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Risk factors of non-specific neck pain and low back pain in computer-using workers

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Abstract

Objectives: Several studies have found that inappropriate workstation associates with musculoskeletal disorders. Herein, the cross-sectional study aimed to identify the risk factors of non-specific neck pain (NP) and low back pain (LBP) among computer-using workers. ***Design:*** Observational, retrospective analysis of cross-sectional sample. ***Setting:*** This study has surveyed 15 companies in Zhejiang province, China. ***Participants:*** After excluding participants with missing variables, 417 office workers including 163 men and 254 women were analyzed. ***Outcome measures:*** Demographic information was collected by self-report. The standard Northwick Park Neck Pain Questionnaire and Oswestry Low Back Pain Disability Index, along with other relevant questions, were used to assess the potential occupational factors and perceived levels of pain. Multinomial logistic regression analysis adjusted for age, sex, body mass index, education, marriage, and neck/low back injury was performed. ***Results:*** Compared with low-level NP, the computer location (monitor not in front) was associated with odds ratios (ORs) of 2.590 and 2.939 for medium- and high-level NP, respectively. For LBP, high-level pain was associated with an OR of 3.215 compared with low-level pain in females. Significant associations were also observed between the office temperature (OR: 5.352 for high vs. low) and LBP, and between office work ≥5 years (OR: 2.702 for medium vs. low) and NP in female office workers. ***Conclusions:*** Not having the computer monitor located in front was an important risk factor of NP and LBP in female computer-using workers. This information not only enables the development of potential preventive strategies but also provides new insights for designing appropriate workstations.

Strengths and limitations of this study:

- This is the first study on the associations of computer monitor horizontal location with NP and LBP in Chinese computer users.
- Most participants are young and recruited via the identification of alumni.
- This study has not explored the relationships between exact angle of the computer monitor location and NP/LBP based on objectively measurement.

Keywords: Low back disorder; Computer use; Musculoskeletal pain; White-collar worker; Self-reported questionnaire.

Introduction

Non-specific low back pain (LBP) and neck pain (NP) are highly common musculoskeletal disorders and the leading causes of disability worldwide[1]. It has been well established that LBP and NP are not only risk factors of severe spine problems or functional disability, but they are also associated with decreased quality of life and productivity of workers[2]. Although NP and LBP are musculoskeletal conditions affecting different body parts, they generally have similar symptoms, hazards, and etiology[3].

The risk factors of NP or LBP are commonly multidimensional, including muscular, skeletal, and nervous system-related factors; can be both modifiable and non-modifiable; and can be divided into individual and occupational factors. Previous studies have shown that individual factors such as sex, age, history of neck/low back injury, and psychological factors (e.g., mental stress, anxiety, depression, and social support) are related to NP and/or LBP[4 5]. In addition, limited studies have also indicated that occupational factors, including prolonged sedentary or office work hours, high work load/demands, and inappropriate workstation design, are associated with NP and/or LBP[6-8].

Sedentary or office workers in schools, hospitals, or the military have been observed to have high incidences and prevalence of NP and LBP[9-11]. This might be caused by prolonged sitting time and specific body postures, such as inappropriate neck or low back flexion or rotation, and other workplace environmental factors[12]. However, the current literature on modifiable determinants of NP/LBP among workers in modern workplace environments, where intensive computer use is common, is insufficient[13]. Thus, the present study aimed to explore the associations of occupational risk factors with NP and LBP in computer-using office workers.

Methods

Participants

The cross-sectional study was conducted in 15 financial organizations, Zhejiang, China. A total of 425 office workers were recruited and investigated based on cluster sampling from September to December 2015, via the identification of alumni of Zhejiang Financial College (ZFC). All subjects signed informed consent before participating in the study. After excluding subjects with individual and/or occupational information missing (n=8), 417 subjects were included in the final analysis. The study was granted approval by ZFC's Institutional Review Board.

Data collection and variables definition

Data were collected by mailed questionnaires, which included the Northwick Park Neck Pain Questionnaire (NPQ)[14] and the Oswestry Low Back Pain Disability Index (ODI)[15] to measure NP and LBP, respectively. Individual and demographic information, including sex, age, height, weight, education, marriage status, and history of related injuries, was collected by a validated questionnaire. Based on previous literature and a pre-survey, the potential occupational risk factors (e.g., office work years, office temperature, location of the computer monitor, and duration of computer use per day) were determined by the research group. Subjects with non-specific NP or LBP were defined by a self-rated value of the NPQ or ODI of > 0. Body mass index (BMI) was calculated as the weight (kg) divided by the squared height (m^2). All data were double-entered and checked with Epidata 3.1.

Statistical analysis

First, we classified the values of NPQ and ODI into tertiles (low: ODI<0.19 NPQ<0.25, medium: 0.19≤ODI<0.24 and 0.25≤NPQ<0.34, and high: ODI≥0.24 and NPQ≥0.34). To test the differences in the categorical variables according to the NPQ or ODI results, the Chi-square test or Fisher's exact test was used if the cell number was <5, while ANOVA was used for continuous variables. Independent associations of occupational variables with NPQ or ODI and their interactions were analyzed using a multinomial logistic regression model stratified by sex, because significant interactions between sex and occupational variables were observed. The results are presented as the odds ratios (ORs) with 95% confidence intervals (CIs). A sensitivity analysis was conducted by including subjects with missing variables. All statistical analyses were conducted with IBM SPSS 20.0 (IBM Corporation, New York, USA). Statistical significance was defined as $p<0.05$.

Results

The characteristics of the study subjects are shown in Table 1. The mean age was 29.12 (±6.79) years. The prevalence rates of NP and LBP were 86.33% and 75.54%, respectively; subjects with LBP combined with NP accounted for 71.46%. The differences in sex, marriage status, history of neck injury, and office temperature among the NPQ tertiles were significant ($p<0.05$). Similarly, the differences in marital status, history of low back injury, office temperature, and location of the computer monitor significantly differed among the ODI tertiles ($p<0.05$).

Table 2 shows the results of the multinomial logistic regression of individual and occupational factors related to NP. In the total subjects, compared with the low NPQ tertile, office work ≥ 5 years (medium tertile; OR: 2.006, 95% CI: 1.038-3.877), male sex (high tertile; OR: 0.355, 95% CI: 0.197-0.638), history of neck injury (high tertile; OR: 9.612, 95% CI: 1.056-87.517), and computer monitor not located in front (i.e. on the right or left side of the operator) (high tertile; OR: 1.994, 95% CI: 1.169-3.401) were significantly associated with the risk of NP after adjusting for age, BMI, sex, education, marriage status, and history of neck injury. Among the male participants, no significant associations were observed between occupational factors and the NPQ tertiles. In females, having the computer monitor not located in front (vs. in front) was a significant risk factor for the medium (OR: 2.582, 95% CI: 1.254-5.318) and high (OR: 3.052, 95% CI: 1.469-6.344) NPQ tertiles, as compared with the low NPQ tertile. Work ≥ 5 years (vs. < 5 years) was a significant risk factor for the medium (OR: 2.702, 95% CI: 1.051-6.943) but not high NPQ tertile ($p>0.05$).

The results of the multinomial logistic regression analysis for LBP are presented in Table 3. In the total subjects, compared with the low ODI tertile, married individuals (high; OR: 2.078, 95% CI: 1.058-4.081), history of low back injury (high; OR: 4.358, 95% CI: 1.653-11.705), cold office temperature (medium tertile; OR: 2.429, 95% CI: 1.019-5.791 and high tertile; OR: 4.173, 95% CI: 1.819-9.573), and the computer monitor not located in front (high; OR: 2.048, 95% CI: 1.219-3.442) were significant risk factors for LBP after adjusting for age, BMI, sex, education, marriage status, and history of low back injury. In males, age (medium tertile; OR: 0.914, 95% CI: 0.837-0.998), history of low back injury (medium tertile; OR: 7.240, 95% CI: 1.304-40.204 and high tertile; 5.775, 95% CI: 1.074-31.065), and education (high tertile; OR: 0.385, 95% CI: 0.159-0.928) were significant risk factors for LBP, while no significant associations were observed between occupational factors and the ODI tertiles. In females, married individuals (medium tertile; OR: 3.310, 95% CI: 1.343-8.158 and high tertile; OR: 3.501, 95% CI: 1.392-8.805), low back injury (high tertile; OR: 4.205, 95% CI: 1.175-15.042), cold office temperature (high tertile; OR:

5.352, 95% CI: 1.787-16.028), and not having the computer monitor in front (high tertile; OR: 3.215, 95% CI: 1.581-6.539) were significant risk factor of LBP as compared with the low ODI tertile.

The results showed no significant differences between included and excluded the participants with missing variables.

Discussion

In the present study, having the computer monitor not located in front (i.e. on the right or left side), cold office temperature, and work ≥5 years were significantly associated with non-specific NP and/or LBP after controlling for age, BMI, sex, education, marital status, and history of neck/low back injury. This result has significance for developing prevention or intervention strategies against non-specific NP and LBP in computer-using office workers.

Previous researches on the associations of occupational factors among intensive computer users with non-specific NP/LBP are scarce[6]. Limited studies have indicated that psychosocial stress, long work hours, poor social support, and neck/low back flexion/bending in the workplace might be occupational risk factors[7 8 12]. Paksaichol et al. (2015) indicated that monitor height (vertical level) might be an indirect risk factor associated with neck pain[16]. However, to our knowledge, few studies have indicated that the location of the computer monitor (lateral level) is an important risk factor of non-specific NP/LBP. Prolonged and repeated body trunk over-rotation/flexion might cause non-specific NP/LBP by damaging the musculoskeletal system of neck or low back[17 18], as the individual needs to turn around and face the computer monitor if it is not located directly in front. Especially, many workstations in various organizations and companies are multifaceted, requiring the office workers or operators to rotate their body/trunk continuously while working.

This result might have crucial implications and provide a direction of practice for future workstation designs in related industries.

In addition, it has been well established that cold stimulation is a risk factor of musculoskeletal pain[19-21]. Our result also found that there was an association between cold office temperature and non-specific LBP, providing further evidence for this possible causal relationship, although there might be reciprocal causation between these two variables, with individuals with LBP potentially being much more susceptible to cold environments (lower office temperature) or experiencing enhanced perceived pain via their sensory nerves[22]. On the other hand, it can be speculated that a warm office temperature might be associated with less non-specific LBP among intensive computer users or sedentary workers.

In this study, we also found that longer work years and individual factors, including injuries of the neck/low back, married individuals, and female sex, were associated with non-specific NP/LBP. This result is consistent with the relevant previous studies[6-8]. Women are known to have a higher prevalence of NP/LBP and to be more susceptible to environmental risk factors than men. This might be due to their lower bone mineral density and specific anatomical structure[23 24]. The reason why BMI, education, and computer-using time were not significantly associated with NP/LBP may be because of the narrow distribution of these variables in our limited study subjects. Our participants were younger (85% of the subjects were younger than 35 years) than the general industrial workers in China, and it is difficult to determine whether there is statistical significance based on variables with such a narrow distribution.

There were some limitations in this study that need to be acknowledged. Due to the cross-sectional design of the study, we were unable to detect the potential causality. Meanwhile, most participants were young and comprised intensive computer users and financial office workers. Thus, care must be taken when generalizing our results to other populations. Lastly, the use of a self-report questionnaire might generate systematical bias. Although physical factors can be assessed objectively, most previous studies used self-reported questionnaires for measuring non-specific pain and individual or environmental factors[5 7 8 25]. Nevertheless, in this study, we tested and verified the significance of occupational and environmental risk factors, including the location of the computer monitor and the office temperature, for non-specific NP/LBP. These findings are important for modern office workers, especially for those who are intensive computer users.

Conclusions

Location of the computer monitor not in front (i.e. on the left or right side) of the operator is a modifiable occupational risk factor of non-specific NP and LBP. Additionally, a history of neck/low back injury, longer office work years, female sex, and married individuals were also important occupational or individual determinants that correlate with NP/LBP. Further prospective studies using objective measurements of work-related body posture and repetitiveness are required to confirm our findings.

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Contributorship statement: Sunyue Ye constructed the questionnaire, performed the final statistical analyses and prepared the first version of manuscript.

Qinglei Jing and Jie Lu collected the data. Chen Wei critically reviewed, commented and revised the manuscript. All authors were responsible and approved the final manuscript.

Competing interests: There are no competing interests.

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Table 1 Characteristics of Chinese office workers stratified by the presence of neck pain or low back pain

Variables	Total n=417	Northwick Park Questionnaire Low n=149	Northwick Park Questionnaire Medium n=137	Northwick Park Questionnaire High n=131	$p^{\#}$	The Oswestry Disability Index Low n=162	The Oswestry Disability Index Medium n=121	The Oswestry Disability Index High n=134	$p^{\#}$
Individual variables:									
Gender (n, %)									
Male	163(39.09)	74(49.66)	53(38.69)	36(27.48)	0.001	74(45.68)	45(37.19)	44(32.84)	0.069
Female	254(60.91)	75(50.34)	84(61.31)	95(72.52)		88(54.32)	76(62.81)	90(67.16)	
Age (years)	29.12(6.79)	29.14(7.06)	28.28(7.11)	30.00(6.04)	0.119	28.81(7.37)	28.32(5.16)	30.24(7.27)	0.062
Height (cm)	165.87(11.10)	166.66(15.83)	166.19(6.79)	164.62(7.70)	0.289	165.92(15.08)	166.16(7.51)	165.55(7.64)	0.907
Weight (kg)	58.01(12.40)	59.32(13.44)	57.68(11.21)	56.80(12.30)	0.236	57.87(13.33)	58.35(11.36)	57.86(12.19)	0.938
Body mass index (kg/m^2)	20.90(3.35)	21.06(3.32)	20.79(3.28)	20.83(3.46)	0.766	20.78(3.66)	20.98(2.88)	20.98(3.36)	0.841
Education (n, %)									
College or less	117(28.06)	35(23.49)	37(27.01)	45(34.35)	0.123	38(23.46)	34(28.10)	45(33.58)	0.155
Bachelor or more	300(71.94)	114(76.51)	101(72.99)	87(65.65)		124(76.54)	87(71.90)	89(66.42)	
Marriage (n, %)									
Married or other	235(56.35)	67(44.97)	70(51.09)	45(34.35)	0.020	83(51.23)	53(43.80)	46(34.33)	0.014
Unmarried	182(43.65)	82(55.03)	67(48.91)	86(65.65)		79(48.77)	68(56.20)	88(65.67)	
Neck injury (n, %)	14(3.4)	1(0.67)	5(3.65)	8(6.11)	0.028	-	-	-	-
Low back injury (n, %)	-	-	-	-	-	6(3.70)	11(9.09)	20(14.93)	0.003
Work related variables:									
Work years (n, %)									
<5 years	204(48.92)	80(53.69)	70(51.09)	54(41.22)	0.094	88(54.32)	60(49.59)	56(41.79)	0.098
≥5 years	213(51.08)	69(46.31)	67(48.91)	77(58.78)		74(45.68)	61(50.41)	78(58.21)	
Office temperature (n, %)									
Cold	52(12.47)	12(8.05)	16(11.68)	24(18.32)	0.033	9(5.56)	16(13.22)	27(20.15)	0.001
Median or hot	365(87.53)	137(91.95)	121(88.32)	107(81.68)		153(94.44)	105(86.78)	107(79.85)	
Location of computer displayer (n, %)									
In front	265(63.55)	105(70.47)	86(62.77)	74(56.49)	0.051	113(69.75)	81(66.94)	71(52.99)	0.008
Not in front	152(36.45)	44(29.53)	52(37.23)	57(43.51)		49(30.25)	40(33.06)	63(47.01)	
Computer-using time (n, %)									
<8 hours	203(48.68)	80(53.69)	62(45.26)	61(46.57)	0.305	86(53.09)	55(45.45)	62(46.27)	0.354
≥8 hours	214(51.32)	69(46.31)	75(54.74)	70(53.43)		76(46.91)	66(54.55)	72(53.73)	

Pearson Chi-square test for categorical variables, ANOVA for continuous variables, or Fisher's exact test for categorical variables if the number of cells was < 5.

Table 2 Multinomial logistic regression models for correlates of neck pain

z	Low	Medium			High		
		OR†	95%CI†	*p* value	*OR*†	95%CI†	*p* value
Total subjects:							
Age (yrs)	Ref.	0.965	0.918-1.016	0.176	0.993	0.944-1.043	0.768
BMI† (kg/m^2)	Ref.	1.011	0.931-1.097	0.799	1.006	0.920-1.099	0.901
Male	Ref.	0.603	0.353-1.030	0.064	**0.355**	**0.197-0.638**	**0.001**
Bachelor or more	Ref.	0.904	0.518-1.577	0.722	0.688	0.388-1.220	0.201
Married	Ref.	0.664	0.350-1.260	0.211	1.197	0.607-2.360	0.604
Neck injury	Ref.	7.877	0.846-73.312	0.070	**9.612**	**1.056-87.517**	**0.045**
Work years ≥5 yrs	Ref.	**2.006**	**1.038-3.877**	**0.038**	1.763	0.880-3.530	0.110
Cold office temperature	Ref.	1.045	0.459-2.380	0.916	1.872	0.846-4.142	0.122
Computer displayer not in front	Ref.	1.406	0.841-2.351	0.194	**1.994**	**1.169-3.401**	**0.011**
Computer use ≥8 h/d	Ref.	1.265	0.777-2.058	0.345	1.015	0.605-1.701	0.956
Male:							
Age (yrs)	Ref.	1.017	0.950-1.089	0.631	0.948	0.876-1.026	0.183
BMI† (kg/m^2)	Ref.	1.019	0.897-1.158	0.770	0.975	0.855-1.112	0.707
Bachelor or more	Ref.	1.511	0.624-3.662	0.360	0.624	0.250-1.558	0.313
Married	Ref.	0.521	0.190-1.430	0.206	1.018	0.339-3.055	0.974
Neck injury	Ref.	7.505	0.744-75.673	0.087	7.975	0.674-94.354	0.100
Work years ≥5 yrs	Ref.	1.153	0.418-8.304	0.783	2.666	0.868-8.188	0.087
Cold office temperature	Ref.	2.016	0.489-8.304	0.332	1.115	0.212-5.855	0.898
Computer displayer not in front	Ref.	0.660	0.296-1.473	0.311	1.431	0.604-3.392	0.416
Computer use ≥8 h/d	Ref.	1.237	0.590-2.595	0.573	0.534	0.219-1.304	0.168
Female:*							
Age (yrs)	Ref.	0.935	0.861-1.016	0.112	1.026	0.950-1.109	0.509
BMI† (kg/m^2)	Ref.	1.008	0.900-1.129	0.889	1.026	0.910-1.158	0.673
Bachelor or more	Ref.	0.661	0.305-1.433	0.295	0.581	0.268-1.259	0.169
Married	Ref.	0.812	0.336-1.967	0.645	1.413	0.580-3.443	0.447
Work years ≥5 yrs	Ref.	**2.706**	**1.052-6.957**	**0.039**	1.522	0.590-3.926	0.385
Cold office temperature	Ref.	0.787	0.277-2.236	0.653	2.060	0.799-5.312	0.135
Computer displayer not in front	Ref.	**2.590**	**1.257-5.337**	**0.010**	**2.939**	**1.414-6.108**	**0.004**
Computer use ≥8 h/d	Ref.	1.368	0.703-2.664	0.356	1.363	0.696-2.671	0.367

Northwick Park Neck Pain Questionnaire. * The variable of neck injury was excluded from the female regression model because there were no subjects in the low NPQ tertile. † OR, odds ratio; CI, confidence interval; BMI, body mass index.

Table 3 Multinomial logistic regression models for correlates of low back pain

Variables/ODI#	Low	Medium			High		
		OR†	95%CI†	*p* value	*OR*†	95%CI†	*p* value
Total subjects:							
Age (yrs)	Ref.	0.950	0.899-1.004	0.067	1.005	0.956-1.056	0.848
BMI† (kg/m^2)	Ref.	1.040	0.953-1.136	0.377	1.008	0.924-1.100	0.858
Male	Ref.	0.720	0.416-1.245	0.239	0.589	0.335-1.036	0.066
Bachelor or more	Ref.	0.772	0.442-1.347	0.362	0.643	0.368-1.124	0.122
Married	Ref.	1.652	0.864-3.161	0.129	**2.078**	**1.058-4.081**	**0.034**
Low back injury	Ref.	2.122	0.726-6.199	0.169	**4.358**	**1.653-11.705**	**0.003**
Work years ≥5 yrs	Ref.	1.213	0.625-2.351	0.568	1.059	0.532-2.105	0.871
Cold office temperature	Ref.	**2.429**	**1.019-5.791**	**0.045**	**4.173**	**1.819-9.573**	**0.001**
Computer displayer not in front	Ref.	1.046	0.619-1.769	0.867	**2.048**	**1.219-3.442**	**0.007**
Computer use ≥8 h/d	Ref.	1.232	0.751-2.019	0.409	1.040	0.625-1.731	0.879
Male:							
Age (yrs)	Ref.	**0.914**	**0.837-0.998**	**0.045**	0.978	0.912-1.049	0.542
BMI† (kg/m^2)	Ref.	1.069	0.923-1.239	0.373	0.983	0.864-1.119	0.797
Bachelor or more	Ref.	0.628	0.248-1.589	0.326	**0.385**	**0.159-0.928**	**0.034**
Married	Ref.	0.911	0.316-2.625	0.863	1.302	0.441-3.840	0.633
Low back injury	Ref.	**7.240**	**1.304-40.204**	**0.024**	**5.775**	**1.074-31.065**	**0.041**
Work years ≥5 yrs	Ref.	2.735	0.951-7.862	0.062	2.329	0.775-6.998	0.132
Cold office temperature	Ref.	1.454	0.325-6.501	0.624	2.140	0.529-8.653	0.286
Computer displayer not in front	Ref.	0.440	0.177-1.093	0.077	1.291	0.570-2.923	0.541
Computer use ≥8 h/d	Ref.	1.413	0.637-3.134	0.394	0.712	0.310-1.639	0.425
Female:							
Age (yrs)	Ref.	0.975	0.906-1.050	0.501	1.028	0.958-1.104	0.438
BMI† (kg/m^2)	Ref.	1.025	0.915-1.149	0.669	1.030	0.914-1.161	0.626
Bachelor or more	Ref.	0.821	0.393-1.717	0.601	0.790	0.372-1.678	0.540
Married	Ref.	**3.310**	**1.343-8.158**	**0.009**	**3.501**	**1.392-8.805**	**0.008**
Low back injury	Ref.	0.922	0.185-4.595	0.921	**4.205**	**1.175-15.042**	**0.027**
Work years ≥5 yrs	Ref.	0.607	0.239-1.539	0.292	0.566	0.219-1.463	0.240
Cold office temperature	Ref.	2.877	0.922-8.980	0.069	**5.352**	**1.787-16.028**	**0.003**
Computer displayer not in front	Ref.	1.930	0.955-3.900	0.067	**3.215**	**1.581-6.539**	**0.001**
Computer use ≥8 h/d	Ref.	1.081	0.559-2.090	0.816	1.126	0.570-2.225	0.732

Oswestry low back pain disability index. † OR, odds ratio; CI, confidence interval; BMI, body mass index.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	*5-6*
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	*5-6*
		(*b*) Describe any methods used to examine subgroups and interactions	*5-6*
		(*c*) Explain how missing data were addressed	*5-6*
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	*5-6*
		(*e*) Describe any sensitivity analyses	*5-6*
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	5
		(c) Consider use of a flow diagram	ns
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6-7
		(b) Indicate number of participants with missing data for each variable of interest	5
Outcome data	15*	Report numbers of outcome events or summary measures	6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7-11
		(*b*) Report category boundaries when continuous variables were categorized	5
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	ns
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	10
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Risk factors of non-specific neck pain and low back pain in computer-using office workers in China: a cross-sectional study

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Risk factors of non-specific neck pain and low back pain in computer-using office workers in China: a cross-sectional study

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Abstract

Objectives: Several studies have found that inappropriate workstations are associated with musculoskeletal disorders. The present cross-sectional study aimed to identify the risk factors of non-specific neck pain (NP) and low back pain (LBP) among computer-using workers. ***Design:*** Observational study with a cross-sectional sample. ***Setting:*** This study surveyed 15 companies in Zhejiang province, China. ***Participants:*** After excluding participants with missing variables, 417 office workers, including 163 men and 254 women, were analyzed. ***Outcome measures:*** Demographic information was collected by self-report. The standard Northwick Park Neck Pain Questionnaire and Oswestry Low Back Pain Disability Index, along with other relevant questions, were used to assess the potential occupational factors and perceived levels of pain. Multinomial logistic regression analysis, adjusted for age, sex, body mass index, education, marriage status, and neck/low back injury, was performed. ***Results:*** Compared with low-level NP, the computer location (monitor not in front) was associated with odds ratios (ORs) of 2.6 and 2.9 for medium- and high-level NP, respectively. For LBP, high-level pain was associated with an OR of 3.2 compared with low-level pain in females. Significant associations were also observed between the office temperature (OR: 5.4 for high vs. low) and LBP, and between office work ≥5 years (OR: 2.7 for medium vs. low) and NP in female office workers. ***Conclusions:*** Not having the computer monitor located in front was an important risk factor of NP and LBP in computer-using female workers. This information not only enables the development of potential preventive strategies but also provides new insights for designing appropriate workstations.

Strengths and limitations of this study:

- This is the first study on the associations of the horizontal location of the computer monitor with neck pain and low back pain in Chinese computer users.
- However, most participants were young and recruited via the identification of college alumni, limiting the generalizability of our findings.
- Further, this study did not explore the relationships between the exact angle of the computer monitor location and neck pain/low back pain based on objective measurements.

Keywords: Low back disorder; Computer use; Musculoskeletal pain; White-collar worker; Self-reported questionnaire.

Introduction

Non-specific neck pain (NP) and low back pain (LBP) are highly common musculoskeletal disorders and the leading causes of disability worldwide[1]. It has been well established that NP and LBP are not only risk factors of severe spine problems or functional disability, but are also associated with decreased quality of life and productivity of workers[2]. Of note, although NP and LBP are musculoskeletal conditions affecting different body parts, they generally have similar symptoms, hazards, and etiology[3].

The risk factors of NP or LBP are commonly multidimensional, including muscular, skeletal, and nervous system-related factors; can be both modifiable and non-modifiable; and can be divided into individual and occupational factors. Individual factors related to NP and/or LBP include, among others, sex, age, history of neck/low back injury, and psychological factors (e.g., mental stress, anxiety, depression, and social support) [4 5]. In addition, a few studies have also indicated that occupational factors, including prolonged sedentary or office work hours, high work load/demands, and inappropriate workstation design, are associated with NP and/or LBP [6-8].

Sedentary or office workers in schools, hospitals, or the military have been observed to have high incidences and prevalence of NP and LBP[9-11]. This might be caused by their prolonged sitting time and specific body postures, such as inappropriate neck or low back flexion or rotation, and other workplace environmental factors[12]. However, the current literature on modifiable determinants of NP/LBP among office workers in modern workplace environments, where intensive computer use is common, is insufficient[13]. Thus, the present study aimed to explore the associations of occupational risk factors with NP and LBP in computer-using office workers.

Methods

Participants

This cross-sectional study was conducted in 15 financial organizations, Zhejiang, China. A total of 425 office workers, aged 18-59 years, were recruited and investigated based on cluster sampling from September to December 2015, via the identification of alumni of Zhejiang Financial College. All participants gave informed consent before participating in the study. After excluding participants with missing individual and/or occupational information (n=8), 417 participants were included in the final analysis. The study was granted approval by Zhejiang Financial College's Institutional Review Board.

Data collection and variable definitions

Data were collected by mailed questionnaires, which included the Northwick Park Neck Pain Questionnaire (NPQ)[14] and the Oswestry Low Back Pain Disability Index (ODI)[15] to measure NP and LBP, respectively[16]. Individual and demographic information, including sex, age, height, weight, education, marriage status, and history of general neck/low back injuries, was collected by a questionnaire. Based on previous literature and a pre-survey, the potential occupational risk factors (e.g., years of office work at current job, office temperature, location of the computer monitor, and duration of computer use per day) were determined by self-report. Participants with non-specific NP or LBP were defined by a self-rated value of the NPQ or ODI of > 0. Body mass index (BMI) was calculated as the weight (kg) divided by the squared height (m^2). All data were double-entered and checked with Epidata 3.1.

Statistical analysis

First, we classified the values of the NPQ and ODI into tertiles (low: ODI<0.19 and NPQ<0.25, medium: 0.19≤ODI<0.24 and 0.25≤NPQ<0.34, and high: ODI≥0.24 and NPQ≥0.34). To test the differences in the categorical variables according to the NPQ or ODI results, the Chi-square test or Fisher's exact test was used if the cell number was <5, while ANOVA was used for continuous variables. Independent associations of occupational variables with the NPQ or ODI were analyzed using multinomial logistic or linear regression models in the total participants and stratified by sex, because significant interactions between sex and the occupational variables were observed in the present study. The results are presented as the odds ratios (ORs) with 95% confidence intervals (CIs). A sensitivity analysis was conducted by including participants with missing variables, encoded as the mean for continuous variables and mode for categorical variables. All statistical analyses were conducted with IBM SPSS 20.0 (IBM Corporation, New York, USA). Statistical significance was defined as $p<0.05$.

Results

The characteristics of the participants are shown in Table 1. The mean age was 29.1 (±6.8) years. The point prevalence rates of NP and LBP (mild to severe levels of pain) were 86.3% and 75.5%, respectively; participants with NP combined with LBP accounted for 71.5%. The differences in sex, marriage status, history of neck injury, and office temperature among the NPQ tertiles were significant ($p<0.05$). Similarly, the differences in marital status, history of low back injury, office temperature, and location of the computer monitor significantly differed among the ODI tertiles ($p<0.05$).

Table 2 shows the results of the multinomial logistic and linear regression analyses of individual and occupational factors related to NP. In the total participants, compared with the low NPQ, office work ≥5 years, sex, history of neck injury, and computer monitor not located in front (i.e. on the right or left side of the operator) were significantly associated with the high NPQ after adjusting for age, BMI, sex, education, marriage status, and history of neck injury. Significant linear associations of NP (continuous variable) with female sex, neck injury, cold office temperature, and computer displayer not in front were also observed ($p<0.05$). Among the male participants, no significant associations were observed between occupational factors and the NPQ tertiles, except for neck injury, in the linear regression model. In females, having the computer monitor not located in front and cold office temperature were significant risk factors for the higher NPQ tertiles, while office work ≥ 5 years (vs. < 5 years) was a significant risk factor for the medium, but not high, NPQ ($p>0.05$).

The results of the multinomial logistic and linear regression analyses for LBP are presented in Table 3. In the total participants, compared with the low ODI, married status, history of low back injury, cold office temperature, and the computer monitor not located in front were significant risk factors for LBP after adjusting for age, BMI, sex, and education. In males, age, history of low back injury, and education were significant risk factors for LBP, while no significant associations were observed between occupational factors and the ODI tertiles. In females, married individuals, low back injury, cold office temperature, and not having the computer monitor in front were significantly related to higher levels of LBP. Additionally, the results showed no significant differences between the included and excluded the participants with missing variables.

Discussion

In the present study, having the computer monitor not located in front (i.e. on the right or left side), cold office temperature, and office work ≥5 years were significantly associated with non-specific NP and/or LBP after controlling for age, BMI, sex, education, marital status, and history of neck/low back injury. This result has significance for developing prevention or intervention strategies against non-specific NP and LBP in computer-using office workers.

Previous researches on the associations of specific adjustable behavioral or occupational factors among intensive computer-using office workers with non-specific NP/LBP are scarce, although epidemiological evidence of a correlation between computer-using time and NP/LBP has been well established [6 17 18]. A few studies have indicated that psychosocial stress, long work hours, poor social support, and neck/low back flexion/bending in the workplace might be occupational risk factors[7 8 12]. Paksaichol et al. indicated that improper height (vertical level) of video display units might be an indirect risk factor associated with neck pain[19]. However, to our knowledge, few studies have indicated that the location of the computer monitor (lateral level) is an important risk factor of non-specific NP/LBP. Prolonged and repeated body trunk over-rotation/flexion might cause non-specific NP/LBP by damaging the musculoskeletal system of the neck or low back[20 21], as the individual needs to turn around and face the computer monitor if it is not located directly in front. Especially, many workstations in various organizations and companies are multifaceted, requiring the office workers or operators to rotate their body/trunk continuously while working. These results provide a direction for future workstation designs in related industries.

In addition, it has been well established that cold stimulation is a risk factor of musculoskeletal pain[22-24]. Our study also found that there was an association between cold office temperature and non-specific NP and LBP, providing further evidence for this possible causal relationship, although there might be reciprocal causation between these two variables, with individuals with NP and LBP potentially being much more susceptible to cold environments (lower office temperature) or experiencing enhanced perceived pain via their sensory nerves[25]. Conversely, it can be speculated that a warm office temperature might be associated with less non-specific NP and LBP among intensive computer users or sedentary workers.

In this study, we further found that longer work years and injuries of the neck/low back were associated with both non-specific NP and LBP, as were female sex and married individuals. These results are consistent with those of previous studies[6-8]. Women are known to have a higher prevalence of NP/LBP and to be more susceptible to environmental risk factors than men. This might be due to their physical inactivity, lower bone mineral density, and specific anatomical structure [26-28]. The reason why BMI, education, and computer-using time were not significantly associated with NP/LBP may be because of the narrow distribution of these variables in our limited study sample. Our participants were younger (85% of the participants were younger than 35 years) than the general industrial workers in China, and it is difficult to determine whether there is statistical significance based on variables with such a narrow distribution.

There were some limitations in this study that need to be acknowledged. Due to the cross-sectional design of the study and the relative small sample size, we were unable to detect the causality and other potential risk factors. Meanwhile, as mentioned above, most participants were young and comprised intensive computer users and financial office workers. Thus, care must be taken when generalizing our results to other populations. Lastly, the use of a self-report questionnaire might generate systematical bias. Although physical factors can be assessed objectively, most previous studies used self-reported questionnaires for measuring non-specific pain and individual or environmental factors[5 7 8 29]. Nevertheless, in this study, we assessed and verified the significance of various occupational and environmental risk factors, including the location of the computer monitor and the office temperature, for non-specific NP/LBP. These findings are important for modern office workers, especially for those who are intensive computer users.

Conclusions

Location of the computer monitor not in front (i.e. on the left or right side) of the operator and cold office temperature are modifiable occupational risk factors of non-specific NP and LBP in computer-using office workers. Additionally, a history of neck/low back injury, longer office work years, female sex, and married individuals were also identified as important occupational or individual determinants that correlate with NP/LBP. Accordingly, our results indicate that ensuring proper horizontal position of the computer monitor and maintaining a relative warm office environment are important for preventing NP and LBP, especially in neck- and/or back-injured intensive computer-using female office workers. Further prospective studies using objective measurements of work-related body posture and repetitiveness are required to confirm our findings.

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Table 1 Characteristics of Chinese office workers stratified by the presence of neck pain or low back pain

Variables	Total	Northwick Park Questionnaire				The Oswestry Disability Index			
	n=417	Low n=149	Medium n=137	High n=131	$p^{\#}$	Low n=162	Medium n=121	High n=134	$p^{\#}$
Individual variables:									
Gender (n, %)									
Male	163(39.1)	74(49.7)	53(38.7)	36(27.5)	0.001	74(45.7)	45(37.2)	44(32.8)	0.069
Female	254(60.9)	75(50.3)	84(61.3)	95(72.5)		88(54.3)	76(62.8)	90(67.2)	
Age (years)	29.1(6.8)	29.1(7.1)	28.3(7.1)	30.0(6.0)	0.119	28.8(7.4)	28.3(5.2)	30.2(7.3)	0.062
Height (cm)	165.9(11.1)	166.7(15.8)	166.2(6.8)	164.6(7.7)	0.289	165.9(15.1)	166.2(7.5)	165.6(7.6)	0.907
Weight (kg)	58.0(12.4)	59.3(13.4)	57.7(11.2)	56.8(12.3)	0.236	57.9(13.3)	58.4(11.4)	57.9(12.2)	0.938
Body mass index (kg/m^2)	20.9(3.4)	21.1(3.3)	20.8(3.3)	20.8(3.5)	0.766	20.8(3.7)	21.0(2.9)	21.0(3.4)	0.841
Education (n, %)									
College or less	117(28.1)	35(23.5)	37(27.0)	45(34.4)	0.123	38(23.5)	34(28.1)	45(33.6)	0.155
Bachelor or more	300(71.9)	114(76.5)	101(73.0)	87(65.7)		124(76.5)	87(71.9)	89(66.4)	
Marriage (n, %)									
Married or other	235(56.4)	67(45.0)	70(51.1)	45(34.4)	0.020	83(51.2)	53(43.8)	46(34.3)	0.014
Unmarried	182(43.7)	82(55.0)	67(48.9)	86(65.7)		79(48.8)	68(56.2)	88(65.7)	
Neck injury (n, %)	14(3.4)	1(0.7)	5(3.7)	8(6.1)	0.028	-	-	-	-
Low back injury (n, %)	-	-	-	-	-	6(3.7)	11(9.1)	20(14.9)	0.003
Work related variables:									
Work years (n, %)									
<5 years	204(48.9)	80(53.7)	70(51.1)	54(41.2)	0.094	88(54.3)	60(49.6)	56(41.8)	0.098
≥5 years	213(51.1)	69(46.3)	67(48.9)	77(58.8)		74(45.7)	61(50.4)	78(58.2)	
Office temperature (n, %)									
Cold	52(12.5)	12(8.1)	16(11.7)	24(18.3)	0.033	9(5.6)	16(13.2)	27(20.2)	0.001
Median or hot	365(87.5)	137(92.0)	121(88.3)	107(81.7)		153(94.4)	105(86.8)	107(79.9)	
Location of computer displayer (n, %)									
In front	265(63.6)	105(70.5)	86(62.8)	74(56.5)	0.051	113(69.8)	81(66.9)	71(53.0)	0.008
Not in front	152(36.5)	44(29.5)	52(37.2)	57(43.5)		49(30.3)	40(33.1)	63(47.0)	
Computer-using time (n, %)									
<8 hours	203(48.7)	80(53.7)	62(45.3)	61(46.6)	0.305	86(53.1)	55(45.5)	62(46.3)	0.354
≥8 hours	214(51.3)	69(46.3)	75(54.7)	70(53.4)		76(46.9)	66(54.6)	72(53.7)	

Pearson Chi-square test for categorical variables, ANOVA for continuous variables, or Fisher's exact test for categorical variables if the number of cells was < 5.

Table 2 Multinomial logistic regression models for correlates of neck pain

Variables/NPQ[#]	Low	Medium			High			*p* value for trend[‡]
		OR[†]	95%CI[†]	*p* value	*OR*[†]	95%CI[†]	*p* value	
Total participants:								
Age (yrs)	Ref.	0.97	0.92-1.02	0.18	0.99	0.94-1.04	0.768	0.541
BMI[†] (kg/m^2)	Ref.	1.01	0.93-1.10	0.80	1.01	0.92-1.10	0.901	0.868
Male	Ref.	0.60	0.35-1.03	0.06	**0.36**	**0.20-0.64**	**0.001**	**0.000**
Bachelor or more	Ref.	0.90	0.52-1.58	0.72	0.69	0.39-1.22	0.201	0.344
Married	Ref.	0.66	0.35-1.26	0.21	1.20	0.61-2.36	0.604	0.425
Neck injury	Ref.	7.88	0.85-73.31	0.07	**9.61**	**1.06-87.52**	**0.045**	**0.006**
Work years ≥5 yrs	Ref.	**2.01**	**1.04-3.88**	**0.04**	1.76	0.88-3.53	0.110	0.088
Cold office temperature	Ref.	1.05	0.46-2.38	0.92	1.87	0.85-4.14	0.122	**0.011**
Computer displayer not in front	Ref.	1.41	0.84-2.35	0.19	**1.99**	**1.17-3.40**	**0.011**	**0.001**
Computer use ≥8 h/d	Ref.	1.27	0.78-2.06	0.35	1.02	0.61-1.70	0.956	0.561
Male:								
Age (yrs)	Ref.	1.02	0.95-1.09	0.631	0.95	0.88-1.03	0.183	0.649
BMI[†] (kg/m^2)	Ref.	1.02	0.90-1.16	0.770	0.98	0.86-1.11	0.707	0.570
Bachelor or more	Ref.	1.51	0.62-3.66	0.360	0.62	0.25-1.56	0.313	0.539
Married	Ref.	0.52	0.19-1.43	0.206	1.02	0.34-3.06	0.974	0.574
Neck injury	Ref.	7.51	0.74-75.67	0.087	7.98	0.67-94.35	0.100	**0.013**
Work years ≥5 yrs	Ref.	1.15	0.42-8.30	0.783	2.67	0.87-8.19	0.087	0.140
Cold office temperature	Ref.	2.02	0.49-8.30	0.332	1.12	0.21-5.86	0.898	0.791
Computer displayer not in front	Ref.	0.66	0.30-1.47	0.311	1.43	0.60-3.39	0.416	0.281
Computer use ≥8 h/d	Ref.	1.24	0.59-2.60	0.573	0.53	0.22-1.30	0.168	0.078
Female[*]*:*								
Age (yrs)	Ref.	0.94	0.86-1.02	0.112	1.03	0.95-1.11	0.509	0.150
BMI[†] (kg/m^2)	Ref.	1.01	0.90-1.13	0.889	1.03	0.91-1.16	0.673	0.420
Bachelor or more	Ref.	0.66	0.31-1.43	0.295	0.58	0.27-1.26	0.169	0.365
Married	Ref.	0.81	0.34-1.97	0.645	1.41	0.58-3.44	0.447	0.168
Work years ≥5 yrs	Ref.	**2.71**	**1.05-6.96**	**0.039**	1.52	0.59-3.93	0.385	0.378
Cold office temperature	Ref.	0.79	0.28-2.24	0.653	2.06	0.80-5.31	0.135	**0.010**
Computer displayer not in front	Ref.	**2.59**	**1.26-5.34**	**0.010**	**2.94**	**1.41-6.11**	**0.004**	**0.001**
Computer use ≥8 h/d	Ref.	1.39	0.70-2.66	0.356	1.36	0.70-2.67	0.367	0.714

Northwick Park Neck Pain Questionnaire. * The variable of neck injury was excluded from the female regression model because there were no participants in the low NPQ tertile. † OR, odds ratio; CI, confidence interval; BMI, body mass index. ‡ The *p* values for trend were obtained from multiple linear regression models.

Table 3 Multinomial logistic regression models for correlates of low back pain

Variables/ODI[#]	Low	Medium			High			*p* value for trend[‡]
		OR[†]	95%CI[†]	*p* value	*OR*[†]	95%CI[†]	*p* value	
Total participants:								
Age (yrs)	Ref.	0.95	0.90-1.00	0.067	1.01	0.96-1.06	0.848	0.740
BMI[†] (kg/m^2)	Ref.	1.04	0.95-1.14	0.377	1.01	0.92-1.10	0.858	0.269
Male	Ref.	0.72	0.42-1.25	0.239	0.59	0.34-1.04	0.066	0.241
Bachelor or more	Ref.	0.77	0.44-1.35	0.362	0.64	0.37-1.12	0.122	0.626
Married	Ref.	1.65	0.86-3.16	0.129	**2.08**	**1.06-4.08**	**0.034**	**0.000**
Low back injury	Ref.	2.12	0.73-6.20	0.169	**4.36**	**1.65-11.71**	**0.003**	**0.000**
Work years ≥5 yrs	Ref.	1.21	0.63-2.35	0.568	1.06	0.53-2.11	0.871	0.264
Cold office temperature	Ref.	**2.43**	**1.02-5.79**	**0.045**	**4.17**	**1.82-9.57**	**0.001**	**0.000**
Computer displayer not in front	Ref.	1.05	0.62-1.77	0.867	**2.05**	**1.22-3.44**	**0.007**	**0.005**
Computer use ≥8 h/d	Ref.	1.23	0.75-2.02	0.409	1.04	0.63-1.73	0.879	0.312
Male:								
Age (yrs)	Ref.	**0.91**	**0.84-1.00**	**0.045**	0.98	0.91-1.05	0.542	0.838
BMI[†] (kg/m^2)	Ref.	1.07	0.92-1.24	0.373	0.98	0.86-1.12	0.797	0.450
Bachelor or more	Ref.	0.63	0.25-1.59	0.326	**0.39**	**0.16-0.93**	**0.034**	0.092
Married	Ref.	0.91	0.32-2.63	0.863	1.30	0.44-3.84	0.633	0.144
Low back injury	Ref.	**7.24**	**1.30-40.20**	**0.024**	**5.78**	**1.07-31.07**	**0.041**	0.053
Work years ≥5 yrs	Ref.	2.74	0.95-7.86	0.062	2.33	0.78-7.00	0.132	0.203
Cold office temperature	Ref.	1.45	0.33-6.50	0.624	2.14	0.53-8.65	0.286	0.629
Computer displayer not in front	Ref.	0.44	0.18-1.09	0.077	1.29	0.57-2.92	0.541	0.144
Computer use ≥8 h/d	Ref.	1.41	0.64-3.13	0.394	0.71	0.31-1.64	0.425	0.180
Female:								
Age (yrs)	Ref.	0.98	0.91-1.05	0.501	1.03	0.96-1.10	0.438	0.574
BMI[†] (kg/m^2)	Ref.	1.03	0.92-1.15	0.669	1.03	0.91-1.16	0.626	0.476
Bachelor or more	Ref.	0.82	0.39-1.72	0.601	0.79	0.37-1.68	0.540	0.737
Married	Ref.	**3.31**	**1.34-8.16**	**0.009**	**3.50**	**1.39-8.81**	**0.008**	**0.001**
Low back injury	Ref.	0.92	0.19-4.60	0.921	**4.21**	**1.18-15.04**	**0.027**	**0.002**
Work years ≥5 yrs	Ref.	0.61	0.24-1.54	0.292	0.57	0.22-1.46	0.240	0.594
Cold office temperature	Ref.	2.88	0.92-8.98	0.069	**5.35**	**1.79-16.03**	**0.003**	**0.000**
Computer displayer not in front	Ref.	1.93	0.96-3.90	0.067	**3.22**	**1.58-6.54**	**0.001**	**0.016**
Computer use ≥8 h/d	Ref.	1.08	0.56-2.09	0.816	1.13	0.57-2.23	0.732	0.499

Oswestry low back pain disability index. † OR, odds ratio; CI, confidence interval; BMI, body mass index. ‡ The *p* values for trend were obtained from multiple linear regression models.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	*5-6*
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	*5-6*
		(*b*) Describe any methods used to examine subgroups and interactions	*5-6*
		(*c*) Explain how missing data were addressed	*5-6*
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	*5-6*
		(*e*) Describe any sensitivity analyses	*5-6*
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	5
		(c) Consider use of a flow diagram	ns
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6-7
		(b) Indicate number of participants with missing data for each variable of interest	5
Outcome data	15*	Report numbers of outcome events or summary measures	6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7-11
		(*b*) Report category boundaries when continuous variables were categorized	5
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	ns
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	10
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Risk factors of non-specific neck pain and low back pain in computer-using office workers in China: a cross-sectional study

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Risk factors of non-specific neck pain and low back pain in computer-using office workers in China: a cross-sectional study

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Abstract

Objectives: Several studies have found that inappropriate workstations are associated with musculoskeletal disorders. The present cross-sectional study aimed to identify the risk factors of non-specific neck pain (NP) and low back pain (LBP) among computer-using workers. ***Design:*** Observational study with a cross-sectional sample. ***Setting:*** This study surveyed 15 companies in Zhejiang province, China. ***Participants:*** After excluding participants with missing variables, 417 office workers, including 163 men and 254 women, were analyzed. ***Outcome measures:*** Demographic information was collected by self-report. The standard Northwick Park Neck Pain Questionnaire and Oswestry Low Back Pain Disability Index, along with other relevant questions, were used to assess the presence of potential occupational risk factors and the perceived levels of pain. Multinomial logistic regression analysis, adjusted for age, sex, body mass index, education, marital status, and neck/low back injury, was performed to identify significant risk factors. ***Results:*** Compared with low-level NP, the computer location (monitor not in front) was associated with odds ratios (ORs) of 2.6 and 2.9 for medium- and high-level NP, respectively. For LBP, the computer location (monitor not in front) was associated with an OR of 3.2 for high-level pain, as compared with low-level pain, in females. Significant associations were also observed between the office temperature and LBP (OR: 5.4 for high vs. low), and between office work ≥5 years and NP in female office workers (OR: 2.7 for medium vs. low). ***Conclusions:*** Not having the computer monitor located in front was found to be an important risk factor of NP and LBP in computer-using female workers. This information may not only enable the development of potential preventive strategies but may also provide new insights for designing appropriate workstations.

Strengths and limitations of this study:

▪ This is the first study on the associations of the horizontal location of the computer monitor with neck pain and low back pain in Chinese computer users.

▪ However, most participants were young and recruited via the identification of college alumni, limiting the generalizability of our findings.

▪ Further, this study did not explore the relationships between the exact angle of the computer monitor location and neck pain/low back pain based on objective measurements.

Keywords: Low back disorder; Computer use; Musculoskeletal pain; White-collar worker; Self-reported questionnaire.

Introduction

Non-specific neck pain (NP) and low back pain (LBP) are highly common musculoskeletal disorders and the leading causes of disability worldwide[1]. It has been well established that NP and LBP are not only risk factors of severe spine problems and functional disability, but that they are also associated with decreased quality of life and productivity of workers[2]. Of note, although NP and LBP are musculoskeletal conditions affecting different body parts, they generally have similar symptoms, hazards, and etiology[3].

The risk factors of NP or LBP are commonly multidimensional, including muscular, skeletal, and nervous system-related factors. Further, they can be both modifiable and non-modifiable, and can be divided into individual and occupational factors. Individual factors related to NP and/or LBP include, among others, sex, age, history of neck/low back injury, and psychological factors (e.g., mental stress, anxiety, depression, and lack of social support) [4 5]. In addition, some studies have also indicated that occupational factors, including prolonged sedentary or office work hours, high work load/demands, and inappropriate workstation designs, are associated with NP and/or LBP [6-8].

Sedentary or office workers in schools, hospitals, and the military have been observed to have high incidences and prevalence of NP and LBP[9-11]. This might be caused by their prolonged sitting time and specific body postures, such as inappropriate neck or low back flexion or rotation, as well as other workplace environmental factors[12]. However, the current literature on modifiable determinants of NP/LBP among office workers in modern workplace environments, where intensive computer use is common, is insufficient[13]. Thus, the present study aimed to explore the associations of occupational risk factors with NP and LBP in computer-using office workers.

Methods

Participants

This cross-sectional study was conducted in 15 financial organizations in Zhejiang, China. A total of 425 office workers, aged 18-59 years, were recruited and investigated based on cluster sampling from September to December 2015, via the identification of alumni of Zhejiang Financial College. All participants provided informed consent before participating in the study. After excluding participants with missing individual and/or occupational information (n=8), 417 participants were included in the final analysis. The study was approved by the Institutional Review Board of Zhejiang Financial College.

Data collection and variable definitions

Data were collected using mailed questionnaires, which included the Northwick Park Neck Pain Questionnaire (NPQ)[14] and the Oswestry Low Back Pain Disability Index (ODI)[15] to measure NP and LBP, respectively[16]. In addition, individual and demographic information, including sex, age, height, weight, education, marital status, and history of general neck/low back injuries, was collected by a questionnaire. Based on previous literature and a pre-survey, the potential occupational risk factors (e.g., years of office work at current job, office temperature, location of the computer monitor, and duration of computer use per day) were determined by self-report. Participants with non-specific NP or LBP were defined by a self-rated value of the NPQ or ODI of >0. Body mass index (BMI) was calculated as the weight (kg) divided by the squared height (m^2). All data were double-entered and checked with Epidata 3.1.

Statistical analysis

First, we classified the values of the NPQ and ODI into tertiles (low: ODI<0.19 and NPQ<0.25, medium: 0.19≤ODI<0.24 and 0.25≤NPQ<0.34, and high: ODI≥0.24 and NPQ≥0.34). To test the differences in the categorical variables according to the NPQ or ODI results, the Chi-square test or Fisher's exact test was used if the cell number was <5, while ANOVA was used for continuous variables. Independent associations of occupational variables with the NPQ or ODI tertiles were analyzed using multinomial logistic or linear regression models in the total participants and stratified by sex, because significant interactions between sex and the occupational variables were observed in the present study. The results are presented as odds ratios (ORs) with 95% confidence intervals (CIs). A sensitivity analysis was conducted by including participants with missing variables, encoded as the mean for continuous variables and mode for categorical variables. All statistical analyses were conducted with IBM SPSS 20.0 (IBM Corporation, New York, USA). Statistical significance was defined as p<0.05.

Results

The characteristics of the participants are shown in Table 1. The mean age was 29.1 (±6.8) years. The point prevalence rates of NP and LBP (mild to severe levels of pain) were 86.3% and 75.5%, respectively; 71.5% of participants reported both NP and LBP. The differences in sex, marital status, history of neck injury, and office temperature among the NPQ tertiles were significant (p<0.05). Similarly, the differences in marital status, history of low back injury, office temperature, and location of the computer monitor significantly differed among the ODI tertiles (p<0.05).

Table 2 shows the results of the multinomial logistic and linear regression analyses of individual and occupational factors related to NP. In the total participants, compared with the low NPQ tertile, office work ≥5 years, sex, history of neck injury, and having the computer monitor not located in front (i.e. on the right or left side of the operator) were significantly associated with the high NPQ tertile after adjusting for age, BMI, education, and marital status. Significant linear associations of NP (as a continuous variable) with female sex, neck injury, cold office temperature, and the computer monitor not located in front were also observed ($p<0.05$). Among the male participants, no significant associations were observed between occupational factors and the NPQ tertiles in the linear regression model, except for neck injury. In females, having the computer monitor not located in front and cold office temperature were significant risk factors for both the medium and high NPQ tertiles, while office work ≥5 years (vs. <5 years) was a significant risk factor for the medium, but not the high, NPQ tertile ($p>0.05$).

The results of the multinomial logistic and linear regression analyses for LBP are presented in Table 3. In the total participants, compared with the low ODI tertile, married status, history of low back injury, cold office temperature, and the computer monitor not located in front were significant risk factors for LBP after adjusting for age, BMI, sex, and education. In males, age, history of low back injury, and education were significant risk factors for LBP, while no significant associations were observed between occupational factors and the ODI tertiles. In females, married status, low back injury, cold office temperature, and not having the computer monitor in front were significantly related to higher levels of LBP. Additionally, the results showed no significant differences between the included and excluded participants with missing variables.

Discussion

In the present study, having the computer monitor not located in front (i.e. on the right or left side), cold office temperature, and office work ≥5 years were significantly associated with non-specific NP and/or LBP after controlling for age, BMI, sex, education, marital status, and history of neck/low back injury. These results may have significance for developing prevention or intervention strategies against non-specific NP and LBP in computer-using office workers.

Previous researches on the associations of specific adjustable behavioral or occupational factors among intensive computer-using office workers with non-specific NP/LBP are scarce, although epidemiological evidence of a correlation between computer-using time and NP/LBP has been well established [6 17 18]. A few studies have indicated that psychosocial stress, long work hours, poor social support, and neck/low back flexion/bending in the workplace might be occupational risk factors[7 8 12]. Paksaichol et al. indicated that improper height (vertical level) of computer monitors might be an indirect risk factor associated with NP[19]. However, to our knowledge, few studies have indicated that the location of the computer monitor (horizontal level) is an important risk factor of non-specific NP/LBP. Prolonged and repeated body trunk over-rotation/flexion might cause non-specific NP/LBP by damaging the musculoskeletal system of the neck or low back[20 21], as the individual needs to turn around to face the computer monitor if it is not located directly in front. Especially, many workstations in various organizations and companies are multifaceted, requiring the office workers or operators to rotate their body/trunk continuously while working. These results provide a direction for future workstation designs in related industries.

In addition, it has been well established that cold stimulation is a risk factor of musculoskeletal pain[22-24]. Our study also found that there was an association between cold office temperature and non-specific NP and LBP, providing further evidence for this possible causal relationship. However, there might be reciprocal causation between these two variables, with individuals with NP and LBP potentially being much more susceptible to cold environments (lower office temperature) or experiencing enhanced perceived pain via their sensory nerves[25]. Conversely, it can be speculated that a warm office temperature might be associated with less non-specific NP and LBP among intensive computer users or sedentary workers.

In this study, we further found that longer work years and injuries of the neck/low back were associated with both non-specific NP and LBP, as were female sex and married status. These results are consistent with those of previous studies[6-8]. Women are known to have a higher prevalence of NP/LBP and to be more susceptible to environmental risk factors than men. This might be due to their physical inactivity, lower bone mineral density, and specific anatomical structure [26-28]. The reason why BMI, education, and computer-using time were not significantly associated with NP/LBP may be because of the narrow distribution of these variables in our limited study sample. Our participants were younger (85% of the participants were aged <35 years) than the general industrial workers in China, and it is difficult to determine whether there is statistical significance based on variables with such a narrow distribution.

There were some limitations in this study that need to be acknowledged. Due to the cross-sectional design of the study and the relative small sample size, we were unable to detect the causality and other potential risk factors. Meanwhile, as mentioned above, most participants were young and comprised intensive computer users and financial office workers. Thus, care must be taken when generalizing our results to other populations. Lastly, the use of a self-reported questionnaire might generate systematic bias. However, although physical factors can be assessed objectively, most previous studies used self-reported questionnaires for measuring non-specific pain and individual or environmental factors[5 7 8 29]. Nevertheless, in this study, we assessed and verified the significance of various occupational and environmental risk factors, including the location of the computer monitor and the office temperature, for non-specific NP/LBP. These findings are important for modern office workers, especially for those who are intensive computer users.

Conclusions

Having the computer monitor located not in front (i.e. on the left or right side) of the operator and cold office temperature are modifiable occupational risk factors of non-specific NP and LBP in computer-using office workers. Additionally, a history of neck/low back injury, longer office work years, female sex, and married status were also identified as important occupational or individual factors associated with NP/LBP. Accordingly, our results indicate that ensuring proper horizontal position of the computer monitor and maintaining a relative warm office environment are important for preventing NP and LBP, especially in neck- and/or back-injured female office workers with intensive computer use. Further prospective studies using objective measurements of work-related body posture and repetitiveness are required to confirm our findings.

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Table 1 Characteristics of Chinese office workers stratified by the presence of neck pain or low back pain

Variables	Total n=417	Northwick Park Questionnaire Low n=149	Medium n=137	High n=131	$p^{\#}$	The Oswestry Disability Index Low n=162	Medium n=121	High n=134	$p^{\#}$
Individual variables:									
Gender (n, %)									
Male	163(39.1)	74(49.7)	53(38.7)	36(27.5)	0.001	74(45.7)	45(37.2)	44(32.8)	0.069
Female	254(60.9)	75(50.3)	84(61.3)	95(72.5)		88(54.3)	76(62.8)	90(67.2)	
Age (years)	29.1(6.8)	29.1(7.1)	28.3(7.1)	30.0(6.0)	0.119	28.8(7.4)	28.3(5.2)	30.2(7.3)	0.062
Height (cm)	165.9(11.1)	166.7(15.8)	166.2(6.8)	164.6(7.7)	0.289	165.9(15.1)	166.2(7.5)	165.6(7.6)	0.907
Weight (kg)	58.0(12.4)	59.3(13.4)	57.7(11.2)	56.8(12.3)	0.236	57.9(13.3)	58.4(11.4)	57.9(12.2)	0.938
Body mass index (kg/m^2)	20.9(3.4)	21.1(3.3)	20.8(3.3)	20.8(3.5)	0.766	20.8(3.7)	21.0(2.9)	21.0(3.4)	0.841
Education (n, %)									
College or less	117(28.1)	35(23.5)	37(27.0)	45(34.4)	0.123	38(23.5)	34(28.1)	45(33.6)	0.155
Bachelor or more	300(71.9)	114(76.5)	101(73.0)	87(65.7)		124(76.5)	87(71.9)	89(66.4)	
Marriage (n, %)									
Married or other	235(56.4)	67(45.0)	70(51.1)	45(34.4)	0.020	83(51.2)	53(43.8)	46(34.3)	0.014
Unmarried	182(43.7)	82(55.0)	67(48.9)	86(65.7)		79(48.8)	68(56.2)	88(65.7)	
Neck injury (n, %)	14(3.4)	1(0.7)	5(3.7)	8(6.1)	0.028	-	-	-	-
Low back injury (n, %)	-	-	-	-	-	6(3.7)	11(9.1)	20(14.9)	0.003
Work related variables:									
Work years (n, %)									
<5 years	204(48.9)	80(53.7)	70(51.1)	54(41.2)	0.094	88(54.3)	60(49.6)	56(41.8)	0.098
≥5 years	213(51.1)	69(46.3)	67(48.9)	77(58.8)		74(45.7)	61(50.4)	78(58.2)	
Office temperature (n, %)									
Cold	52(12.5)	12(8.1)	16(11.7)	24(18.3)	0.033	9(5.6)	16(13.2)	27(20.2)	0.001
Median or hot	365(87.5)	137(92.0)	121(88.3)	107(81.7)		153(94.4)	105(86.8)	107(79.9)	
Location of computer displayer (n, %)									
In front	265(63.6)	105(70.5)	86(62.8)	74(56.5)	0.051	113(69.8)	81(66.9)	71(53.0)	0.008
Not in front	152(36.5)	44(29.5)	52(37.2)	57(43.5)		49(30.3)	40(33.1)	63(47.0)	
Computer-using time (n, %)									
<8 hours	203(48.7)	80(53.7)	62(45.3)	61(46.6)	0.305	86(53.1)	55(45.5)	62(46.3)	0.354
≥8 hours	214(51.3)	69(46.3)	75(54.7)	70(53.4)		76(46.9)	66(54.6)	72(53.7)	

Pearson Chi-square test for categorical variables, ANOVA for continuous variables, or Fisher's exact test for categorical variables if the number of cells was <5.

Table 2 Multinomial logistic regression models for correlates of neck pain

Variables/NPQ#	Low	Medium			High			*p* value for trend‡
		OR†	95%CI†	*p* value	*OR*†	95%CI†	*p* value	
Total participants:								
Age (yrs)	Ref.	0.97	0.92-1.02	0.18	0.99	0.94-1.04	0.768	0.541
BMI† (kg/m^2)	Ref.	1.01	0.93-1.10	0.80	1.01	0.92-1.10	0.901	0.868
Male	Ref.	0.60	0.35-1.03	0.06	**0.36**	**0.20-0.64**	**0.001**	**0.000**
Bachelor or more	Ref.	0.90	0.52-1.58	0.72	0.69	0.39-1.22	0.201	0.344
Married	Ref.	0.66	0.35-1.26	0.21	1.20	0.61-2.36	0.604	0.425
Neck injury	Ref.	7.88	0.85-73.31	0.07	**9.61**	**1.06-87.52**	**0.045**	**0.006**
Work years ≥5 yrs	Ref.	**2.01**	**1.04-3.88**	**0.04**	1.76	0.88-3.53	0.110	0.088
Cold office temperature	Ref.	1.05	0.46-2.38	0.92	1.87	0.85-4.14	0.122	**0.011**
Computer displayer not in front	Ref.	1.41	0.84-2.35	0.19	**1.99**	**1.17-3.40**	**0.011**	**0.001**
Computer use ≥8 h/d	Ref.	1.27	0.78-2.06	0.35	1.02	0.61-1.70	0.956	0.561
Male:								
Age (yrs)	Ref.	1.02	0.95-1.09	0.631	0.95	0.88-1.03	0.183	0.649
BMI† (kg/m^2)	Ref.	1.02	0.90-1.16	0.770	0.98	0.86-1.11	0.707	0.570
Bachelor or more	Ref.	1.51	0.62-3.66	0.360	0.62	0.25-1.56	0.313	0.539
Married	Ref.	0.52	0.19-1.43	0.206	1.02	0.34-3.06	0.974	0.574
Neck injury	Ref.	7.51	0.74-75.67	0.087	7.98	0.67-94.35	0.100	**0.013**
Work years ≥5 yrs	Ref.	1.15	0.42-8.30	0.783	2.67	0.87-8.19	0.087	0.140
Cold office temperature	Ref.	2.02	0.49-8.30	0.332	1.12	0.21-5.86	0.898	0.791
Computer displayer not in front	Ref.	0.66	0.30-1.47	0.311	1.43	0.60-3.39	0.416	0.281
Computer use ≥8 h/d	Ref.	1.24	0.59-2.60	0.573	0.53	0.22-1.30	0.168	0.078
*Female**:								
Age (yrs)	Ref.	0.94	0.86-1.02	0.112	1.03	0.95-1.11	0.509	0.150
BMI† (kg/m^2)	Ref.	1.01	0.90-1.13	0.889	1.03	0.91-1.16	0.673	0.420
Bachelor or more	Ref.	0.66	0.31-1.43	0.295	0.58	0.27-1.26	0.169	0.365
Married	Ref.	0.81	0.34-1.97	0.645	1.41	0.58-3.44	0.447	0.168
Work years ≥5 yrs	Ref.	**2.71**	**1.05-6.96**	**0.039**	1.52	0.59-3.93	0.385	0.378
Cold office temperature	Ref.	0.79	0.28-2.24	0.653	2.06	0.80-5.31	0.135	**0.010**
Computer displayer not in front	Ref.	**2.59**	**1.26-5.34**	**0.010**	**2.94**	**1.41-6.11**	**0.004**	**0.001**
Computer use ≥8 h/d	Ref.	1.39	0.70-2.66	0.356	1.36	0.70-2.67	0.367	0.714

Northwick Park Neck Pain Questionnaire. * The variable of neck injury was excluded from the female regression model because there were no participants in the low NPQ tertile. † OR, odds ratio; CI, confidence interval; BMI, body mass index. ‡ The *p* values for trend were obtained from multiple linear regression models.

Table 3 Multinomial logistic regression models for correlates of low back pain

Variables/ODI#	Low	Medium			High			*p* value for trend‡
		OR†	95%CI†	*p* value	*OR*†	95%CI†	*p* value	
Total participants:								
Age (yrs)	Ref.	0.95	0.90-1.00	0.067	1.01	0.96-1.06	0.848	0.740
BMI† (kg/m^2)	Ref.	1.04	0.95-1.14	0.377	1.01	0.92-1.10	0.858	0.269
Male	Ref.	0.72	0.42-1.25	0.239	0.59	0.34-1.04	0.066	0.241
Bachelor or more	Ref.	0.77	0.44-1.35	0.362	0.64	0.37-1.12	0.122	0.626
Married	Ref.	1.65	0.86-3.16	0.129	**2.08**	**1.06-4.08**	**0.034**	**0.000**
Low back injury	Ref.	2.12	0.73-6.20	0.169	**4.36**	**1.65-11.71**	**0.003**	**0.000**
Work years ≥5 yrs	Ref.	1.21	0.63-2.35	0.568	1.06	0.53-2.11	0.871	0.264
Cold office temperature	Ref.	**2.43**	**1.02-5.79**	**0.045**	**4.17**	**1.82-9.57**	**0.001**	**0.000**
Computer displayer not in front	Ref.	1.05	0.62-1.77	0.867	**2.05**	**1.22-3.44**	**0.007**	**0.005**
Computer use ≥8 h/d	Ref.	1.23	0.75-2.02	0.409	1.04	0.63-1.73	0.879	0.312
Male:								
Age (yrs)	Ref.	**0.91**	**0.84-1.00**	**0.045**	0.98	0.91-1.05	0.542	0.838
BMI† (kg/m^2)	Ref.	1.07	0.92-1.24	0.373	0.98	0.86-1.12	0.797	0.450
Bachelor or more	Ref.	0.63	0.25-1.59	0.326	**0.39**	**0.16-0.93**	**0.034**	0.092
Married	Ref.	0.91	0.32-2.63	0.863	1.30	0.44-3.84	0.633	0.144
Low back injury	Ref.	**7.24**	**1.30-40.20**	**0.024**	**5.78**	**1.07-31.07**	**0.041**	0.053
Work years ≥5 yrs	Ref.	2.74	0.95-7.86	0.062	2.33	0.78-7.00	0.132	0.203
Cold office temperature	Ref.	1.45	0.33-6.50	0.624	2.14	0.53-8.65	0.286	0.629
Computer displayer not in front	Ref.	0.44	0.18-1.09	0.077	1.29	0.57-2.92	0.541	0.144
Computer use ≥8 h/d	Ref.	1.41	0.64-3.13	0.394	0.71	0.31-1.64	0.425	0.180
Female:								
Age (yrs)	Ref.	0.98	0.91-1.05	0.501	1.03	0.96-1.10	0.438	0.574
BMI† (kg/m^2)	Ref.	1.03	0.92-1.15	0.669	1.03	0.91-1.16	0.626	0.476
Bachelor or more	Ref.	0.82	0.39-1.72	0.601	0.79	0.37-1.68	0.540	0.737
Married	Ref.	**3.31**	**1.34-8.16**	**0.009**	**3.50**	**1.39-8.81**	**0.008**	**0.001**
Low back injury	Ref.	0.92	0.19-4.60	0.921	**4.21**	**1.18-15.04**	**0.027**	**0.002**
Work years ≥5 yrs	Ref.	0.61	0.24-1.54	0.292	0.57	0.22-1.46	0.240	0.594
Cold office temperature	Ref.	2.88	0.92-8.98	0.069	**5.35**	**1.79-16.03**	**0.003**	**0.000**
Computer displayer not in front	Ref.	1.93	0.96-3.90	0.067	**3.22**	**1.58-6.54**	**0.001**	**0.016**
Computer use ≥8 h/d	Ref.	1.08	0.56-2.09	0.816	1.13	0.57-2.23	0.732	0.499

Oswestry low back pain disability index. † OR, odds ratio; CI, confidence interval; BMI, body mass index. ‡ The *p* values for trend were obtained from multiple linear regression models.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	*5-6*
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	*5-6*
		(*b*) Describe any methods used to examine subgroups and interactions	*5-6*
		(*c*) Explain how missing data were addressed	*5-6*
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	*5-6*
		(*e*) Describe any sensitivity analyses	*5-6*
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	5
		(c) Consider use of a flow diagram	ns
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6-7
		(b) Indicate number of participants with missing data for each variable of interest	5
Outcome data	15*	Report numbers of outcome events or summary measures	6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7-11
		(*b*) Report category boundaries when continuous variables were categorized	5
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	ns
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	10
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.