JOURNAL OF SCIENCE, Hue University, N^0 61, 2010

WORK ENVIRONMENT HAZARDS FOR MUSCULOSKELETAL DISORDERS AMONG UNIVERSITY OFFICE WORKERS IN KHONKAEN, THAILAND

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SUMMARY

***Introduction**: Musculoskeletal disorders are commonly found in office workers, however, it is unclear if work environment factors related to musculoskeletal disorders are common among University officers. This cross-sectional analytical study is aimed at investigating environmental hazards in workplaces for musculoskeletal disorders among University office workers. **Methods**: 142 participants who were full time University office staff from Khon Kaen University. Demographic characteristics and musculoskeletal disorders were evaluated from structural questionnaires. Anthropometric parameters were determined and ergonomic workstations and illuminations were measured at workstations. Descriptive statistics were percentages, means, and standard deviations (SD). Inferential statistics were chi-square test and the student t-test at 95% confidence interval. **Results**: 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. The one-month prevalence of musculoskeletal disorders was 69.0%. The onset of symptoms was during working hours and the majority of self-reported causes was prolonged sitting in the same posture at work (73.3%). Light intensities were lower than the minimum standard requirement (400 lux) for 55.8% workstations. Most workstations (75.6%) had significantly inappropriate height (above elbow height of workers). Moreover, the anthropometric characteristics of musculoskeletal disorders cases were significantly different from healthy office workers (p-value<0.05) i.e. popliteal height, buttock-popliteal length, hip breadth, sitting elbow height. **Conclusions**: The findings suggest that ergonomic workstations need to be improved appropriately for individual workers and improvements of working conditions following the standard requirements, which should be considered.*

***Keywords**: musculoskeletal disorders, office workers, ergonomics, environment*

1. Introduction

Persistant musculoskeletal disorders are common in society. 70-85% of all people have low-back pain at some time in life. The annual prevalence of back pain ranges from 15% to 45% with a point prevalence averaging 45%. 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. Previous studies showed that a one year prevalence of neck pain in office workers at Hong Kong University was found to be 59% and 63% in a Swedish study of medical secretaries. One year prevalence of low back pain among Greek public office workers was 37.8%. Back pain prevalence in academic personnel was 21.8% among school personnel in Nagoya, Japan. Many studies have investigated the relationship between musculoskeletal disorders and risk factors in working conditions. Postulated factors in the occupation group include: individual factors, anthropometric and ergonomic factors (workstations and instruments, lifting, repetitive work), physical factors (prolonged sitting, awkward posture, twisting and bending of the trunk), psychosocial factor i.e. stress and perceived muscular tension. While prevalence of back pain is quite high in university office workers, it is unclear if work environment factors relate to musculoskeletal disorders. Therefore, the aim of this study was to investigate work environment hazards in office workplaces related to musculoskeletal disorders among university officers.

2. Methodology

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 the study. They were considered eligible for inclusion in this study if they were a full-time university employee and had at least one-year working experience at the 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 the structural questionnaires dealing with individual factors, musculoskeletal disorders and the onset of symptoms, and working environments. Here we define musculoskeletal disorders as 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 applied from Maniadakis and Gray. Participants reported the region of pain by putting X on the area at body chart (drawing) where he/she feel pain.

The body weight, height, waist circumference (WC) and anthropometric characteristics were measured using standardized procedures with established reliability. Measured parameters were determined for popliteal height, hip breadth, buttock-popliteal-length, sitting shoulder height, sitting elbow height and elbow height. Waist circumferences which were greater than 80 cm among women and 90 cm among men identified obesity. To investigate work environment factors (ergonomic factors and illuminations), Data logging light meter (model: 401036 version 2.3 11/13, range 20-200000, Extech Instruments) was used to measure the lighting at 129 work stations

during working hours. Illumination data were evaluated by comparing to the standard requirement of general office workplace at 400 lux. The dimensions of table, seat and work area were evaluated from 131 workstations using steel measuring tape.

Statistical analysis

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

3. Results

3.1. Demographic characteristics

Most participants in this study were women (81.7%). There were 116 women and 26 men. Among office staff, the mean age was 38$\pm$10 years (Min=23 years, Max = 59 years). Regarding work experience in current position at the time of answering the questionnaire, the mean value was 12.3$\pm$10.8 years (Min =1 years, Max= 39 years). Fifty percent of participants had work experience of less than 10 years. Bachelor degrees were the major group of educational background (79.6%) and another group was master degrees (20.4%). The average body height was 159.2$\pm$7.0 cm. The mean WC was 83.6$\pm$8.5 cm for men (n=26) and 73.9$\pm$9.3 cm for women (n=116), identified no obesity. Most office staff (79.6%) did no regularly exercise ($\geq$ 30 minutes and >2 times a week).

3.2. Work environment factors

To determine work environment hazards, data were collected by both questionnaires and measurements of light intensity, size of table, seat and work area. From questionnaires, participant reported self adjustment of appropriate or inappropriate conditions. Most participants (77.3% or 110 participants) reported appropriate conditions and others (2.7% or 32 participants) reported inappropriate conditions (insufficient light = 8 stations, and glare problem = 24 stations). By measurements at 129 workstations, an illumination ranged from 110 lux as the minimum to 823 lux as the maximum (Mean = 388.7$\pm$139.3 lux) (Table 3). Under Thai regulations for occupational health and work environmenst, the minimum standard requirement of lighting in office workplace is 400 lux. Data showed that illumination of 55.8% workstations were lower than the standard requirement.

For ergonomic workstations, results of size measurement of table, chair, and work area were shown in Table 1 as value of 5^{th}, 50^{th}, 95^{th} percentile. We compared

body anthropometry of 131 officers to ergonomic workstations (sitting, 131 workstations). Comparison the mean height of table (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 recommended level (below or equal the elbow height) of each workers at $p<0.001$. By self adjustment, 72.5% of musculoskeletal disorders cases reported inappropriate table heights and 56.1% of cases reported inappropriate seat heights (see Table 4). By comparing the mean height of the seat to the popliteal height of participants, all were height-adjustable seats. The mean value of seat width, depth and backrest height were significantly greater than hip breadth, buttock-popliteal length, and sitting shoulder height, of workers, respectively (see Table 1). Considering appropriate size to all office workers, chair height (5^{th} percentile = 37.8±4.3 cm) was appropriate to participant's popliteal height (5^{th} percentile = 37.6±4.6 cm). By individual consideration, the level of most workstations (75.6%) was higher than elbow height of each worker.

3.3. The musculoskeletal disorders and risk factors

This study recorded one-month prevalence of musculoskeletal disorders at 69% or 98 cases from 142 university staff. The most self-reported causes of musculoskeletal disorders was 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 a trunk (18.8%), respectively. Importantly, over 60% of office workers suffered from musculoskeletal disorders during work hour and 31.1% of office workers had pain attacks at the end of day (after work hour).

Data analyses did not show ignificant associations of musculoskeletal disorders and individual factors i.e. age, gender, work experience, waist circumference and exercise. The anthropometric characteristics i.e. the hip breadth, buttock popliteal-length and sitting elbow height of cases were significantly different from healthy officers ($p<0.05$) (see Table 2). An important finding was that inappropriate seat height was significantly associated with musculoskeletal disorders ($p=0.034$). Concerning lighting intensities, there were no significant relationship between illumination and musculoskeletal disorders. However, the results showed the higher proportion of under standard workstations (illumination <400 lux) among cases than among healthy officers. (see Table 4).

4. Discussions

This study showed that most University office workers were female and non - obese determined by WC. The result confirmed previous study that used body mass index to determine. The high prevalence of musculoskeletal disorders (69%) and the major causes of musculoskeletal disorders were prolonged sitting in the same posture, bending forward or twisting the trunk, reported by cases. The prevalence and causes confirms the adverse health effects of office workers as previous studies. A higher

proportion of musculoskeletal disorders was found in women than men. However, the analyses did not show the significant associations of musculoskeletal disorders to individual factors (age, gender, work experience, obese) as several previous studies. One suggestion from the results is that a design using a larger sample size might be helpful for more powerful statistical analysis.

Comparisons to Thai regulations for occupational health and work environment, measurements showed that 55.8% of workstations had lower intensity than the minimum standard requirement (400 lux). The problem of insufficient lighting and glare were also reported by office workers. Although, the glare problem was not confirmed by measurement, from observation, participants complained that too much glare from the sunlight in the morning and the afternoon caused the problem when look at the screen of computer. These results identified the unsafe conditions in university office workplace. Previous studies rarely reported the association of glare or the lack of local lighting and musculoskeletal disorders. However, insufficient illumination and glare might force workers to adopt awkward posture in order to see their work or the screen, leading to musculoskeletal disorders.

The significant greater of the seat dimension compared to anthropometric parameters of workers indicated the dimension-adjustable seat in this study. Interestingly, the anthropometric characteristics i.e. the hip breadth, buttock popliteal-length and sitting elbow height of cases were significantly different from healthy officers ($p<0.05$). However, the seat dimensions shown in this study were the average value as well as anthropometric characteristics of officers. By self-adjustment of each office worker, an inappropriate seat height significantly correlated to musculoskeletal disorders in this study (p-value=0.034). Therefore, individual size fitting should be calculated following the guideline of Anthropometry and OSHA.

By individual consideration, the level of most workstations was significantly higher than elbow height of each officer worker. This non-optimized ergonomic workstation for individual worker indicated risk conditions to musculoskeletal disorders. Even though, there were no significant correlations of inappropriate table height by self-adjustment by officers, 72.5% of cases reported this hazardous condition and it occurred in a higher proportion compared to healthy officers (27.5%).

The inappropriate ergonomic workstations and lighting conditions are hazardous conditions, which might play a role on the musculoskeletal disorders among university office workers. The results supported the previous reports of occupational risk factors of musculoskeletal disorders among office workers. These findings therefore suggest office workers and organizations raise awareness of the adverse health effects of occupational exposures to work environment hazards, and improve ergonomic workstations appropriately for individual worker. The prospective cohort study might be a suggested further study to investigate incidence and work related risk factors of

musculoskeletal disorders.

5. Conclusions

The high prevalence and causes of musculoskeletal disorders reported by university office workers indicate an adverse health effect from office work.

This study discovered inappropriate ergonomic workstations for university office workers. The level of most workstations was significantly higher than the elbow height of each officer worker and the anthropometric characteristics i.e. the hip breadth, buttock popliteal-length and sitting elbow height of cases were significantly different from healthy officers ($p<0.05$). An inappropriate seat height significantly correlated to musculoskeletal disorders among university office workers (p-value=0.034). This non-optimized ergonomic workstations for individual workers indicated risk conditions to musculoskeletal disorders.

Considering the minimum standard requirement of office illumination (400 lux), there were 55.8% of workstations that had lower intensities. The unsatisfied conditions for working i.e. insufficient lighting, glare problems, inappropriate workstations, height and seat height indicate that university office workers are exposed to environmental hazards in workplaces which might play a role in musculoskeletal disorders.

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	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	37.6	45.2	52.8	4.6	0.697^{A}

	(g)					
	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 (e) 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. *Anthropometric characteristics correlated with the musculoskeletal disorders among 142 university office staff*

Characteristics	**Musculoskeletal disorders**		
(mean±SD)	**Yes (n=98)**	**No (n=44)**	**p-value**
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

Characteristics	Musculoskeletal disorders		
(mean±SD)	Yes (n=98)	No (n=44)	p-value
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

Table 3. *Lighting intensity from measurements of 129 work stations*

Illumination (lux)	Work station (n)	Proportion (%)
<300	33	25.6
300-399	39	30.2
400-599	46	35.7
≥600	11	8.5

Table 4. *Environmental factors related to musculoskeletal disorders (n= 142 workstations)*

Variables	Musculoskeletal disorders		p-value
	Yes [n (%)]	No [n (%)]	
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)	

Acknowledgement

This study was supported financially by Khon Kaen University. Khon Kaen, Thailand.

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