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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 of the operator, but on the right or left side) was associated with 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 duration ≥5 years and NP in female office workers (OR 2.7 for medium vs low).

Conclusions Not having the computer monitor located in front of the operator was found to be an important risk factor for 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 (NP) and low back pain (LBP) in Chinese computer users.
- Most participants were young and recruited via the identification of college alumni, limiting the generalisability of our findings.
- This study did not explore the relationships between the exact angle of the computer monitor location and NP/LBP based on objective measurements.

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 for 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 aetiology.[3]

The risk factors for 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 (eg, 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 a high incidence 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 organisations 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 (eg, 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 >0. Body mass index (BMI) was calculated as the weight (kg) divided by the height squared (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 χ^2 test or Fisher's exact test was used if the cell number was <5, while analysis of variance (ANOVA) was used for continuous variables. Independent associations of occupational variables with the NPQ or ODI tertiles were analysed 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 ORs with 95% 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 Corp, 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. Among the total participants, compared with the low NPQ tertile, office work duration ≥5 years, sex, history of neck injury, and having the computer monitor not located in front (ie, 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. Among the females participants, 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 duration ≥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. Among 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. Among the male participants, 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. Among the female participants, 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.

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				The Oswestry Disability Index			
		Low n=149	Medium n=137	High n=131	p Value*	Low n=162	Medium n=121	High n=134	p Value*
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
BMI (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 χ^2 test for categorical variables, ANOVA for continuous variables, or Fisher's exact test for categorical variables if the number of cells was <5.
ANOVA, analysis of variance; BMI, body mass index.

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

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

DISCUSSION

In the present study, having the computer monitor not located in front of the operator (ie, on the right or left side), cold office temperature and office work duration ≥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 research on the associations of specific adjustable behavioural 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/

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 (years)	Ref.	0.95	0.90 to 1.00	0.067	1.01	0.96 to 1.06	0.848	0.740
BMI (kg/m^2)	Ref.	1.04	0.95 to 1.14	0.377	1.01	0.92 to 1.10	0.858	0.269
Male	Ref.	0.72	0.42 to 1.25	0.239	0.59	0.34 to 1.04	0.066	0.241
Bachelor or more	Ref.	0.77	0.44 to 1.35	0.362	0.64	0.37 to 1.12	0.122	0.626
Married	Ref.	1.65	0.86 to 3.16	0.129	2.08	1.06 to 4.08	0.034	0.000
Low back injury	Ref.	2.12	0.73 to 6.20	0.169	4.36	1.65 to 11.71	0.003	0.000
Work years ≥5 years	Ref.	1.21	0.63 to 2.35	0.568	1.06	0.53 to 2.11	0.871	0.264
Cold office temperature	Ref.	2.43	1.02 to 5.79	0.045	4.17	1.82 to 9.57	0.001	0.000
Computer displayer not in front	Ref.	1.05	0.62 to 1.77	0.867	2.05	1.22 to 3.44	0.007	0.005
Computer use ≥8 hours/day	Ref.	1.23	0.75 to 2.02	0.409	1.04	0.63 to 1.73	0.879	0.312
Male								
Age (years)	Ref.	0.91	0.84 to 1.00	0.045	0.98	0.91 to 1.05	0.542	0.838
BMI (kg/m^2)	Ref.	1.07	0.92 to 1.24	0.373	0.98	0.86 to 1.12	0.797	0.450
Bachelor or more	Ref.	0.63	0.25 to 1.59	0.326	0.39	0.16 to 0.93	0.034	0.092
Married	Ref.	0.91	0.32 to 2.63	0.863	1.30	0.44 to 3.84	0.633	0.144
Low back injury	Ref.	7.24	1.30 to 40.20	0.024	5.78	1.07 to 31.07	0.041	0.053
Work years ≥5 years	Ref.	2.74	0.95 to 7.86	0.062	2.33	0.78 to 7.00	0.132	0.203
Cold office temperature	Ref.	1.45	0.33 to 6.50	0.624	2.14	0.53 to 8.65	0.286	0.629
Computer displayer not in front	Ref.	0.44	0.18 to 1.09	0.077	1.29	0.57 to 2.92	0.541	0.144
Computer use ≥8 hours/day	Ref.	1.41	0.64 to 3.13	0.394	0.71	0.31 to 1.64	0.425	0.180
Female								
Age (years)	Ref.	0.98	0.91 to 1.05	0.501	1.03	0.96 to 1.10	0.438	0.574
BMI (kg/m^2)	Ref.	1.03	0.92 to 1.15	0.669	1.03	0.91 to 1.16	0.626	0.476
Bachelor or more	Ref.	0.82	0.39 to 1.72	0.601	0.79	0.37 to 1.68	0.540	0.737
Married	Ref.	3.31	1.34 to 8.16	0.009	3.50	1.39 to 8.81	0.008	0.001
Low back injury	Ref.	0.92	0.19 to 4.60	0.921	4.21	1.18 to 15.04	0.027	0.002
Work years ≥5 years	Ref.	0.61	0.24 to 1.54	0.292	0.57	0.22 to 1.46	0.240	0.594
Cold office temperature	Ref.	2.88	0.92 to 8.98	0.069	5.35	1.79 to 16.03	0.003	0.000
Computer displayer not in front	Ref.	1.93	0.96 to 3.90	0.067	3.22	1.586.54	0.001	0.016
Computer use ≥8 hours/day	Ref.	1.08	0.56 to 2.09	0.816	1.13	0.57 to 2.23	0.732	0.499

*The p values for trend were obtained from multiple linear regression models.
BMI, body mass index; ODI, Oswestry Low Back Pain Disability Index.

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. Many workstations in various organisations 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 for 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 generalising 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 (ie, on the left or right side) of the operator and cold office temperature are modifiable occupational risk factors for 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 positioning 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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Contributors SY constructed the questionnaire, performed the final statistical analyses and prepared the first version of manuscript. QJ and JL collected the data. CW critically reviewed, commented and revised the manuscript. All authors were responsible and approved the final manuscript.

Competing interests None declared.

Patient consent Obtained.

Ethics approval Zhejiang Financial Colleges Institutional Review Board.

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