | 591 | 79.0 |
| Low (score < 11) | 88 | 11.8 |
| Supervisory support (mean 11.1, SD 2.1, range 4–16) | | |
| High (score > 11) | 533 | 71.1 |
| Medium (score 9–11) | 128 | 17.1 |
| Low (score < 9) | 89 | 11.9 |
| Job security | | |
| Agree (totally) | 634 | 83.6 |
| Disagree (totally) | 117 | 15.4 |

5 of whom were absent from work twice due to neck pain twice during the follow-up period, and one subject was absent from work three times due to neck pain. The mean duration of sickness absence was 17 days, and the median was 11 days. Furthermore, the duration of the sickness absence was 8 days or longer for 20 of these 36 workers. Each worker was followed for a maximum of 44 months. The mean time until sickness absence due to neck pain was 17 (range 1–44) months.

The potential confounders are listed in the appendix. The variables marked with an asterisk were found to be univariately associated with sickness absence due to neck pain, with a P-value of <0.25.

The percentage of the worktime with a minimum of 60 degrees of upper arm elevation and work with video display terminals correlated with a number of work-related physical and psychosocial variables (Pearson's correlation coefficients ranging from -0.65 to 0.62). Skill discretion and decision authority were also correlated (Pearson's correlation coefficient 0.47). To avoid collinearity, we decided not to combine these variables into one single multivariate analysis.

Work-related physical variables and sickness absence due to neck pain

The results of the univariate and multivariate analyses of the association between the work-related physical variables and sickness absence due to neck pain are presented in table 3. Compared with the reference category, workers with the neck flexed a minimum of 20 degrees for more than 40% of the worktime had a statistically significant increased crude and adjusted rate ratio of 3.4 and 4.2, respectively, for sickness absence due to neck pain. In addition, workers with the neck flexed a minimum of 45 degrees for >5% of the worktime had an increased crude and adjusted rate ratio of 2.2 and 2.8, respectively. The crude and adjusted rate ratio for workers with the neck rotated a minimum of 45 degrees for >25% of their worktime was 1.9 and 2.8, respectively.

For the fourth work-related physical factor (ie, the percentage of worktime sitting) a statistically significant rate ratio of <1 was found for the workers who sat for 1–50% of their worktime (adjusted RR 0.3). The adjusted rate ratio for sitting for 50–95% of the worktime was still decreased, but no longer statistically significant. The effect disappeared for the group of subjects who were sitting for more than 95% of their worktime.

The most important confounders in the analysis of the relationship between work-related physical variables and sickness absence due to neck pain were other physical variables. These were more important than the psychosocial variables or individual characteristics.

Work-related psychosocial variables and sickness absence due to neck pain

The results of the univariate and multivariate analyses of the associations between the work-related psychosocial variables and sickness absence due to neck pain are also presented in table 3. The workers who scored relatively low on decision authority showed a statistically significant increased crude and adjusted rate ratio of 4.4 and 3.7, respectively. Moreover, the rate ratio for medium decision authority was also statistically significantly increased. Medium skill discretion was statistically significantly related to sickness absence due to neck pain (crude RR 2.7, adjusted RR 2.6). The crude and adjusted rate ratios for low skill discretion were also increased, but not statistically significant. Furthermore, increased risks were found for high quantitative job demands and low job security in relation to sickness absence due to neck pain. However, the adjusted rate ratios were not statistically significant for these variables. Finally, no relationship was found between conflicting job demands, supervisory support, or co-worker support and sickness absence due to neck pain.

The most important confounders in the analysis of the relationship between work-related psychosocial variables and sickness absence due to neck pain were other psychosocial variables. These variables were more important than the physical variables or individual characteristics.

Neck pain at the beginning of the study

Seventeen percent of the workers reported that they had had neck pain in the 12 months prior to the beginning of the study. Neck pain in the 12 months prior to the beginning of the study was univariately associated with sickness absence due to neck pain, with a rate ratio of 2.66 (95% CI 1.40–5.08). However, comparable adjusted rate ratios were found for the relationship between the work-related physical and psychosocial variables and sickness absence due to neck pain when the variable "neck pain in the 12 months prior to the beginning of the study" was added to the multivariate model of each of the work-related physical and psychosocial variables (data not shown).

Discussion

The objective of our study was to investigate the relationship between work-related physical and psychosocial variables and sickness absence due to neck pain. We believe that this is the first prospective cohort study in which this relationship has been studied specifically for sickness absence due to neck pain. Moreover, the study

Table 3. Results of the univariate and multivariate analyses of the association between work-related physical and psychosocial variables and sickness absence due to neck pain with a minimal duration of 3 days. (RR = rate ratio, 95% CI = 95% confidence interval)

| Work-related variable | Crude ^a | | Adjusted ^b | |
|---------------------------------|--------------------|-------------|-----------------------|-------------|
| | RR | 95% CI | RR | 95% CI |
| Neck flexion ≥ 20 degrees | | | | |
| <30% of worktime | 1.00 | . | 1.00 ^c | . |
| 30–40% of worktime | 1.56 | 0.58–4.23 | 2.65 | 0.88–7.97 |
| >40% of worktime | 3.37 | 1.35–8.39* | 4.19 | 1.50–11.69* |
| Neck flexion ≥ 45 degrees | | | | |
| <5% of worktime | 1.00 | . | 1.00 ^d | . |
| >5% of worktime | 2.24 | 1.12–4.45* | 2.76 | 1.27–5.99* |
| Neck rotation ≥ 45 degrees | | | | |
| <25% of worktime | 1.00 | . | 1.00 ^e | . |
| >25% of worktime | 1.89 | 0.92–3.91 | 2.81 | 1.29–6.09* |
| Sitting | | | | |
| <1% of worktime | 1.00 | . | 1.00 ^f | . |
| 1–50% of worktime | 0.38 | 0.17–0.87* | 0.32 | 0.13–0.76* |
| 50–95% of worktime | 0.28 | 0.11–0.68* | 0.38 | 0.12–1.16 |
| >95% of worktime | 1.00 | 0.39–2.57 | 1.70 | 0.46–6.31 |
| Quantitative job demands | | | | |
| Low | 1.00 | . | 1.00 ^g | . |
| Medium | 0.78 | 0.37–1.61 | 0.73 | 0.35–1.53 |
| High | 2.43 | 1.05–5.59* | 1.96 | 0.83–4.62 |
| Conflicting job demands | | | | |
| Disagree (totally) | 1.00 | . | 1.00 ^h | . |
| Agree (totally) | 0.95 | 0.50–1.80 | 0.96 | 0.51–1.83 |
| Decision authority | | | | |
| High | 1.00 | . | 1.00 ⁱ | . |
| Medium | 3.47 | 1.56–7.73* | 3.03 | 1.35–6.82* |
| Low | 4.36 | 1.75–10.83* | 3.66 | 1.44–9.26* |
| Skill discretion | | | | |
| High | 1.00 | . | 1.00 ^j | . |
| Medium | 2.70 | 1.17–6.24* | 2.56 | 1.08–6.04* |
| Low | 2.08 | 0.99–4.36 | 1.64 | 0.73–3.69 |
| Co-worker support | | | | |
| High | 1.00 | . | 1.00 ^k | . |
| Medium | 1.16 | 0.36–3.81 | 0.92 | 0.26–3.18 |
| Low | 0.79 | 0.16–3.91 | 0.51 | 0.10–2.70 |
| Supervisory support | | | | |
| High | 1.00 | . | 1.00 ^l | . |
| Medium | 1.91 | 0.96–3.79 | 1.62 | 0.81–3.24 |
| Low | 1.23 | 0.47–4.24 | 0.96 | 0.35–2.60 |
| Job security | | | | |
| Agree (totally) | 1.00 | . | 1.00 ^m | . |
| Disagree (totally) | 1.98 | 0.96–4.09 | 1.70 | 0.80–3.60 |

^a Crude rate ratio and 95% CI from the Poisson regression analysis.

^b Adjusted rate ratio and 95% CI from the Poisson regression analysis.

^c Adjusted for gender, age, neck rotation of ≥ 45 degrees, sitting posture, decision authority, skill discretion, leisure-time activities with hands above shoulder level, and sports participation.

^d Adjusted for gender, age, sitting posture, and leisure-time activities with hands above shoulder level.

^e Adjusted for gender, age, neck flexion of ≥ 45 degrees, sitting posture, and sports participation.

^f Adjusted for gender, age, neck flexion of ≥ 45 degrees, neck rotation of ≥ 45 degrees, decision authority, skill discretion, frequent flexion or rotation of the upper part of the body during leisure time, driving a vehicle during leisure time, sports participation, and coping (active problem solving).

^g Adjusted for gender, age, and decision authority.

^h Adjusted for gender and age.

ⁱ Adjusted for gender, age, sports participation, and coping (active problem solving).

^j Adjusted for gender, age, sitting posture, and coping (active problem solving).

^k Adjusted for gender, age, neck flexion of ≥ 20 degrees, neck rotation of ≥ 45 degrees, sitting posture, decision authority, skill discretion, and supervisory support.

^l Adjusted for gender, age, quantitative job demands, and decision authority.

^m Adjusted for gender, age, neck flexion of ≥ 20 degrees, and decision authority.

* $P < 0.05$.

is based on sickness absence information registered by the participating companies and on quantified physical exposure data. The potential confounding effects of various important work-related and nonwork-related physical and psychosocial variables and individual characteristics were taken into account.

Summary of the results and comparison with the literature

Comparison of the results of our study with those of studies described in the literature is difficult, since there are hardly any studies that have investigated the relationship between work-related risk factors and neck-specific sickness absence. Many studies have investigated the relationship between work-related physical and psychosocial factors and sickness absence due to a broader range of reasons (15, 26–31).

Furthermore, the results of this study can be compared with those of two other studies in which the relationship is described of the same work-related physical and psychosocial variables and the occurrence of neck pain, based on the same dataset (9, 10). However, this comparison is hampered by several points, the most important being the difference in the number of subjects included in the analyses, which leads to an adaptation in the categorization of the exposure variables. Another point that hampers the comparison is a more theoretical one. Neck pain can be seen as a health problem. Sickness absence includes more than just a health problem. It can be seen as an integrated measure of physical, psychological, and social functioning in studies of working populations (32). It is therefore reasonable to expect that there are also other risk factors involved in the prediction of neck pain and sickness absence due to neck pain.

Earlier analyses with the same dataset indicated that neck flexion was related to the occurrence of neck pain (9). In agreement with this finding, our study showed that neck flexion was also related to sickness absence due to neck pain. Although not related to the occurrence of neck pain (9), neck rotation proved, in our study, to be related to sickness absence due to neck pain.

Work-related sitting was not associated with an increased risk of sickness absence due to neck pain. This finding does not agree with the results of the study carried out by Ekberg & Wildhagen (26), who concluded that uncomfortable sitting was a major predictor of days of sick leave due to neck and shoulder disorders. Earlier analyses of the data on the relationship between work-related physical variables and the occurrence of neck pain showed that prolonged sitting (more than 95% of worktime) was a risk factor for neck pain (9). In contrast, prolonged sitting was not related to sickness ab-

sence due to neck pain. Apparently, subjects who sit for a substantial amount of their worktime report neck pain more often, but are not more often absent from work due to their neck pain.

Our study showed that workers involved in jobs with low decision authority appeared to have an increased risk of sickness absence due to neck pain. Several authors have reported comparable findings with regard to decision authority in relation to general sickness absence (15, 27–29). An earlier analysis of the same data showed that there were also indications for a relationship between low decision authority and the occurrence of neck pain (10).

The workers who reported medium skill discretion had an increased risk of sickness absence due to neck pain. The relationship between low skill discretion and sickness absence due to neck pain was increased, however, not statistically significantly. A reason for not finding a statistically significantly increased risk in our study could be the relatively low power of the study. However, the finding of an univariate statistically significantly increased risk of 4.4 and a multivariate nonstatistically significantly increased risk of 1.6 may be an indication of the existence of a relationship between low skill discretion and sickness absence due to neck pain. Our earlier analysis did not show a relationship between medium and low skill discretion and the occurrence of neck pain (10).

In our present study, the rate ratio for high quantitative job demands in relation to sickness absence due to neck pain was increased, but not statistically significantly. In reports in the literature on the relationship between quantitative job demands and general sickness absence, the results are not consistent. While Kirstensen (27) and Parkes (30) reported that the risk of general sickness absence increases with higher job demands, North et al (28), Smulders & Nijhuis (29), and Parkes (31) found an inverse effect of high job demands on general sickness absence. If low quantitative job demands were related to the occurrence of neck pain, a statistically significantly increased risk was found (10).

In our present study, low job security was related to an increase in sickness absence due to neck pain, but this relationship was not statistically significant. Low job security was not related to the occurrence of neck pain (10). No reports were found of other studies on the relationship between job security and sickness absence (due to neck pain). Vahtera et al (33) and Kivimäki et al (34) studied the effect of organizational downsizing on general sickness absence. Downsizing, the reduction of personnel in an organization, can be considered a form of job insecurity and is supposed to affect health. In both studies, a statistically significantly relationship was found between organizational downsizing and increased sickness absence.

For the other work-related psychosocial variables investigated in this study (ie, conflicting job demands, supervisory support, or co-worker support) no clear relationship with sickness absence due to neck pain was found.

According to the demand-control-support model developed by Karasek (15, 35), the risk for adverse health effects (eg, sickness absence due to neck pain) is increased in jobs with high demands, low decision latitude, and low workplace support. Because of the relatively low power of the present study, we could not test this hypothesis completely. We have studied only the main effects of these psychosocial variables on sickness absence due to neck pain and did not test the interaction effect between these variables. High quantitative job demands as well as low decision authority and low skill discretion (which together form the dimension decision latitude) were, indeed, related to increased sickness absence due to neck pain. However, neither co-worker support nor supervisory support was found to be related to sickness absence due to neck pain.

In our present study, neck pain in the 12 months prior to the beginning of the study was statistically significantly associated with sickness absence due to neck pain. On the basis of the results of their study, Burdorf et al (3) also concluded that complaints of the neck or shoulder in the 12 months prior their study were associated with sickness absence for these complaints during the follow-up period. However, in our present study, neck pain during the 12 months prior to the beginning of the study did not influence the relationship between the work-related physical and psychosocial variables and sickness absence due to neck pain.

Some methodological points

One strength of our study was the relatively "hard" quality of the sickness absence data (frequency, duration and diagnosis), which had been registered in a standardized way by the participating companies and the occupational health physicians. However, of the 34 companies involved in this study, registrations of sickness absence of 13 companies could not be used in the analysis because there were too many missing entities. For the remaining 21 companies, the diagnoses of sickness absence were sometimes missing, especially for short periods of sickness absence. In everyday practice of Dutch occupational health care, it is very difficult to register the reason for sickness absence if the period of sickness absence lasts only 1 or 2 days. Consequently, in cases of periods of sickness absence lasting only 1 or 2 days, we had many missing values for the variable regarding the reason for sickness absence. We therefore decided to study sickness absence due to neck pain with a mini-

mal duration of 3 days. Consequently, we could include 758 workers in the analysis. This number would have been even lower if we had looked at periods of sickness absence shorter than 3 days. Due to the relatively small number of subjects in certain exposure categories, the effect estimates have rather wide 95% confidence intervals. Despite of these limitations, several statistically significant relationships were found.

Implications for prevention

The results of our study suggest that decreasing the percentage of time working with the neck flexed or rotated will have a positive effect on the prevention of sickness absence due to neck pain. Increasing a worker's authority over decisions and increasing learning possibilities and the development of skills in a job will probably reduce sickness absence due to neck pain. Moreover, the reduction of job demands (eg, working under time pressure or working with deadlines) will possibly also reduce sickness absence due to neck pain.

The results of our study therefore imply that both adequate workstation design to optimize neck position and organizational changes to increase decision latitude and decrease demands will contribute to the prevention of sickness absence due to neck pain.

Concluding remarks

1. Working with the neck flexed >20 degrees for >40% of the worktime and working with the neck flexed >45 degrees for >5% of the worktime are prospectively and independently related to sickness absence due to neck pain.
2. Working with the neck rotated >45 degrees for >25% of the worktime is prospectively and independently related to sickness absence due to neck pain.
3. Prolonged sitting at work does not increase sickness absence due to neck pain.
4. Low decision authority and medium skill discretion are prospectively and independently related to sickness absence due to neck pain.
5. There are indications for a relationship between high quantitative job demands, low skill discretion, and low job security with sickness absence due to neck pain.
6. Conflicting job demands, low co-worker support, and low supervisory support are not related to sickness absence due to neck pain.

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Appendix

Potential confounders of the association between work-related physical and psychosocial variables and sickness absence due to neck pain with a minimal duration of 3 days:

Work-related physical factors

- Number of times lifting ≥ 25 kg per 8-hour workday (no lifts, at least 1 lift)
- Percentage of worktime with ≥ 60 degrees upper arm elevation ($< 5\%$, $> 5\%$)^a
- Percentage of worktime carrying out repeated movements > 4 times/minute (0% , $> 0\%$)
- Video display terminal work (seldom or never, sometimes, often, very often)^a
- Work with hands above shoulder level (seldom or never, sometimes, often, very often)^a
- Work with vibrating tools (seldom or never, sometimes, often, very often)
- Driving a vehicle (seldom or never, sometimes, often, very often)
- Frequent flexion or rotation of upper part of body (seldom or never, sometimes, often, very often)

Nonwork-related physical factors

- Prolonged sitting (seldom or never, sometimes, often, very often)
- Video display terminal work (seldom or never, sometimes, often, very often)
- Activities with hands above shoulder level (seldom or never, sometimes, often, very often)^a
- Force exertion with hand or arms (seldom or never, sometimes, often, very often)
- Activities in the same posture for a long time (seldom or never, sometimes, often, very often)
- Work with vibrating tools (seldom or never, sometimes, often, very often)
- Frequent flexion or rotation of upper part of body (seldom or never, sometimes, often, very often)^a
- Repeated movements with hands or arm many times a minute (seldom or never, sometimes, often, very often)
- Driving a vehicle (seldom or never, sometimes, often, very often)^a
- Frequency of sports or heavy physical activities that cause sweating during the past 4 months (> 3 times/month, 1–3 times/month, < 1 time/month)^a

Individual characteristics

- Gender (male, female)
- Age (continuous variable)^a
- Body mass index (< 25 , 25–30, > 30 kg/m²)
- Coping: avoidance behavior (low, high)
- Coping: social support seeking (low, high)
- Coping: active problem solving (low, high)^a
- Stressful life events in previous 12 months (no stressful life events, at least one stressful life event)^a

^a These variables were univariately associated with sickness absence due to neck pain with a minimal duration of 3 days with a P-value of < 0.25