Individual, physical and psychological risk factors for neck pain in Australian office workers: a 1-year longitudinal study

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Abstract Neck pain is more prevalent in office workers than in the general community. To date, findings from prospective studies that investigated causal relationships between putative risk factors and the onset of neck pain in this population have been limited by high loss to follow-up. The aim of this research was to prospectively evaluate a range of risk factors for neck pain in office workers, using validated and reliable objective measures as well as attain an estimate of 1-year incidence. We assembled a cohort of 53 office workers without neck pain and measured individual, physical, workplace and psychological factors at baseline. We followed participants for 1 year to measure the incidence of neck pain. We achieved 100% participant follow-up. Cox regression analysis was applied to examine the relationship between the putative risk factors and the cumulative incidence of neck pain. The 1-year incidence proportion of neck pain in Australian office workers was estimated in this study to be 0.49 (95% CI 0.36–0.62). Predictors of neck pain with moderate to large effect sizes were female gender (HR: 3.07; 95% CI: 1.18–7.99) and high psychological stress (HR: 1.64; 95% CI: 0.66–4.07). Protective factors included increased mobility of the

cervical spine (HR: 0.44; 95% CI: 0.19–1.05) and frequent exercise (HR: 0.64; 95% CI: 0.27–1.51). These results reveal that neck pain is common in Australian office workers and that there are risk factors that are potentially modifiable.

Keywords Neck pain · Risk factors · Incidence · Office workers

Introduction

Neck pain is common in the general population. Reports of 1-year prevalence vary from 15 to 44% [9, 10, 33]. Prevalence of neck pain is even higher in office workers than in the general community, reaching levels as high as 50 to 60% [2, 6, 8, 19]. Neck pain can impact on the ability to perform normal daily activities, and the resultant treatment costs and work loss contribute to a substantial economic burden for both the individual and society [1, 4, 5]. Data about the incidence of neck pain in office workers are lacking, as previous studies have reported on estimates of prevalence. Incidence data are valuable because they convey specific information about risk that is useful to evaluate the efficacy of preventative interventions.

It is unclear which factors place office workers in particular at higher risk of developing neck pain. Postulated factors include: individual factors (e.g. gender) [6, 11, 19, 21] work environment factors (e.g. repetitive work, exposure level) [19, 21, 38] and psychosocial factors (e.g. stress, high job demands, low decision latitude) [4, 6, 17, 21, 38]. However, methodological considerations limit interpretation of existing studies either because of high loss to follow-up (22% [21] to 48% [38]) in longitudinal studies, which can introduce significant bias into the study findings,

This study was wholly conducted at the Faculty of Health Sciences, The University of Sydney, Australia.

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or because a cross-sectional design was used [6, 8, 11, 17, 19], where inferences of cause-and-effect cannot be made.

Physical risk factors such as prolonged sitting and neck flexion have been reported as predictors of neck pain in a mixed population of workers from various industry, health and professional settings [3]. However, these and other physical factors (such as posture, cervical range of motion and neck muscle endurance) have not been prospectively investigated in office workers without neck pain. Physical risk factors are useful to investigate as they potentially can be modified with interventions, for instance exercise [18], whereas individual characteristics, such as age or gender cannot be modified. It has been argued that both physical and psychosocial contributors to work-related neck pain need to be assessed together in longitudinal designs [37], to evaluate their relative contribution to the onset of work-related musculoskeletal pain. Such longitudinal studies are lacking in a population of office workers.

The aims of this research were (1) to estimate the 1-year incidence proportion of neck pain in Australian office workers and (2) to investigate the relative contribution of individual, physical, workplace and psychological factors to the onset of neck pain. To achieve this, we conducted an exploratory 1-year longitudinal study of 14 potential risk factors that were assessed at baseline with objective measures.

Materials and methods

Study design

We conducted a longitudinal study of a cohort of office workers at an Australian university. This setting was selected because there is evidence that the prevalence of neck pain in university staff is higher than the general community [8]. Potential risk factors for neck pain were measured on enrolment into the study and participants were followed up for 1 year or until they reported an episode of neck pain. An episode of neck pain was defined as *a period of neck pain lasting for more than 24 h* modified from the definition of an episode of care for back pain [36]. The lead investigator (JH) was blinded to the baseline measures to minimise bias during follow-up and data analysis. A flow chart of the study design is illustrated in Fig. 1. The study was approved by the University of Sydney Human Research Ethics Committee. A detailed description of the study protocol has been published elsewhere [16].

Participants

University office workers, including academics, general staff and graduate research students were invited to par-

Fig. 1 Flow of participants through the study

ticipate in the study during the period March 2006 to March 2007. A trained health researcher screened volunteers by telephone interview to confirm eligibility. Participants were eligible for inclusion if they were employed or studied full-time, performed predominantly sedentary work, spoke and read English and were aged between 18 and 60 years. Participants were excluded if they had current neck pain or any diagnosed disease affecting the cervical spine (e.g. rheumatoid arthritis), prolonged absence from work anticipated during the follow-up period, or an episode of care for neck pain in the past 3 months. An episode of care for neck pain was defined as *a consultation or series of consultations with a health professional for neck pain* [36]. The standardized Nordic Questionnaire [22] definition of neck pain was used supplemented by a pain-region drawing, as follows: “Neck pain is defined as ache, pain or discomfort in the shaded area illustrated.” The reporting of neck pain using this questionnaire has been found to have high test-retest reliability [22]. Fifty-three participants were included in this exploratory study.

Predictors

Potential risk factors were measured once at baseline, using self-report questionnaires and measures of physical neck function, as outlined below:

Individual factors

Age, gender and self-reported estimates of frequency of weekly exercise (continuous activity for at least 30 min) were collected by questionnaire.

Physical factors

Range of cervical movement (flexion, extension, lateral flexion and rotation in degrees) were measured using the cervical range of movement (CROM) device [7]. Cervical spine posture in usual sitting position (protraction in cm) was also measured using the CROM. Endurance of the cervical extensor muscles (min) was assessed using the Cervical Biering-Sorenson Test [25].

Workplace factors

1. *Physical* Each participant was asked to estimate the total duration of sitting (h) and the duration of sitting between breaks (h) at work each day.
2. *Psychosocial* Psychosocial workplace factors were assessed using the standard version of the job content questionnaire (JCQ) [20], consisting of 49 questions, supplemented with the job dissatisfaction subscale. This instrument is a widely-used measure of psychosocial stress at work comprising three domains: mental work load (psychological job demands), decision latitude and social support.

Psychological distress

Depression, anxiety and psychological stress were assessed using the DASS21 self-report instrument [28].

Participant follow-up

Participants were followed up once per fortnight for 12 months, by email or telephone and were asked: “Have you experienced any neck pain lasting more than 24 h during the past fortnight?” If a participant reported neck pain, further information was obtained regarding the dates of onset and resolution, treatment sought, work loss and whether the episode was related to work, as outlined in the original protocol [16]. Participants who experienced an episode of neck pain were considered

recovered when they reported that their pain had resolved.

Statistical analysis

Estimates of incidence proportions of any neck pain, and work-related neck pain, were calculated as the proportion of new cases in the cohort during the 12-month period of observation. Risk factors for neck pain were investigated using univariate and multivariate Cox regression analyses. All variables associated with neck pain from the univariate analysis with a P value of ≤ 0.2 were entered into the multivariate regression analysis. Variables were considered significant in the multivariate analyses if the P value was ≤ 0.05 and if the 95% confidence interval (CI) of the hazard ratio did not include 1.0. Because of the small sample size in this exploratory study, we considered the magnitude of the point estimate of the hazard ratio in the secondary analyses. We dichotomized the continuous variables at the median value so that the hazard ratios are easier to interpret. This was conducted for both the univariate and multivariate analyses. Data were analysed using SPSS 14.0 software program (SPSS Inc., Chicago, IL).

Results

Description of the study cohort

The flow of participants through the study is shown in Fig. 1. Three thousand and ninety-one participants were invited into the study. Sixty-four people volunteered to participate, 11 were ineligible, due to current or recent history of neck pain, and a total of 53 office workers were included in the study cohort. There were 34 females and 19 males and the mean (SD) age was 42 (11) years. Table 1 lists the individual, physical, workplace and psychological data for the cohort measured at baseline.

Incidence of neck pain

All participants were followed for 1 year or until they experienced an episode of neck pain. The incidence proportion of neck pain was 0.49 (95% CI 0.36–0.62) as 26 of the 53 participants reported an episode of neck pain during the 1-year follow-up. Of these, nine participants experienced an episode of neck pain that was identified specifically as work related (incidence proportion: 0.17; 95% CI: 0.09–0.29). The majority of participants who experienced neck pain recovered quickly: 27% recovered within 1 week and 61% recovered within 2 weeks. Resolution was slower for the remaining 12%: 4% recovered by 4 weeks and 8% required 10 weeks or more for pain to resolve. Nine

Table 1 Description of study cohort: baseline measures of predictor variables

Variable	Mean $\pm$ SD or percent
Age (years)	42 $\pm$ 11
Gender	64% F
Total duration of sitting at work per day (h)	6.9 $\pm$ 2.1
Duration of sitting before break at work (h)	1.3 $\pm$ 0.8
Exercise frequency (sessions per week)	4 $\pm$ 3
Cervical flexion–extension (total range, °)	121 $\pm$ 19
Cervical lateral flexion (total range, °)	81 $\pm$ 20
Cervical rotation (total range, °)	133 $\pm$ 20
Cervical protraction (cm)	20 $\pm$ 4
Cervical extensor endurance (min)	16 $\pm$ 8
Psychosocial work factors (JCQ score/264)	159 $\pm$ 16
Psychological distress (total DASS21 score/63)	12 $\pm$ 10
Depression (DASS21 subscale score/21)	3 $\pm$ 4
Anxiety (DASS21 subscale score/21)	2 $\pm$ 3
Stress (DASS21 subscale score/21)	6 $\pm$ 4

participants (35%) sought treatment from a health practitioner for their neck pain and three participants (12%) had a period of work absence due to their neck pain. Of those who had an episode of neck pain, 77% were female and 23% were male.

Risk factors for neck pain

The *univariate analysis* of dichotomized continuous variables (Table 2) showed large effect sizes of the following variables: gender (HR: 2.65; 95% CI: 1.06–6.60); cervical flexion–extension (HR: 0.50; 95% CI: 0.23–1.11); depression (HR: 1.91; 95% CI: 0.88–4.17); anxiety (HR: 2.39; 95% CI: 1.09–5.22) and psychological stress (HR: 1.89; 95% CI: 1.79–4.50).

Variables in the univariate analysis with P value ≤ 0.2 were entered into the multivariate regression analysis. These variables were: gender, duration of sitting between breaks, exercise frequency, range of cervical flexion–extension and lateral flexion and psychological stress (Table 2). Anxiety was not included in the multivariate analysis as a correlation matrix revealed that it was highly correlated with the stress score.

The results of the *multivariate analysis* of predictors of neck pain are shown in Table 3. Because of the exploratory nature of this investigation, the magnitude of the point estimate of the hazard ratios provides a clearer indication of the potential contribution of each variable to neck pain than the P value. For this reason the results presented below focus predominantly on point estimates of the hazard ratio.

From the multivariate analysis of dichotomized data, we found that office workers were three times more likely to develop neck pain if they were female (HR: 3.07; 95% CI: 1.18–7.99) and this large effect is illustrated in the Cox hazard curves in Fig. 2. Those who exercised more than three times per week were 1.5 times less likely to develop neck pain (HR: 0.64; 95% CI: 0.27–1.51), as shown in the Cox hazard curves in Fig. 3. The effect size of duration of sitting before taking a break was HR: 0.49 (95% CI 0.20–1.20). Increased range of cervical flexion and extension was protective, with the effect size (HR: 0.44; 95% CI: 0.19–1.05) indicating that those with total range $\geq 120^\circ$, were 2.3 times less likely to develop neck pain, as shown in Fig. 4. Based on the point estimate of a hazard ratio of 0.99, range of cervical lateral flexion was not predictive in the final multivariate model (HR: 0.99; 95% CI: 0.40–2.42). Finally, workers with high psychological stress (score ≥ 5 on the DASS21 subscale) had, on average, a 1.6 greater probability of an episode of neck pain (HR: 1.64; 95% : 0.66–4.07), as illustrated in the Cox hazard curves in Fig. 5.

It should be noted that while we originally aimed to analyse data for work-related neck pain separately [16], we broadened our analysis to include neck pain of any origin. Both researchers and participants in this study considered that it was difficult to be certain whether the neck pain was work related, particularly considering trends of increased sitting and computer use during leisure time.

Discussion

We found that the 1-year incidence of neck pain in Australian office workers was particularly high, being 49% (95% CI 36–62). This information about the high proportion of new cases of neck pain each year in office workers is a valuable addition to the literature because most previous research has reported on estimates of prevalence rather than incidence. Information about incidence is useful because it conveys specific information about risk that is valuable to assess the effectiveness of preventative measures. One other study has prospectively investigated the annual incidence of neck pain in office workers in Finland [21]. Korhonen et al. [21] reported a lower incidence, of 34% (95% CI 25–41), than our result, although there is overlap of the confidence intervals.

Our longitudinal study also provided quantitative estimates of the predictive role of individual, physical, workplace and psychological factors for neck pain in office workers. The multivariate analysis revealed that factors which may impact on the risk of developing neck pain in office workers are gender, exercise frequency, mobility of the cervical spine and psychological stress. However, we

Table 2 Predictors of neck pain: results from univariate analysis

Variable	Continuous data			Dichotomized data ^a	
	<i>P</i> value	HR	95% CI	HR	95% CI
Age	0.740	0.99	0.96–1.03	0.92	0.43–1.99
Female gender	0.037	2.65	1.06–6.60	2.65	1.06–6.60
Total duration sitting	0.247	0.89	0.73–1.08	0.83	0.38–1.82
Duration sitting before break	0.140	0.64	0.35–1.16	0.67	0.29–1.55
Exercise frequency	0.074	0.83	0.68–1.02	0.66	0.30–1.43
Cervical flexion–extension	0.022	0.97	0.95–1.00	0.50	0.23–1.11
Cervical lateral flexion	0.134	0.98	0.96–1.01	0.74	0.35–1.62
Cervical rotation	0.952	1.00	0.98–1.02	0.95	0.44–2.05
Cervical protraction	0.361	0.95	0.89–1.07	0.91	0.42–1.97
Cervical extensor endurance	0.497	1.00	1.00–1.00	1.04	0.48–2.23
Psychosocial work factors	0.546	1.01	0.98–1.03	0.89	0.41–1.92
Depression	0.598	1.02	0.94–1.12	1.91	0.88–4.17
Anxiety	0.066	1.10	0.99–1.21	2.39	1.09–5.22
Psychological stress	0.023	1.10	1.01–1.20	1.89	1.79–4.50

Significance and hazard ratios with 95% CI for continuous and dichotomized data from the univariate analysis

^a Continuous variables were dichotomized at median values and HRs apply to dichotomized variables as follows: age ≥ 43 years; total duration sitting ≥ 7 h; duration sitting before break ≥ 1 h; exercise frequency ≥ 3 times/week; cervical flexion–extension total range $\geq 120^\circ$; cervical lateral flexion total range $\geq 82^\circ$; cervical rotation total range $\geq 132^\circ$; cervical protraction ≥ 19 cm; cervical extensor endurance ≥ 16.3 min; psychosocial work factors: JCQ score ≥ 159 ; depression subscale score ≥ 1 ; anxiety subscale score ≥ 1 ; psychological stress subscale score ≥ 5

Table 3 Predictors of neck pain: results from multivariate analysis

Variable	Continuous data			Dichotomized data ^a	
	<i>P</i> value	HR	95% CI	HR	95% CI
Female gender	0.077	2.43	0.91–6.49	3.07	1.18–7.99
Exercise frequency	0.167	0.85	0.68–1.07	0.64	0.27–1.51
Duration sitting before break	0.317	0.71	0.37–1.38	0.49	0.20–1.20
Cervical flexion–extension	0.028*	0.97	0.94–0.99	0.44	0.19–1.05
Cervical lateral flexion	0.475	1.01	0.99–1.03	0.99	0.40–2.42
Psychological stress	0.042*	1.11	1.00–1.22	1.64	0.66–4.07

Significance and hazard ratios with 95% CI for continuous and dichotomized data from the multivariate analysis

* $P \leq 0.05$

^a Continuous variables were dichotomized at median values and HRs apply to dichotomized variables as follows: exercise frequency ≥ 3 times/week; duration sitting before break ≥ 1 h; cervical flexion–extension total range $\geq 120^\circ$; cervical lateral flexion total range $\geq 82^\circ$; psychological stress subscale score ≥ 5

emphasize that in this exploratory study, gender was the only variable to reach statistical significance in the final model. The precision of the point estimates was undoubtedly compromised by dichotomizing the continuous variables and further loss of statistical power results from the small sample size. For these reasons, the results should be considered preliminary. However, given that the majority of previous studies on risk factors for neck pain in office workers have used a cross-sectional design or assessed exposure using data from questionnaires, our longitudinal study, the first of its kind, provides valuable new data about potentially important risk factors.

The large effect size of gender aligns with reports of higher 1-year *prevalence* rates in female office workers in Sweden [19] and Australia [17] and is consistent with previous findings that females are at greater risk of developing neck pain [6, 8, 11, 21, 23, 24]. For example, female office workers were found to have a 2.3-fold risk compared with men (OR: 2.3; 95% CI: 1.2–4.4) in a longitudinal study in Finland [21] although in our study the effect was even greater (HR: 3.07; 95% CI: 1.18–7.99). The reason for this effect of female gender is not clear. Female office workers are known to work with higher musculoskeletal load when using computers [32] and report

Fig. 2 Cox hazard curves showing the effect of gender on risk of neck pain

Fig. 4 Cox hazard curves showing the effect of range of cervical flexion–extension on the risk of neck pain. Data were dichotomized at the median value of 120°

Fig. 3 Cox hazard curves showing the effect of exercise frequency on risk of neck pain. Data were dichotomized at the median value of 3 sessions of exercise per week

Fig. 5 Cox hazard curves showing the effect of psychological stress on the risk of neck pain. Data were dichotomized at the median stress subscale score of 5

symptoms more frequently than males [32], which may contribute to increased risk.

Our finding that increased cervical mobility (flexion–extension) may be protective of neck pain, by a factor of 2.3, is novel as this variable has not been assessed prospectively in office workers before. Passive neck mobility as a risk factor for neck and shoulder pain has been investigated prospectively in other populations, but with conflicting results. In laundry workers, those with reduced flexion mobility of the neck were more likely (RR: 3.1; 95% CI: 1.2–8.3) to develop neck/shoulder pain [29]. However, in a higher quality study of male student fighter

pilots, the incidence of neck pain was not predicted by flexion–extension mobility [13]. It is possible that the differences in these findings may be due to an interaction effect between cervical spine mobility, gender and neck pain. Our result suggests that active range of flexion–extension exercises may be worthwhile to consider for inclusion in primary prevention programs for office workers.

While it is commonly accepted that distress is a common consequence of painful musculoskeletal conditions, prospective studies of general psychological stress (as distinct from job strain) as a risk factor for neck pain in office workers are limited. A recent review reported that stress has been consistently associated with work-related neck and upper extremity symptoms in a general working population, but the cross-sectional design of these studies precludes the drawing of conclusions regarding causation [4]. A systematic review of prospective studies [26] reported a clear link between stress, distress or anxiety and back or neck pain, but not specifically in office workers. Job stress specifically has been consistently associated with work-related upper limb and neck symptoms [4]. We found that office workers with stress levels above 5 on the DASS21 subscale may have a 1.6-fold higher risk of developing neck pain, although the broad 95% CI (0.66–4.07) must be noted. This is interesting because this stress score of 5 (on a 0–21 scale) is relatively low, suggesting that even slightly elevated stress levels may impact on the risk of neck pain. The role of psychological stress is likely to be complex. One model has been proposed to explain how psychological strain can produce muscle tension and musculoskeletal symptoms such as neck pain in office workers [31], although data are lacking to support this theory. Importantly, stress is a risk factor that is potentially modifiable.

Our results showed that exercise may be protective of neck pain in office workers. We found that those who exercised at least three times per week may be 1.5 times less likely to develop neck pain confirming two similar findings in the literature. Korhonen et al. [21] found in their longitudinal study that office workers who exercised less than twice per week had a 1.4 times greater risk of neck pain (OR: 1.4; 95% CI: 0.7–2.7) and a cross-sectional association between physical activity in office workers and neck pain (OR: 1.85; 95% CI: 1.14–2.99) was reported by Cagnie et al. [6]. This would be an interesting relationship to investigate further, particularly to investigate whether the mode of exercise is important. For instance, it could be explored whether activities that require greater mobility of the cervical spine or control of the head on the trunk (such as in sports like soccer or tennis) specifically reduce the risk of neck pain. The association between exercise frequency and stress in relation to neck pain would also be a logical relationship to explore in future studies, particularly in light of a previous report of an interaction between high stress and low physical activity increasing the risk for neck pain (OR: 6.7; 95% CI: 1.0–43.6) [21]. Exercise has been demonstrated to reduce the intensity of neck symptoms in office workers by 49% (95% CI 13–85) [34] and would be promising to pursue as a primary prevention intervention.

High-risk work styles have been described by Feuerstein and colleagues [12] as individual responses to high work

demands and include behaviours such as taking shorter work breaks. An association between long periods of sitting and greater upper extremity pain in female office workers has been reported previously in a cross-sectional study [14]. Curiously, we found the opposite effect: that those who sit for longer times (more than an hour before taking a break) appear to have a lower risk of neck pain (HR: 0.49; 95% : 0.2–1.2). It would be expected that more frequent work breaks would reduce static loading to neck muscles and may possibly also have a positive impact on psychological stressors. Further investigation into work style behaviours is warranted, particularly as they are potentially modifiable.

The multivariate analysis did not reveal a significant association between psychosocial work factors (mental workload, decision latitude and social support) as measured by the JCQ and neck pain (HR: 1.01; 95% CI: 0.98–1.03; $P = 0.546$). It is possible that this may be due to limited statistical power resulting from the small sample size in this study, although the 95% CI is narrow. Psychosocial work factors such as high job demands, low decision latitude and co-worker support, have frequently been found to be associated with increased risk of neck pain in office workers [17, 19, 21, 27, 38] as well as in some [3, 30] but not all [24] studies of general working populations.

Sustained cervical postures at work such as forward head posture [6, 15] and sustained neck flexion [2, 33, 35] have been found in previous research to be associated with neck and shoulder pain. For instance, Cagnie et al. [6] reported that office workers who hold their neck in a forward bent posture for a prolonged time have 2.6-fold greater odds of developing neck pain. We did not find a relationship between cervical protraction and neck pain in our study (HR: 0.91; 95% CI: 0.42–1.97). However, despite our efforts to replicate usual working posture in sitting, we are not convinced that the measure of protraction we used with the CROM device achieved this. Alternative objective measures of protraction in sitting postures used at work may need to be considered for future studies.

The main limitation of this exploratory study was the small sample size. However, this longitudinal study has significant design strengths. We successfully completed a prospective study with 100% follow-up at 1 year, assessed a relevant spectrum of risk factors using objective measures and attained an estimate of 1-year incidence that has reasonable precision.

Conclusion

The results of this study indicate that the incidence of neck pain in Australian office workers is very high (1-year incidence proportion: 0.49). We found that female gender

and high psychological stress may increase the risk of developing neck pain in this population and that greater mobility of the cervical spine and frequent exercise may be protective.

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