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Article

Work Ergonomic Hazards for Musculoskeletal Pain among University Office Workers

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Abstract

This cross-sectional analytic study aimed to investigate ergonomic hazards in the workplace for musculoskeletal pain among university office workers. There were 142 full-time office staff from Khon Kaen University. Demographic characteristics and musculoskeletal pain were evaluated from a structured questionnaire. Ergonomic workstations, i.e. size of table, seat, work area and illuminations were measured at the workstations and anthropometric parameters were determined. Descriptive statistics were used for data analysis which were percentage, mean, and standard deviation. Inferential statistics were chi-square test and the student t-test at 95 % confidence interval. The results showed that 81.7 % of office workers were female, the mean age was 38.0 ± 10.0 years, the average work experience was 12.3 ± 10.8 years. One-month prevalence of musculoskeletal pain was 69.0 %. The onset of symptoms was during working hours and the majorly reported the cause as prolonged sitting in the same posture at work (73.3 %). From measurements, 55.8 % of all workstations had insufficient illumination being lower than the minimum standard requirement (400 lux). Most workstations (75.6 %) had significantly inappropriate height (above elbow height of workers) at $p < 0.001$. From questionnaires, the seat height was significantly associated with musculoskeletal pain ($p = 0.034$). Moreover, anthropometric characteristics of musculoskeletal pain cases (i.e. buttock-popliteal length, hip breadth, sitting elbow height) were significantly different from healthy office workers ($p < 0.05$). The findings suggest that ergonomic workstations need to be improved appropriately for individual workers and improvements in working conditions following standard requirements should be considered.

Keywords: Musculoskeletal pain, office workers, ergonomic

Introduction

Persisting musculoskeletal pain is common in society. 70 - 85 % of all people have low-back pain at some time in their life. The annual prevalence of back pain in general ranges from 15 to 45 % with point prevalence averaging 45 % [1]. Neck and shoulder disorders are prevalent among both women and men. It has been reported that the prevalence of neck or shoulder pain in office workers is much higher than in the general population [2,3]. Previous studies showed that one year prevalence of neck pain in office workers at Hong Kong University was found to be 59 % [2] and 63 % in a Swedish study of medical secretaries [3]. One year prevalence of low back pain among Greek public office workers was 37.8 % [4]. For back pain prevalence in academic personnel, it was 21.8 % among school personnel in Nagoya, Japan [5]. Some studies have investigated the relationship between musculoskeletal pain and risk factors due to working conditions. Postulated

factors in the occupation group include: individual factors [1,2], anthropometric and ergonomic factors (workstations and instruments, lifting, repetitive work), physical factors (prolonged sitting, awkward posture, twisting and bending of the trunk) [4,6], psychosocial factor i.e. stress [7] and perceived muscular tension [6]. While the prevalence of back pain is quite high in university office workers, it is unclear which environmental factors relate to back pain [8]. Therefore, the objective of this study is to investigate ergonomic hazards in the workplace for musculoskeletal pain among university office workers.

Materials and methods

This study was designed as a cross-sectional analytic investigation of 142 university office staff (116 women and 26 men). The participants were invited and interviewed before entering into this study. They were considered eligible for inclusion in this study if they were a full-time university employee and had at least one-year work experience in their current position. Participants were excluded if they had chronic musculoskeletal diseases or injuries affecting cervical, thoracic or lumbar spine, renal dysfunction or unwillingness to participate. Participants were interviewed by using a structured questionnaire dealing with demographic characteristics, musculoskeletal pain and the onset of symptoms, and working environment. Here, we define musculoskeletal pain as the pain experienced in the spine area or more specifically between the inferior angle of the scapula and the gluteal folds, or between the buttocks and the vertebrae prominence as detailed by Maniadakis and Gray [9]. Participants reported the region of pain by putting X on the area of a body chart (drawing) where he/she had pain. The severities and causes of pain were evaluated from a questionnaire.

The body weight, height, waist circumference (WC) and anthropometric characteristics were measured using standardized procedures with established reliability [10,11]. Measured anthropometric parameters were popliteal height, hip breadth, buttock-popliteal-length, sitting shoulder height, sitting elbow height and elbow height. Waist circumferences in centimeter (cm) were compared to the standard (80 cm for women and 90 cm for men) to identify obesity in participants [12]. The degree of illumination at all workstations, and data from a previous study [8] which matched all workstations in this study were selected and re-analysed. The standard degree of illumination in the general office workplace was 400 lux [13]. The dimensions of the table, seat and work area were measured at 131 workstations by using a steel measuring tape.

Statistical Analysis

All analyses were performed using STATA version 8.2, Texas, USA. 2007. The percentage of musculoskeletal pain and other parameters were calculated proportionally. Descriptive statistics were percentages, and mean and standard deviations (SD). The associations between musculoskeletal pain and studied factors were identified by using chi-square test and student t-test at 95 % confidence interval. This study was approved by the appropriate institutional ethical review committee, Khon Kaen University.

Results and discussion

Demographic Characteristics of University Office Workers

Most participants in this study were women (81.7 %). There were 116 women and 26 men. Among the office staff, the mean age was 38 ± 10 years (min = 23 years, max = 59 years). Concerning gender and the age, the mean age of men (40.1 ± 10.9 years) was higher than that of women (37.5 ± 9.8 years). Regarding work experience in their current position, the mean value was 12.3 ± 10.8 years (min = 1 year, max = 39 years). Fifty percent of participants had less than 10 years work experience. Bachelor degree was the major group of educational background (79.6 %) and the minor group was master degree (20.4 %). In terms of marital statuses 51.4 % were single, 40.9 % were married-couple, and 7.7 % were separated/divorced/widowed.

The average body height was 159.2 ± 7.0 cm. Comparison to the standard WC (90 cm for male and 80 cm for female), the mean WC for male officers was 83.6 cm (SD = 8.5) and the mean WC for females officers was 73.9 cm (SD = 9.3). Data in terms of WC shows that most university office workers were not obese. This parameter confirmed no obesity as identified by the body mass index (BMI) in university office workers from a previous study [8]. Most participants (79.6 %) did no

regular exercise (at least 30 min and 3 times a week). These only describe general characteristics of university office workers, the correlations between these factors and musculoskeletal pain are discussed in the next section**.**

Work Environment Factors

To determine work environment hazards, data were collected by both questionnaires and measurements of light intensities, size of table, seat and work area. From questionnaires, participants reported whether they felt their working conditions were appropriate or inappropriate. Regarding illuminations, 77.3 % or 110 participants reported appropriate conditions. The other 22.7 % or 32 participants reported inappropriate conditions which were insufficient light (8 stations) and problems with glare (24 stations). From measurements at 129 workstations, illuminations ranged from 110 lux as the minimum to 823 lux as the maximum and the average value was 388.7 lux (SD = 139.3). Under Thai regulations for Occupational Health and Work Environment, the minimum standard requirement of lighting intensities in an office workplace is 400 lux [13]. However, only 44.2 % workstations had illumination higher than the standard requirement. The problem with glare at workstations was not confirmed by the measurements. However, from observations, participants complained that much of the glare came from sunlight in the morning and the afternoon causing a problem in seeing the computer screen. Based on standards, our results identified unsafe conditions in the university office workplace. No previous studies reported the association between glare or the lack of local lighting and musculoskeletal pain. However, insufficient illuminations might force workers to adopt awkward posture in order to see their work or the screen leading to musculoskeletal pain. For similar reasons, glare may also contribute to musculoskeletal pain in office workers.

For ergonomic workstations, results of size measurements of tables, chairs, and work areas are shown in **Table 1** as values of 5^{th}, 50^{th}, 95^{th} percentile. We compared anthropometric parameters of 131 officers to ergonomic workstations (sitting, 131 workstations). Comparison of the mean height of tables (75.2 ± 1.1 cm) to the mean elbow height (69.5 ± 7.7 cm) showed that the level of 75.6 % workstations were significantly above the recommended level (below or equal the elbow height) for each worker at $p < 0.001$. By self adjustment of workers, 72.5 % of musculoskeletal pain cases reported inappropriate table heights and 56.1 % of cases reported inappropriate seat heights (**Table 2**). Results of the comparison between the mean height of seats and the popliteal height of participants were height-adjustable seat. The mean values of seat width, depth and backrest height were significantly different from hip breadth, buttock-popliteal length, and sitting shoulder height of workers, respectively (**Table 1**). However, these differences indicated the dimension-adjustable to average anthropometric characteristics of all workers by following the guideline of Anthropometry [10] and OSHA [14].

Considering an appropriate size for all office workers, chair height (5^{th} percentile = 37.8 ± 4.3 cm) was appropriate to the participant's popliteal height (5^{th} percentile = 37.6 ± 4.6 cm). Individually the levels of most workstations (75.6 %) were higher than the elbow height of workers. This optimized ergonomic workstation for individual workers may contribute to the incidence of musculoskeletal pain. The sizes of the tables and chairs shown in this study were the average values, however, an individual fitting was confirmed for the table height.

Table 1 Results of dimension measurements of workstations (n = 131) and anthropometric parameters of office workers (n = 131).

Workstation/ Body size	Dimension Parameters	Size (cm)				*p*-value
		5th percentile	50th percentile	95th percentile	SD	
Seat	Height (a)	37.8	44.9	52.0	4.3	
	Width (b)	41.5	46.6	51.7	3.1	
	Depth (c)	39.0	43.8	48.6	2.9	
	Backrest height (d)	39.0	49.4	59.8	6.3	
Table	Height (e)	73.4	75.2	77.0	1.1	
	Width	67.6	159.1	250.6	55.6	
	Depth	54.2	71.5	88.8	10.5	
Workspace	Width	22.0	114.4	206.8	56.2	
	Depth	25.0	52.8	80.6	16.9	
Body	Popliteal height (g)	37.6	45.2	52.8	4.6	0.697^{A}
	Hip Breadth (h)	30.1	37.5	44.9	4.5	$< 0.001^{B}$
	Buttock-popliteal length(i)	34.6	45.8	57.0	6.8	$< 0.001^{C}$
	Sitting shoulder height (j)	43.5	53.2	62.9	5.9	$< 0.001^{D}$
	Elbow height (k)	56.8	69.5	82.2	7.7	$< 0.001^{E}$
	Sitting elbow height	15.9	24.3	32.7	5.1	

A: non-significant difference between 5th percentile of seat height (a) and popliteal height (g) at *p*-value = 0.697.
B: significant difference between 95th percentile of seat width (b) and hip breadth (h) at *p*-value < 0.001.
C: significant difference between 95th percentile of seat depth (c) and buttock-popliteal length (i) at *p*-value < 0.001.
D: significant difference between 95th percentile of backrest height (d) and sitting shoulder height (j) at *p*-value < 0.001.
E: significant difference between 50th percentile of table height (e) and elbow height (k) at *p*-value < 0.001.

Table 2 Factors related to musculoskeletal pain among 142 university office workers.

Variables	Musculoskeletal pain		*p*-value
	Yes [n (%)]	No [n (%)]	
Gender			0.167
Male	15 (57.3)	11 (42.7)	
Female	83 (71.6)	33 (29.4)	
Exercise			0.371
Yes	22 (75.9)	7 (24.1)	
No	76 (67.3)	37 (32.7)	
Table height (by questionnaires)			0.472
Inappropriate	35 (72.5)	13 (27.5)	
Appropriate	63 (67.0)	31 (23.0)	
Seat height (by questionnaires)			0.034
Inappropriate	23 (56.1)	18 (43.9)	
Appropriate	75 (74.3)	26 (25.7)	
Illumination (129 workstations)			
< 400 lux	51 (70.8)	21 (29.2)	0.473
≥ 400 lux	37 (64.9)	20 (35.1)	

The Prevalence of Musculoskeletal Pain

This study recorded one-month prevalence of musculoskeletal pain at 69 % or 98 cases from 142 university staff. Among the 98 cases of musculoskeletal pain, there were 51 % of office workers suffering from pain at the time of answering the questionnaire. The characteristics of pain attacks were mostly defined as muscle fatigue (63.4 %) and the frequencies of pain were 3 - 4 times per week (39.2 %), once a week (33 %) and every day (20.6 %). About 7 % of office workers complained of constant pain. The highest proportion of the severity was mild pain (60.4 %) followed by moderate pain (31.7 %).

Most reported the cause of musculoskeletal pain as prolonged sitting in the same posture at work (73.3 %) followed by lifting or handling heavy materials (37.6 %), stress (27.7 %) and bending forward or twisting of the trunk (18.8 %), respectively. The attack of musculoskeletal pain did not limit the daily activities of most officers (64.3 %). There were nearly no sick absences because of musculoskeletal pain (12.0 %). The musculoskeletal pain started after 58.1 min long sitting (SD = 55.6), 43.8 min long standing (SD = 30.4) and 53.1 min long walking (SD = 36.6). Regarding the time, about 21 % of office workers had pain attacks after 6 h of work. Importantly, over 60 % of office workers suffered from musculoskeletal pain during work hours and 31.1 % of office workers had pain attacks after work. Among musculoskeletal pain cases, most of them did not have to lift materials heavier than 20 kg each day (86.2 %) or did not have to drive more than 2 h long (78.2 %).

When cases were asked about the treatment, pain reliefs by massage (53.2 %), changing posture (49.3 %), having a rest (27.5 %) and doing exercise (25.4 %) were reported. The postures to relieve the pain were trunk extension and bending the trunk backward (66.2 %), supine lying (33.1 %), and bending the trunk forward (26.1 %). The mostly common behaviors during prolonged sitting at work (≥ 2 h) were upper body movement for some time (64.1 %), standing up to walk every hour (37.3 %), and postural change every 30 min (37.3 %). Considering the prevalence and causes, our results confirm the adverse health effects for office workers as in previous studies [9,15]. The onset of musculoskeletal pain during working hours may identify work-related musculoskeletal pain in this study.

Risk Factors and Musculoskeletal Pain among University Office Workers

The analyses did not show significant associations of musculoskeletal pain to individual factors (age, gender, work experience, waist circumference and exercise) as in several previous studies [1,2,16,17] (**Table 2** and **3**). An interesting finding was that there was a higher proportion of musculoskeletal pain in women (71.6 %) than in men (57.3 %) in this study. One suggestion from the results is that a design of bigger sample size might be helpful for more powerful statistical analysis. The major causes of musculoskeletal pain which were prolonged sitting in the same posture, bending forward or twisting a trunk reported by cases may contribute to work-related musculoskeletal pain. The results supported the previous reports of occupational risk factors of musculoskeletal disorders among office workers [4,6,18]. Obviously, the correlation of work-related factors to the onset of musculoskeletal pain might be identified clearly by following up cases in a prospective cohort study.

Concerning work conditions, the analysis did not indicate a significant relationship between illuminations and musculoskeletal pain. However, cases were reported for those with inappropriate table height (72.5 %) more than healthy officers (27.5 %). The finding of a significantly higher level of workstations compared to elbow height of officers indicated risk conditions for musculoskeletal pain in office workers. Regarding the anthropometric characteristics, the hip breadth, buttock popliteal-length and sitting elbow height of cases were significantly different from healthy officers ($p < 0.05$). Moreover, the result of inappropriate seat height reported by office workers identified a significant correlation with musculoskeletal pain ($p = 0.034$). Data of the higher prevalence of musculoskeletal pain in the group of appropriate seating height than inappropriate seating height was unclear. However, this direction might be a warning to office workers who have supplementary materials for better seating (44.6 % of officer) without positive behavior-best practice for musculoskeletal pain prevention. This explanation might be supported by the low attitude of preventive behavior to back pain among university office workers from previous findings [8].

Table 3 Personal and anthropometric characteristics correlated with musculoskeletal pain among 142 university office workers.

Characteristics	**Musculoskeletal pain**		***p*-value**
(mean ± SD)	**Yes (n = 98)**	**No (n = 44)**	
Age (year)	37.9 ± 10.0	38.2 ± 10.8	0.447
Work experience (year)	12.2 ± 10.7	12.7 ± 10.8	0.406
Height (cm)	159.1 ± 6.7	159.4 ± 7.7	0.395
Body weight	55.6 ± 10.3	57.1 ± 10.2	0.211
Waist circumference(cm)	75.3 ± 10.1	76.5 ± 9.4	0.245
Popliteal height (cm)	44.8 ± 4.4	46.1 ± 5.0	0.050
Hip breadth (cm)	36.9 ± 4.1	38.9 ± 4.8	*0.006
Buttock-popliteal length (cm)	45.0 ± 6.6	47.8 ± 7.0	*0.010
Sitting shoulder height (cm)	53.8 ± 4.8	52.1 ± 7.6	0.057
Sitting elbow height (cm)	24.8 ± 4.9	23.2 ± 5.4	*0.048
Elbow height (cm)	69.5 ± 7.5	69.4 ± 8.1	0.455

*Indicates significant difference at *p*-value < 0.05

Conclusions and recommendations

Exploring data of the high prevalence of musculoskeletal pain among university office workers indicates an adverse health effect for officers. The major causes of musculoskeletal pain which were prolonged sitting, twisting and bending of the trunk confirm the onset of work-related musculoskeletal pain in this study. The further study of prospective cohort study design might be helpful for investigating the incidence and related factors to the onset of musculoskeletal pain. Furthermore, a design of a bigger sample size should be considered for statistical analysis.

Under Thai regulation for Occupational Health and Work Environment, illumination in the office workplace must be at least 400 lux. This study found that 55.8 % of workstations had lower light intensities than the minimum standard requirement. The working conditions of insufficient lighting and glare are unsafe conditions for office workers. Moreover, inappropriate workstations and seat heights as well as other ergonomic factors are hazardous conditions which might play a role in the incidence of musculoskeletal pain. The findings suggest that office workers and the organization should be concerned about adverse health effects of occupational exposures to work environment hazards and to improve ergonomic workstations appropriately for each individual worker.

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