

Prince of Songkla University
Faculty of Engineering

Final Examination: Second Semester

Academic year: 2009

Date: February 22, 2010

Time: 09:00 - 12:00

Course: 225-540 Human factors in system design

Room: R300

Instruction

1. This is a closed book exam.
2. Only one sheet of note, non-programmed dictionaries, and calculators are allowed.
3. Total score is 80 from 8 questions on 8 pages.
4. Answer all the questions in the answer book.

Asst Prof Dr Angoon Sungkhapong

ทูลงการสอบ โทษขันต่ำคือ ปรบตกรในรายวิชานั้น และพักการเรียน 1 ภาคการศึกษา

According to the given paper, answer all questions as follows.

1. What were the main work-risk (or symptoms) of the workers? (10 points)
2. How did the researchers collect data for this study? Why did they use that method? (10 points)
3. What were the characteristics of sewing task work-station? (10 points)
4. Apply the RULA technique to assess their working posture which is shown in Figure 1, (make any assumption, if necessary) (10 points)
5. What was the worker's work-schedule? How did it affect his/her health? (10 points)
6. What is the result of this study? What are factors related to the musculoskeletal symptoms? (10 points)
7. How did the researchers recommend to the owners of sewing companies to solve this problem? (10 points)
8. What do you recommend for further researches concerning ergonomic problems? (10 points)

Work-organisational and personal factors associated with upper body musculoskeletal disorders among sewing machine operators

Abstract

Objective : To assess the contribution of work-organisational and personal factors to the prevalence of work-related musculoskeletal disorders (WMSDs) among garment workers in Los Angeles.

Methods : This is a cross-sectional study of self-reported musculoskeletal symptoms among 520 sewing machine operators from 13 garment industry sewing shops. Detailed information on work-organisational factors, personal factors, and musculoskeletal symptoms were obtained in face-to-face interviews. The outcome of interest, upper body WMSD, was defined as a worker experiencing moderate or severe musculoskeletal pain. Unconditional logistic regression models were adopted to assess

the association between both work-organisational factors and personal factors and the prevalence of musculoskeletal pain.

Results : The prevalence of moderate or severe musculoskeletal pain in the neck/shoulder region was 24% and for distal upper extremity it was 16%. Elevated prevalence of upper body pain was associated with age less than 30 years, female gender, Hispanic ethnicity, being single, having a diagnosis of a MSD or a systemic illness, working more than 10 years as a sewing machine operator, using a single sewing machine, work in large shops, higher work–rest ratios, high physical exertion, high physical isometric loads, high job demand, and low job satisfaction.

Conclusion : Work-organisational and personal factors were associated with increased prevalence of moderate or severe upper body musculoskeletal pain among garment workers. Owners of sewing companies may be able to reduce or prevent WMSDs among employees by adopting rotations between different types of workstations thus increasing task variety; by either shortening work periods or increasing rest periods to reduce the work–rest ratio; and by improving the work-organisation to control psychosocial stressors. The findings may guide prevention efforts in the garment sector and have important public health implications for this workforce of largely immigrant labourers.

Introduction

Employment in the garment industry rose worldwide in the late 1990s to approximately 11 million workers in 1998. In the United States, over 300,000 garment workers were employed in 2005 to sew apparel.

California is home to the largest garment production centre in the United States, with the majority of the garment shops located in the Los Angeles basin. Altogether these shops employ over 144,000 sewing machine operators, the majority of whom are minimum wage, unrepresented, immigrant women.

A typical sewing workstation consists of a sewing table with a built-in electric sewing machine, a non-adjustable household chair, and cardboard boxes/cart to hold incoming fabrics and sewn products. Production sewing is a highly repetitive, high-precision task that requires the worker to lean forward to see the point of operation, while simultaneously using the hands to control fabric feed to the needle, and continuously operate foot and knee pedals (fig 1). In the United States, sewing machine operators

are in the top 20 occupations (out of 821) with the highest rate of lost time due to over-use injuries. In spite of this high injury rate, few studies have focused on this occupation.



Figure 1 Typical sewing machine workstations; (A) operator leaning forward in a cramped space, (B) operator using non-adjustable household chair and cardboard boxes to support incoming fabric.

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Generally, sewing machine operators have little control over their workload, work pace and work schedule. Employment is unstable and often involves a tight delivery schedule so that the work pace is fast, time for rest breaks is limited and working hours may be long. Thus, in this population, work-organisation might be an important contributor to musculoskeletal disorders. Work-organisation may contribute to work-related musculoskeletal disorders (WMSDs) via the nature of the work activities, the extent, duration and frequency of workloads, and psychosocial factors. In this study, we assessed the contribution of work-organisational factors to the prevalence of self-reported moderate or severe neck–shoulder and distal upper extremity pain among sewing machine operators.

METHODS

Study design and subjects

This paper evaluates the baseline data collected from a prospective ergonomics intervention study. The study population consisted of sewing machine operators in Los Angeles, California. Subjects were recruited based on the following eligibility criteria: they performed sewing machine operations for more than 20 h per week including work on single/double needle straight-stitch, overlock and cover-stitch machines, were not in a probationary period (the probationary period ranged from 1 to 6 months), did not have an active worker's compensation claim, had worked for at least 3 months, and were not planning to quit their jobs within 6 months. These criteria were not mutually exclusive, and were employed to ensure that subjects were selected from a stable garment worker population.

Data collection

All information was collected in face-to-face interviews conducted in the language of the employee (including Spanish, Cantonese and Mandarin Chinese, and English). The standardised interview elicited information on: (1) musculoskeletal pain symptoms; (2) personal factors; and (3) work-organisational factors, including physical and psychosocial stressors.

Data analysis

Some researchers have suggested that the relation between work organisational factors and musculoskeletal pains is not linear. Therefore, we categorised most continuous variables into quartiles of the observed distribution to examine linear and non-linear associations. Four continuous variables were categorised differently: 'number of rests' was split into three categories (one, two, and more than two breaks); 'work–rest ratio'

was split into three categories: 0–9.2, 9.2–11.6, and 11.6+ [Note: the California law requires a total 20 min rest period and 30 min lunch break when working 6 or more hours per day; thus, the ratio of 9.2 and 11.6 are the legally required work–rest ratios for 8-h and 10-h shifts and were used to represent appropriate (according to the law) versus non-appropriate work schedules in our population]. Some variables were better categorised as tertiles: ‘job insecurity’ (0–24, 25–74 and 75+ percentile), ‘physical isometric loads’ (0–49, 50–74 and 75+ percentile), and ‘job satisfaction’ (‘not satisfied’, ‘satisfied’ and ‘very satisfied’).

RESULTS

All 520 participants were immigrant workers; the majority were female (64.4%), Hispanic or Asian (67.1% and 28.3% respectively), with a mean age of 38 years (range, 18–65). More than half (54.0%) were overweight or obese with a BMI above 24.9 kg/m², but few had ever smoked (10.4%) or were currently smoking (4.8%), or reported a physician-diagnosed systemic illness (14.8%) or musculoskeletal disorder (10.0%). Almost half (45.2%) did not complete high school, 21.0% had lived in the United States for fewer than 5 years, and a majority (91.2%) spoke little or no English

Upper body pain during more than 1 day per week in the past month was reported by 58% of study participants. The prevalence of moderate or severe pain in the neck/shoulder region (referred from here on as ‘pain’) was 24% and for distal upper extremity it was 16%. The overall prevalence of upper body WMSDs was 32% (165)

The odds ratios for personal factors estimated in multivariate fully adjusted models are shown in. Male compared to female garment workers reported experiencing less pain in both upper body regions (approximately half). Less pain (again approximately half) in the neck and should region alone, was reported by Asian compared to Hispanic workers, workers married and living with a spouse compared to singles and also non-smokers, while age showed a somewhat u-shaped relation with neck/shoulder pains. The prevalence of neck/shoulder or a distal upper extremity pain was also higher among sewing machine operators who reported an ever physician diagnosis of a musculoskeletal disorder or systemic illness. We observed an increase (and positively increasing trend $p_{\text{trend}} = 0.02$) with years of employment in the garment industry for the prevalence of hand/wrist but not for neck/shoulder pain, mostly attributable to employees who had worked in the garment industry for 10 years or more.

No clear patterns emerged for education, living with children, BMI and physical activity, and we observed no associations with pain reports for having to support members of the family outside the household.

We also found some work-organisational factors to be associated with differences in reported prevalence of neck/shoulder and distal upper extremity pain. Operating three or more machines was associated with a reduced prevalence of both upper body pain (88% reduction for neck/shoulder disorders and 58% reduction for distal upper extremity disorders) but our estimates for distal upper extremity disorders were rather imprecise. Subjects working in large garment shops were more than twice more likely to report upper body pain than those from small shops. Interestingly, payment method (piece vs. hourly) affected symptom reporting in opposite directions for employees from small and large shops. Stratification on shop size showed that subjects in large shops paid via piece rate were less likely to report upper body disorders, while the opposite was observed in small shops, where piece rate payment seemed to contribute to pain reports although our estimates were imprecise due to small sample sizes.

The strongest and most consistent association and a strong trend for increasing pain in both upper body regions was observed for the compound scale of physical exertion derived from the JCQ. Another scale, high physical isometric load was also strongly associated with the prevalence of neck/shoulder but not distal upper extremity pain. There was no significant relationship between job control, social support and job insecurity and prevalence of neck/shoulder or distal upper extremity MSD (data not shown).

The prevalence of a neck/shoulder pain was higher among subjects who perceived high job demands, and low job satisfaction. We observed a positive increasing trend for job demands and the prevalence of neck/shoulder pain ($p_{\text{trend}} = 0.03$) and a similar size association with highest level of demands for distal upper extremity pain, but this estimate was less precisely estimated. However, low job satisfaction was strongly associated with the prevalence of distal upper extremity pain.

DISCUSSION

This is one of the largest studies evaluating upper body musculoskeletal symptoms among garment workers. Garment workers are a vulnerable working population, since they are primarily immigrants of low socio-economic status, low educational level, and without union representation. We hypothesised that work-organisational factors may be particularly important risk factors for this population due to the lack of control over job tasks, work schedules and work–rest patterns. Our findings suggest that a number of work-organisational factors as well as some personal factors are associated with increased prevalence of upper body disorders even after mutual adjustment for each other, underscoring the multifactorial nature of WMSDs in these workers.

There were several notable findings regarding the relation of personal factors to upper body disorders. First, the lack of an association between elevated BMI and upper body WMSDs. While elevated BMI has been related to entrapment neuropathies and low back pain among workers, the relation to other upper body disorders seems less consistent and a lack of association with BMI is supported by our data. Second, the literature suggests that living with children is associated with neck and shoulder pain in sewing machine operators. We observed an increased risk for neck/shoulder pain among workers who were single and lived alone compared to workers who were married and lived with a spouse, but no relation between pain and having children at home. Third, we observed that the reported pain prevalence for both upper body regions was lower for males compared with females and the prevalence of neck/shoulder disorders was higher for Hispanics compared with Asians.

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