行政院國家科學委員會專題研究計畫 成果報告

男女電腦族承受之身心壓力之比較--利用多專業評估偵測骨骼肌肉系列症狀之危險因子(WR43)
研究成果報告(精簡版)

計 畫 類 別 ：個別型
計 畫 編 號 ：NSC 96-2629-H-006-004-
執 行 期 間 ：96 年 11 月 01 日至 97 年 10 月 31 日
執 行 單 位 ：國立成功大學物理治療學系

計 畫 主 持 人 ：卓瓊鈺

計畫參與人員： 碩士班研究生-兼任助理人員：蕭立苹
碩士班研究生-兼任助理人員：吳倉華

報 告 附 件 ：出席國際會議研究心得報告及發表論文

處 理 方 式 ：本計畫涉及專利或其他智慧財產權，2 年後可公開查詢

中 華 民 國 98 年 01 月 30 日

男女電腦族承受之身心壓力之比較：
利用多專業評估偵測骨骼肌肉系列症狀之危險因子

Comparison of physical and psychological stress between male and female computer users: detecting risk factors for musculoskeletal symptoms by multi-discipline assessment

計劃主持人：卓瓊鈺
Principle investigator: Chiung-Yu Cho, PT, PhD

Cumulative trauma disorder (CTD) is an umbrella term used to describe disorders of the bones, joints, ligaments, muscles which result from the repeated use of the body part over time. It is not a specific incident [1]. CTD is also called repetitive strain injury (RSI), overuse syndromes, or regional musculoskeletal syndromes [2]. CTD caused by long-term computer use is a common problem in the modern computerized environment [3]. Most computer users spend more than 4 hours per day in front of their computers [4]. This habit greatly increases the risk of musculoskeletal disorders [4]. The high medical costs and disability caused by the growing number of CTD clients has called the attention from different medical professionals. The U.S. Bureau of Labor and Statistics reported that the musculoskeletal disorders accounted or 26% of all workplace injuries in 2000 [5]. Prevalence rates of reported discomfort by computer workers range from 15 to 70% depending upon the type of computer workers [6]. In Taiwan, more than 60% of computer users have demonstrated symptoms, such as eye soreness and musculoskeletal disorders [7]. It is critical to find out a proper intervention strategy to prevent CTD and conduct early intervention before the symptom becomes irreversible.

Risk factors of CTD include repetitive motions, forceful exertions, vibration, mechanical compression, sustained or awkward postures, all occurring over extended periods of time [2]. Approximately 30% of frequent computer users among hospital employees have experienced hand paresthesias [8]. Young computer users may also have musculoskeletal symptoms. Among this population, more than 30 % of them experienced wrist pain [9].

Due to differences in muscle strength, anthropometry, and hormones, female tends to have higher rate of CTD than male [10]. Previous researchers also reported that more women are employed in hand intensive, monotonous jobs. Therefore, they have greater risk of CTD [11]. Cagnie et al. suggested that women had a two-fold risk of neck and upper extremity pain compared with men [12]. Bjorksten et al. [13] compared a group of industrial workers with a group of age matched control. They found the women in the study group were largely responsible for domestic tasks such as laundry, cleaning and cooking. Besides, female tends to have higher rate of CTD which may be related to long term hormonal effects of pregnancy or with activity associated with child rearing [14].

Not only physical factors will contribute to CTD, but also psychosocial factors are associated with neck pain [12]. Several studies focusing on the association between psychosocial working condition and musculoskeletal symptoms have been proposed [15]. Recent research has demonstrated that mental stress can increase muscle activity during simulated visual display unit work [16]. Other study showed that mental stress also tends to increase the forces applied to the computer mouse and leads to more rapid wrist movements for visual display unit workers [15]. High prevalence of musculoskeletal symptom was found to be associated with high psychological distress for high school students [17]. Further analysis of the content of their job or academic work might reveal risk factors contribute to their musculoskeletal symptoms [15, 17]. However, some questions which was used to assess perceived muscular tension and psychological demands in the previous literature tend to be simple and subjective [15]. Further assessment of the psychological distress should consider other questionnaires to be more quantitative to assess distress.

Interventions for CTD were classified as engineering, and administrative, or personal according to the control implementation hierarchy recommended by NIOSH [18]. Engineering interventions were defined as "engineered or physical manipulations of sources of occupational hazards or routes of exposure to them." Examples for engineering interventions include keyboard designs, mouse designs, and their support systems. Adjustment of ergonomic factors is important in reducing CTD but insufficient to prevent CTD [5]. Administrative interventions are " Any management initiative which modified the work process or work exposure to reduce work related musculoskeletal disorder distress". Examples for these interventions are job rotation or establishment of an ergonomics task force. A personal intervention was one that addressed workers' behavior, education, and training. Examples for this intervention are ergonomics training, splint application, electro-myographic biofeedback, and exercise programs. Among the three major approaches, physical therapists are more experienced in personal intervention. Although researchers have suggested that multiple component programs were associated with reduced incidence rates of carpal tunnel syndrome [18], the results are inconclusive because they did not adequately control for potential confounders. Besides, long term outcomes such as incidence of pain after treatment were not reported [18].

Physical therapists often use their knowledge to establish the treatment and prevention programs for computer users. We argue that a multi-discipline pre-work evaluation and education for computer users may be able to detect important risk factors for musculoskeletal symptoms.

We propose to conduct a one-year cross-sectional study. The researchers are interested in implanting a multi-discipline evaluation in among office computer workers. The primary purposes of this study were: first, to compare the prevalence of musculoskeletal symptoms in different body regions between male and female computer workers. Second, to investigate the risk factors among computer users. We hypothesized that the prevalence of musculoskeletal symptoms between male and female was different. We also hypothesized that the risk factors of the musculoskeletal symptoms between male and female was different.

The results of this study may provide the computer user a simple evaluation to assess musculoskeletal symptoms. Multi-discipline evaluation of musculoskeletal symptoms for computer users may help us find out various risk factors, permit proper intervention, or minimize disability in the future.

Method

Subjects:

Forty-three computer users aged from 25-45 years old who spend more than 20 hours per week on computer work were recruited from Tainan area. Subjects had to fill out the general health questionnaire. None of them have musculoskeletal disorders with specific pathology (e.g. Radioculopathy).

Procedure

Multidiscipline assessment

All of the participants had ti\o go through multidiscipline evaluation after they fill out the general health questionnaire.

Questionnaire: psychological distress and pain assessment

Musculoskeletal symptoms questionnaire (MSQ) was used for evaluation of the prevalence for musculoskeletal symptoms [17]. The Maslach Burnout Inventory [12] will be used to assess office workers' psychological distress [19].

Physical assessment:

The subject performed standard typing tasks in fast speed and preferred speed for eight minutes. Another repetitive mouse task for 8 minutes was also performed. Sequence of the three tasks were randomized. Typical working environment will be simulated by adjustment of the table and desk in the postural and balance control lab in the Department of Physical Therapy, National Cheng Kung University.

The head, trunk, and upper arm positions were recorded by a three-dimensional system: MacReflex measurement system (Qualisys Inc., Glasstonbury, CN, USA) at the end of the typing task. Six reflective markers were placed on bilateral ear lobes, outer canthi, acromions. Another four markers were placed on cervical vertebra level 7, right elbow, wrist and end of the third metacarpal bone. The following relative angles of different body segments were calculated: head bending angle, neck flexion angle, upper arm elevation angle, elbow flexion, and wrist deviation angle. Pain threshold: pressure algometry will be tested twice on bilateral trapezius muscle, neck extensor, and right extensor carpi radialis.

Muscle strength: Bilateral shoulder elevation and wrist extension were tested by using hand-held dynamometer. Grip strength were tested on both hands.

EMG: Six pre-amplified bipolar surface electrodes (Delsys Inc., Boston, USA) were used to record electromyographic activities from six muscle groups in the both upper trapezius, both wrist flexors and extensors. The root mean square value of electromyographic data will be calculated.

Ergonomic assessment:

Personal demographic characteristics including: body weight, height, range of motion of the neck and upper extremities, and anthropometric measurement were jointly assessed.

Environmental factors: chair, table height, and backrest inclination; screen height, and its orientation; mouse location; keyboard height, inclination and location will be measured. All of the data were compared with standard working posture and working station design.

Results

We recruited forty-three subjects and three subjects withdraw from this study due to incomplete data collection.

Demographic data was shown in table 1.

Table 1 Demographic data

	Height(cm)	Weight(kg)	Age(y/r)	Work day	Work hours/day
Female	160.5	50.7	31.4	5.32	8.51
Male	172.78	71.4	31.7	5.25	8.79

Postural analysis

Gender difference

There was significant difference between male and female computer users for head and neck flexion angle when they were performing the typing task (p=0.004, p=0.014). Male computer users had a larger head and neck flexion angles than females.

For the repetitive mouse task, there was significant difference between male and female computer users for shoulder, elbow flexion, and wrist deviation (p=0.036, p=0.047, p=0.051). Male computer users had larger shoulder, elbow flexion and wrist radial deviation angles than females.

Table 2 Gender difference of postural changes

Type	Head	Shoulder	Neck	cranio-cervical	Elbow	Wrist
F	77.9±1.2	33.1±2.8	53.6±1.1	152.4±1.7	112.3±3.3	161.6±1.18
M	82.9±1.2	39±2.8	57.6±1.1	153.6±1.7	117.9±3.3	160.3±1.18
Sig level	p=0.004	P=0.146	p=0.014	P=0.602	P=0.24	P=0.428
Mouse	Head	Shoulder	Neck	c-c	Elbow	Wrist
F	74.2±1.5	20.7±3.2	51±2	156.7±2.5	102.2±3.8	160.3±1.4
M	77.9±1.5	30.4±3.1	54.6±2	155.8±2.4	113.1±3.7	156.5±1.3
Sig level	p=0.088	P=0.036	P=0.214	P=0.785	P=0.047	P=0.051

Time difference

There were significant differences existed for head, shoulder, elbow flexion angle among three test sessions when they were performing the typing task.
There were significant differences existed for head, shoulder, elbow flexion and wrist radial deviation angle among three test sessions when they were performing the mouse task.

Table 3 Time difference of postural changes

	Pre (time 1)	mid (time 2)	post (time 3)	Sig level
Head-type	79.4	81.3	80.5	P=0.022
Head-mouse	75.2	75.8	77.1	P=0.05
Shoulder-type	37.6	36.2	34.2	P=0.01
Shoulder-m	29	22.6	25	P=0.006
Neck-type	55.1	54.1	57	P=0.061
Neck-m	54.3	52.5	51.5	P=0.202
cc-type	154.6	153.7	150.7	P=0.3
cc-m	157.1	157.2	154.4	P=0.106
Elbow-type	117.2	115	113.1	P=0.024
Elbow-m	114.2	103.7	105	P=0.000
Wrist-type	161.5	160.7	160.5	P=0.163
Wrist-m	161.3	157.4	156.5	P=0.000

Speed difference

For different typing speed, there was significant difference of shoulder flexion, elbow flexion, and cranio-cervical angles between preferred typing and fast typing speed. Subjects decreased these angles when they performed the fast typing tasks.

Table 4 Speed difference (typing task only) of postural changes

	Preferred type	Fast type	Sig level
Head	80.1	80.7	p=0.18
Shoulder	36.7	35.2	P=0.007
Neck	55.6	55.6	P=0.925
cranio-cervical	154.8	151.2	P=0.043
elbow	115.9	114.3	P=0.007
wrist	161	160.8	P=0.43

<u>EMG analysis</u>

Gender difference

There was no significant difference between male and female computer users for all root mean square value of tested muscles except right extensor digitorium (p=0.004, p=0.009). Male computer users had a smaller RMS of RED than females for both typing and mouse task.

Table 5 Gender difference of RMS

Type	LED	LFDS	Ltra	Rtra	RED	RFDS
F	0.221	0.12	0.258	0.276	0.237	0.107
M	0.186	0.074	0.29	0.257	0.166	0.064
Sig level	P=0.222	P=0.1	P=0.596	P=0.678	P=0.004	P=0.155
Mouse	LED	LFDS	Ltra	Rtra	RED	RFDS
F	0.101	0.062	0.135	0.2	0.215	0.083
M	0.089	0.045	0.206	0.207	0.144	0.056
Sig level	P=0.764	P=0.271	P=0.131	P=0.893	P=0.009	P=0.244

Time difference

There was no significant difference among three test sessions for all root mean square value of tested muscles except right extensor digitorium of the mouse task. Computer users increased their RMS of RED at time 2 and time 3 while performing the mouse task.

Table 6 Time difference of RMS

	Pre (time 1)	mid (time 2)	post (time 3)	Sig level
LED-type	0.204	0.206	0.201	P=0.881
LED-m	0.09	0.099	0.097	P=0.497
LFDS-type	0.115	0.085	0.092	P=0.352
LFDS-m	0.049	0.053	0.059	P=0.45
Ltra-type	0.269	0.266	0.287	P=0.482
Ltra-m	0.168	0.161	0.183	P=0.61
Rtra-type	0.28	0.253	0.265	P=0.552
Rtra-m	0.202	0.194	0.213	P=0.666
RED-type	0.212	0.199	0.193	P=0.593
RED-m	0.167	0.187	0.183	P=0.045 (1,2=0.029, 1,3=0.073)
RFDS-type	0.105	0.074	0.077	P=0.47
RFDS-m	0.067	0.072	0.069	P=0.284

Speed difference

There was no significant difference of the RMS for all muscles between two test speeds for the typing task.

Table 7 Speed difference (typing task only)

	Preferred type	Fast type	Sig level
LED	0.201	0.206	P=0.437
LFDS	0.109	0.085	P=0.184
Ltra	0.271	0.276	P=0.733
Rtra	0.271	0.261	P=0.677
RED	0.211	0.192	P=0.326
RFDS	0.097	0.074	P=0.373

Analysis of Questionnaire

Gender difference

Female tends to have higher symptom scores on upper trunk and extremities except the finger area. However, none of the difference reached the significant level. Female also tends to have more frequent complaints of musculoskeletal symptoms on upper trunk and extremities, especially for back, forearm, and wrist area (p=0.048, p=0.005, p=0.007). For the ergonomic assessment, female tends to use a lower desk, keyboard height, and chair, but none of them reached the significant level.

Linear regression

Linear regression from the results of the musculoskeletal questionnaire revealed that work hour, year of using computer, and age are more important factors correlated with wrist pain score but they did not reach the significant level (p=0.087, p=0.078, p=0.079).

Linear regression from the results of the burnout scale revealed that work hour, year of using computer, and age are highly correlated with Burnout scale, and work hour has reached the significant level (p=0.011).

Linear regression from the results of the ergonomic assessment revealed that desk height was correlated with forearm pain (p=0.053). Chair height was correlated with back pain (p=0.075) and finger pain (p=0.010) but only finger score reached the significant level.

Discussion

Due to differences in muscle strength, anthropometry, and hormones, female tends to have higher rate of CTD than male [10]. Our study confirmed this finding in some aspects: male computer users had a greater head and neck flexion angle, and female had greater upper extremity angles. Females also had greater RMS of right extensor digitorium EMG as compared to males. Although the difference of their symptom scores did not reach the significant level, the difference of their symptom frequency did reach the significant level in back, forearm, and wrist regions.

Previous researchers also reported that more women are employed in hand intensive, monotonous jobs. Therefore, they have greater risk of CTD [11]. Previous study also demonstrated that women used a higher relative force in computer tasks as compared to men (Won, 2008). Our study had similar finding but we found not only did women increase their RMS of right extensor digitorium but also they had more frequent complaints. Bjorksten et al. [13] compared a group of industrial workers with a group of age matched control. They found the women in the study group were largely responsible for domestic tasks such as laundry, cleaning and cooking. Our female workers were responsible for 26 % of domestic work but men did 22%. It seems that men start to share more house keeping and baby sitting work as compared to previous generation.

It was found that there were significant differences existed for head, shoulder, elbow flexion angle among three test sessions when they were performing the typing task. Our subjects gradually increased their postural angles such as head flexion angles and decrease their upper extremity angles after eight-minute typing task. We speculated that as they completed the typing task, they might gradually reach to an awkward posture that might be related to increase tension of the head and neck muscle. However, we did not analyze EMG of head and neck extensor muscles. On the other hand, the computer users decreased the flexion angles of shoulder and elbow after the typing task and we suspected that they tend to use a more relaxed pattern for their upper extremities.

There were significant differences existed for head, shoulder, elbow flexion and wrist radial deviation angle among three test sessions when they were performing the mouse task. Mouse task required the subjects to perform similar postural changes as the typing task except greater wrist radial deviation (3-4degrees). However, since the repetitive mouse task requires high repetitive wrist extension, our study also demonstrated evidence for this phenomenon, we found there was significant increase of the RMS of right wrist extensor muscles after eight minute mouse task ($p=0.045$).

For different typing speed, there was significant difference of shoulder flexion, elbow flexion, and cranio-cervical angles between preferred typing and fast typing speed. Subjects decreased these angles when they performed the fast typing tasks. We speculate that those computer users increased forward head position as the typing speed increased which was reflected on the increase of cranio-cervical angle. They also used a more retracted posture to perform the fast typing task that was demonstrated on decrease of shoulder and elbow flexion angle. However, there was no significant change of RMS for all related muscles found between two typing speeds. We suspected that the speed changes was adjusted by subjects themselves, and they could adjust it to a comfortable speed that they did not have to increase tension immediately. If the typing task lasted longer than our current design, we might be able to detect significant changes of EMG.

Linear regression from the results of the musculoskeletal questionnaire revealed that work hour, year of using computer, and age were more important factors correlated with wrist pain score. Although these factors did not reach the significant level (p=0.087, p=0.078, p=0.079), which might be due to low number of questionnaire. Our future study will use questionnaire survey only and which might lead to more reliable finding.

Linear regression from the results of the burnout scale revealed that work hour, year of using computer, and age are highly correlated with Burnout scale, and work hour has reached the significant level (p=0.011). Longer working hour might be a very important factor for burnout and the computer users could easily get exhausted after long period of working.

Linear regression from the results of the ergonomic assessment revealed that desk height was correlated with forearm pain (p=0.053). Chair height was correlated with back pain (p=0.075) and finger pain (p=0.010) but only finger score reached the significant level. We thought adjustment of the task environment might be able to decrease the occurrence of CTD.

Due to insufficiency of grant, we only recruited 40 subjects. This number of subjects might be enough to detect postural changes but not enough for parameters with high standard deviation such as median frequency of EMG or questionnaire analysis. Future study might need to recruit more subjects for median frequency analysis.

Conclusion

Due to different anthropometry, women have demonstrated different postures as compared to men while were performing different computer tasks. Women also used a higher relative force of right extensor digitorium in computer tasks as compared to men. Our computer users also gradually increased the postural angles and decreased the upper extremity angles as the computer task lasted or the typing speed increased. However, there was no significant change of RMS for all tested muscles except right extensor digirium among three test sessions or two typing speed. We concluded that postural differences were significant between two genders even we have adjusted their computer table and chair as their preference. Different percentages of muscle force were used when they were performing computer tasks. Further studies need to focus on analysis of more postural muscles as well as recruit more participants.

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出席國際學術會議心得報告

計畫編號	NSC 96-2629-H006-004
計畫名稱	男女電腦族承受之身心壓力之比較--利用多專業評估偵測骨骼肌肉系列症狀之危險因子(WR43)
出國人員姓名 服務機關及職稱	卓瓊鈺 國立成功大學物理治療學系
會議時間地點	8/5/2008-8/9/2008 Ann Arbor, Michigan, USA
會議名稱	North American Congress on Biomechanics NACOB
發表論文題目	Changes of arm movements in dual task condition on different walking environment in healthy young adults. The effect of dual task and proprioceptive stimulation on stepping ability for fallers and nonfallers.

一、參加會議經過

在經歷十多小時的飛行後，我們在 8 月 4 日中午抵達 Ann Arbor。5 日下午開始有一連串的課程。我選擇的是如何撰寫 Grant。Mark Redfern and Steve Goldstein 是美國生物力學界的巨擘。Dr. Redfern 也是我博士論文的 outside reader。他們指出許多申請經費的重點，同樣的道理也可以運用在台灣的 grant writing。當天晚上有簡單的歡迎晚宴，雖然比不上台灣的美食，但也爲此大會揭開序幕。

正式會議於 8 月 6 日展開。我們一早就從北校區搭車前來參加 Keynote speech：why bones bend but do not break。接著下來是一連串的 competition。看到許多年輕的學者在講台上綻放光芒，著實令人佩服。生物力學的研究已從巨觀發展到微觀，從 2D 發展到 3D，如何將最新的科技運用到人體實驗，正是近年來生物力學發展的趨勢。

8 月 7 日一早的演講是 UC Berkley, Dr. Mimi Koehl 所講的 moving in a turbulent world。她生動地描述水中動物包括螃蟹、小蟲在遭受干擾的動作情形，博得在場聽眾的喝采。與會聽眾也詢問到她 inter-discipline cooperation 的經驗。像我們成大的 coffee afternoon 應該也是一個尋求合作的好機會。

下午參加了一系列關於 Occupational evaluation using advanced biomechanical models: circumventing work place barriers through simulation。演講中提及傳統的人因工程強調的是 reactive ergonomics；也就是說，由於分析一般人在工作過程中，常會面臨到許多造成傷害的危險因子，因此在設計產品時，應考慮減少或避免這些危險因子。在另一方面，現今的人因工程學則強調 proactive ergonomics；也就是防患於未然之意。所以使用模擬人物來面對工作情境，設計出預防傷害的工作環境。

晚上的晚宴是在 Henry Ford Museum 舉行，搭乘接駁車到 Detroit 後，便魚貫進入博物館。很高興在這裡和我的老師和老朋友們敘舊，相談甚歡。

8 月 8 日除了參加 Dr. Zatsiorsky 的 keynote speech: From biomechanics to motor control 之外，還參加了 Dr. Patla 的系列演講。我曾經讀過他的許多作品，是一位研究步態相當成功的科學家，而我也差一點成為他的門下弟子。這場演講報告的都是他的學生，我才知道他已經因為腦瘤於去年過世了。聽完這些演講，感傷之餘，學生和我愈來愈覺得學術之路不好走了！

下午的 poster 報告則是人滿為患，講到聲音沙啞才得休息。

於是，最後一天的會議，我們選擇慢活。輕鬆的在旅館吃完豐富的早餐後，我們才搭車到會場去。參加了幾場步態的演講之後，便收拾行李出發前往芝加哥訪友。

二、與會心得

這次參加會議的重要心得是：學生及研究員的演講有的都不輸教授，尤其有多場的論文比賽，演說的台風都相當好，這也顯示學術界栽培新血的重要性。而學術之路本來就不易行，套句 Dr. Redfern 的話，認真工作但也要用力玩，才能夠走的長久。