Final Progress Report

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Date and number of reports: To date, we have 3 papers published in scientific journals and one in press (please review ‘Publications’ for detail). We also have been collaborating with the UCLA Labor Occupational Safety and Health (LOSH) program to generate a brochure and a poster (in English, Chinese, and Spanish) based on our findings.

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The ending date: 9/30/2006

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List of Terms and Abbreviations.
garment workers, sewing machine operators, ergonomic intervention, work-related musculoskeletal disorders (WMSDs).

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Abstract.

In 2000, the garment industry employed 11 million workers worldwide with approximately 350,000 workers in the US. Most of the work is done by minimum wage, nonunion, immigrant women in shops that employ fewer than 20 people. Epidemiologic evidence linking garment work to elevated prevalence of neck/shoulder pain is relatively strong; results in previous studies for back/hip pain have been less clear.

Sewing machine operators perform precision tasks while seated and at a relatively fast pace with work cycles of 30 to 60 seconds. This repetitive, stereotyped work is typically performed on nonadjustable workstations and chairs. The task is visually demanding and lighting quality varies widely between shops. Task demands and a general lack of adjustability of garment workstations often require sustained awkward postures, such as cervical and thoracic spine flexion, shoulder elevation and abduction, lumber spine flexion, and repetitive torso twisting the later to move material from the sides to the machine. These motions may contribute to elevated rates of neck, shoulder, back and hip pain.

The main purpose of this project was to determine whether a newly developed ergonomic intervention applied to sewing machine operators working in Los Angeles garment shops can reduce rates of neck/shoulder and back/hip musculoskeletal disorders, severity of pain and impairment, and lost-work-time. We evaluated the influence of a newly designed and relatively affordable ergonomic task chair, a conventional task chair, and a placebo intervention given to industrial sewing machine operators on neck/shoulder pain, and back/hip pain. The primary outcomes we evaluated were monthly pain severity over a 4 months time span. We also identified demographic, psychosocial, and other work-related factors among participants who benefited most from the ergonomic interventions such that they experienced a reduction in upper extremity, neck, low back pain or reduced risk of musculoskeletal disorders. Throughout our study period we were able to recruit 520 subjects from 13 garment shops in Los Angeles. Subjects were randomized to 3 intervention groups.

We evaluated pain score changes over 4 months of follow-up and compared the two intervention groups to the control group using repeated measure linear regression models. Our findings demonstrate that a height adjustable task chair with a swivel function can reduce neck, shoulder, back and hip pain in sewing machine operators in comparison to the chair these garment workers usually used. Furthermore, adding a curved seat pan can reduce neck and shoulder pain severity among sewing machine operators. Our findings may be generalizable to other seated jobs that are visually demanding and involve the repetitive manipulation of material or parts. Healthcare providers should consider recommending an adjustable height task chair with a swivel function for patients with neck, shoulder, back and hip pain who are garment workers or who perform sitting tasks that required forward bending. Finally, owners of sewing companies should consider providing such a task chair for their employees as a way of reducing pain and loss of trained workers due to impaired health.

Highlights/Significant Findings

1. Garment workers experience a high prevalence of neck, shoulder, back, and hip pain.
2. A task chair with a swivel function may reduce pain in the neck, shoulder, back and hip region.
3. A curved seat pan can improve the reduction of neck and shoulder pain severity.

Translation of Findings

The study demonstrates that garment workers may experience an improvement in neck, shoulder, back and hip pain if they are provided height-adjustable task chairs that can swivel. A chair with a curved seat pan can improve the reduction of pain severity in neck and shoulder region.

Unexpectedly, we found a greater reduction in back and hip pain for a chair that was fitted with a flat rather than curved seat pan in men and garment workers who are overweight or obese. These findings suggest that the curved seat is not as effective in physically larger garment workers. One possible reason for this observation may be that the size of seat pans used in this study differed between the two chairs. The curved seat pan was 43 cm deep and 46 cm wide, and the flat pan was 46 cm deep and 48 cm wide. Thus, the curved chair may require further refinements to accommodate the physical needs of larger garment workers or the concept may not be effective for larger workers. Further studies evaluating the effectiveness of curved chairs with several seat pan and backrest sizes among workers of different anthropometric types may be warranted.

Outcomes/Relevance/Impact

Our findings may be generalizable to other seated jobs that are visually demanding and involve the repetitive manipulation of materials or parts. Healthcare providers may consider recommending an adjustable height task chair with a swivel function for patients with neck, shoulder, back and hip pain who are garment workers or perform sitting tasks that require forward bending. Finally, owners of sewing companies should consider providing such a task chair for their employees as a way of reducing pain and loss of trained workers due to impaired health.

Scientific Report

A. Background

In 2000, the garment industry employed 11 million workers worldwide with approximately 350,000 workers in the US (ILO, 2004). Most of the work is done by minimum wage, nonunion, immigrant women in shops that employ fewer than 20 people (Chan, 2002). Epidemiologic evidence linking garment work to elevated prevalence of neck/shoulder pain is relatively strong (Brisson, 1989; Schibye, 1995); results in previous studies for back/hip pain have been less clear (Sokas, 1989).

Sewing machine operators perform precision tasks while seated and at a relatively fast pace with work cycles of 30 to 60 seconds. This repetitive, stereotyped work is typically performed on nonadjustable workstations and chairs. The tasks are visually demanding and lighting quality varies widely between shops. The task demands and the lack of adjustability of the workstations often lead to sustained awkward postures, such as cervical and thoracic spine flexion, shoulder elevation and abduction, lumber spine flexion, and repetitive torso twisting to move material from the side to the machine. These motions may contribute to elevated rates of neck, shoulder, back and hip pain (Blåder, 1991; Anderson, 1993; Punnett, 1987; Jensen, 1993; Li 1982; Vihma, 1982; Chan, 2002; Serratos-Perez, 1993; Cole, 1996; Westgaard, 1992).

The purpose of this project was to determine whether a newly developed ergonomic intervention applied to sewing machine operators working in Los Angeles garment shops – and previously tested for acceptance by workers in Northern California (Chan, 2002) – can reduce rates of neck/shoulder and back/hip musculoskeletal disorders, severity of pain and impairment, and lost-time.

In addition to the project's main objectives, we made use of all data available from the ongoing intervention study to improve the understanding of the effect of work organizational factors both on the risk of developing work-related musculoskeletal disorders (WMSDs) and the recovery from these disorders in sewing machine operators; we also tried to determine whether these risks are likely to be affected by factors related to lifestyle, medical history, family structure, and social support.

The results may help to understand the multifactorial nature of WMSDs regarding the role of physical and psychological workplace factors and individual characteristics in the etiology and development of musculoskeletal pain. It may also be useful for advancing our knowledge about the effectiveness of ergonomics intervention programs to reduce the risk of WMSDs for sewing machine operators. We presented our findings according to these study aims in three separate papers.

Our specific aims were to:

B. Specific Aims

<u>a. Originally we proposed to</u>

1. Compare the effects of a new ergonomic task chair, a conventional task chair, and a placebo intervention assigned to industrial sewing operators with and without neck/shoulder pain, and back/hip pain on a primary outcomes "monthly pain severity".
2. Identify demographic, psychosocial, and work factors of participants who benefit from the ergonomic intervention such that they experienced a reduction in upper extremity, neck, low back pain or a reduced risk of musculoskeletal disorders in general.

<u>b. The following aims we added during project period:</u>

3. Assess whether work organizational factors are associated with WMSDs;
4. Assess how work organizational factors correlate with WMSDs outcomes; and

5. Explore factors affecting or modifying an individual's self-reported pain over time.

C. Procedure

A total of 520 subjects from 13 shops were recruited, and completed a baseline interview and a first time physical examination. 478 subjects in 11 shops were randomly assigned to one of the two intervention groups (3 shops with 42 subjects dropped out of the study before randomization). Four shops located in the South El Monte area accounted for 178 of the subjects enrolled (37.2%), while five shops located in the Los Angeles Chinatown area accounted for 96 of our subjects (20.0%), and two shops located in the Los Angeles downtown area accounted for another 204 subjects (42.7%). The number of subjects in each shop varied from 11 to 146 at enrollment. Epidemiological data were collected with the help of a series of standardized questionnaires and interviews administered during field study visits. Diagnoses were derived from physical examinations by four occupational nurses during the baseline exam, at the time of subjects drop out, and at the end of the study.

D. Methods

<u>Recruitment of Garment Shops and participants</u>

The study population was recruited from two difference sources. First, we recruited subjects working in 18 shops belonging to the Garment Contractors Associations (GCA) in Los Angeles. All of these shops are located in the Los Angeles Chinatown, and Gardena area. We found that there were approximately 150 potential participants working in these shops. Thus in order to recruit enough subjects, we also randomly selected eleven shops listed in the 2001 South California Garment manufacturers and contractors' registration database, and visited each of those shops. We further restricted the selection of shops to an area within 50 miles proximity of UCLA.

Overall, we had contact with 29 shops at the start of our study. Altogether 13 shops decided to participate after a first visit. When shop owners agreed to allow workers to participate in our study, we distributed flyers that described our general study design to each employee in the shop. All sewing machine operators were eligible if they fulfilled our recruitment criteria of being stable employees. The recruitment criteria were : 1) working on a sewing machine more than 20 hours per week, 2) not planning to leave the current employment within the next 12 months, and 3) having worked for the current employer for at least 3 months.

Eligible participants from each shop were enrolled over a 1-3 month period and the enrollment of subjects from different shops was staggered over time (starting in October 2003 and ending in September 2005). This allowed us to have the same staff conduct the baseline interview and the physical exams at the start of the intervention, and also allowed for a reasonable time to set up all interventions in each shop.

Of the 555 potential participants who filled out the Study Entry Questionnaire at our first visit, 520 met the study eligibility criteria and agreed to enroll. Of the 520 participants who successfully completed the Baseline Interview and the first time Physical Examination, 42 participants from 3 shops rejected our interventions due to economic reasons (too much disruption of their tight work schedules) Therefore, 478 participants from 11 shops actually remained in the intervention study and were assigned to one of the three intervention groups.

<u>Intervention Design</u>

Subjects were randomized to 3 intervention groups: (1) the control group received miscellaneous items, (2) the first intervention group received a curved seat pan chair (ergonomic chair) and miscellaneous items, and (3) the second intervention group received a flat seat pan chair (conventional chair) and miscellaneous items. Both of the ergonomic and conventional chairs were adjustable in height and swiveled (Figure 1). The curved seat pan chair was custom designed with a curved, two-part seat pan for use in the garment industry based on the principles proposed for industrial work (figure 2). The seat pan (43 cm depth x 46 cm wide) had two surface elements, a horizontal rear half and downward sloping front half and included a fore/aft tilt mechanism (11 degree range). It also included a short height back support with a lumbar curve (30 cm wide x 28 cm high, 23 degree pitch) (Soma Ergonomics, Berkeley, CA). The flat seat pan group received a conventional task chair with a flat seat pan (46 cm depth x 48 cm wide) and a flat backrest with minimal lumbar and sacral support (36 cm wide x 41 cm high) (model BH3J, Soma Ergonomics, Berkeley, CA). The back support was taller on this chair to provide the appearance of substantial support and importance. The other features of the chairs were identical. Both chairs swiveled to allow the operator to turn sideways. Both had a 5-point base of support (56 cm diameter) with glides instead of casters. The seat pan was adjustable in height (38 to 50 cm). The cushion was firm and the fabric was breathable. The seat pan was large enough to support the operator but small enough so that s/he could use the backrest and maneuver easily within the space available.

Figure 1. The 2 intervention chairs. The left chair has a flat seat pan and the right chair has the curved seat pan. The front half of the curved pan slopes forward at approximately 15°. Both task chairs are adjustable in height and swivel. The chairs have no castors so that they do not move during sewing.

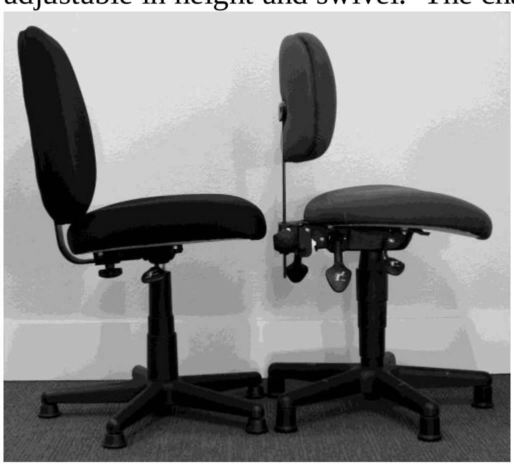
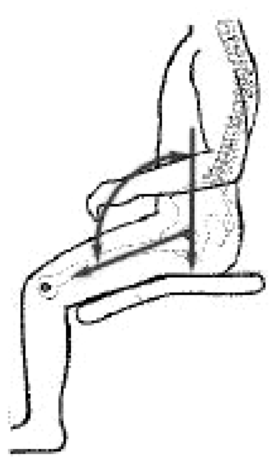


Figure 2. Design of the curved task chair seat pan allowing for a more open thigh-torso angle and preservation of lumbar lordosis.



The miscellaneous items provided to all subjects were a footrest, a small table-top storage box for items such as scissors, a side table, a task lamp, and reading glasses. The miscellaneous items could be rejected by the subjects. The small storage box (11 cm wide x 8 cm high x 30 cm long) was meant to help with scissors and a teacup or can. The side table (61 cm wide x 46 cm high x 91 cm long) was designed to support bundles of garments or fabric to be sewn by the worker. At many sites the workstations already had an additional table positioned to the side of the worker to support the fabric, thus our side table was not needed. A fluorescent task lamp with a long adjustable arm (DS-98K, Kanasm, Korea) was installed on each table. The lamp was brighter and generated less heat than the usual sewing lamps. Subjects were offered eye-glasses for use during garment work choosing from a selection of reading glasses (strength 125 to 400, ¼ diopter increments). If the sewing pedal was narrow and could only be used by one foot, a footrest was also provided to support the other foot.

Statistical Analysis (number correspond to specific aims)

1. Assessment of intervention effects: The data analysis followed an intent-to-treat approach, and included only the subset of participants who reported experiencing back/hip pain during the past month at baseline. The primary outcome of the data analysis was the change in pain intensity score over follow-up from month 1 to month 4 after baseline. The difference in pain score change over time between the 2 treatment arms and the control arm was analyzed using a repeated-measure linear regression model with a first-order autoregressive covariance structure. Specifically, the slope of the pain score change in the control group was set to zero, and the estimates for the two intervention groups are presented as the difference in the slope of pain score change between the two intervention groups and the control group. Missing data for the monthly symptoms was imputed i.e. we replaced missing values with the mean pain value of all subjects in the treatment arm at the corresponding point in time.

2. Identification of effect measure modification : Potential effect measure modification due to baseline pain, age, gender, and days worked per week, was assessed in post-hoc stratified analyses, i.e. we assessed the uniformity or non-uniformity of the estimated intervention effects over categories of these factors. A cross-sectional analysis guided our choice and scaling of these predictors (Wang, 2007).

3. Assessment of the influence of work organizational factors on WMSDs: We estimated the effects [odds ratios (OR) and 95% confidence intervals] for work organizational exposure factors on the prevalence of moderate or severe musculoskeletal pain (upper body WMSD) relying on crude and adjusted unconditional logistic regression models. We mutually adjusted our ORs for all twelve presumed risk factors including age, gender, ethnicity, BMI, medical history of MSDs, smoking behavior, garment shop size, years of employment in the garment industry, number of sewing machines operated, number of rest breaks, job strain, and social support (Chan, 2002; Carayon, 1999; Malchaire, 2001). Furthermore, we assessed whether each variable was an independent risk factor for the outcome of interest and, in addition, unlikely to be an intermediate in the causal pathway. Finally, we considered the potential for collinearity among risk factors. Some researchers suggested that the relation between work organizational factors and musculoskeletal pains is not linear (Hagberg, 1995; Jansen, 2004; Winkel, 1994). Therefore, we categorized most continuous variables into quartiles of the observed distribution to examine linear and non-linear associations. Four continuous variables were categorized differently: “number of rests” was split into 3 categories (1, 2, and more than 2 breaks); “work-rest ratio” was split into 3 categories: 0-9.2, 9.2-11.6, and 11.6+ [Note: the California law requires a total 20 minutes rest period and 30 minutes 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-hour and 10-hour shifts and were used to represent appropriate (according to the law) versus non-appropriate work schedules in our population]. Finally, some variables were categorized into 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”).

4. Assessment of associations between work organizational factors and WMSDs outcomes: First, we described pain frequencies reported for the three body regions when one of the 19 physical signs was present during the physical examinations we condcuted. We also explore the frequency and intensity dimensions of the pain reports with and without physical findings for MSDs in the three body regions. Second, we investigate the reliability of the two MSD measures (self-reported pains and physical finding of MSDs) by body region (a study subject may belong to either or both groups). We defined cases of self-reported pain based on reports of pain experienced in one of the body regions for at least 1 or 2 days in the month before interview. Physical findings of musculoskeletal disorders were defined as signs present in one of the body regions during our nurses’ physical examinations. We estimated Kappa coefficients to test for the independence of the two measures (i.e. whether agreement exceeds chance levels for the two outcome measures), and also employed the marginal homogeneity test (McNemar) to examine whether the two MSD measures arrive at the same conclusion when used to classify subjects as cases and non-cases. Third, we applied the same analysis strategy as above, and compared the reliability of the two MSD measures when using alternative criteria to identify cases i.e. according to symptom reports. We also created a two-dimensional factor that combined both pain frequency and pain intensity (twenty levels) for self-reported pain. Finally, we compared the frequency distributions of individual and work-related risk factors for cases with self-reported pains (according to our primary definition see ‘Data Collection’), cases with physical findings of MSDs in the exam, and for non-cases who did not report pain and for whom we did not record any physical sign during the exam.

5. Explore factors affecting or modifying self-reported neck/shoulder pain: Linear mixed effects models were applied to estimate the intervention effects and effects of other factors of interest on pain score change over follow-up time (Singer, 1998). The linear mixed effects models included the following components: fixed effects, random effects, and non-independent covariance structures. The estimates for fixed effects were assumed to be constant for all subjects. They included time-independent estimates for individual and psychosocial factors collected at baseline, such as age and gender, and time-varying estimates for factors collected over follow-up time, such as the number of sewing tasks performed and changes in work schedule. To account for non-linearity in the outcome measures over time, we included a linear spline function of follow-up time with a change point at the first month of follow-up. The specification of a linear spline function allows us to estimate the non-linear trajectory of pain score change over follow-up time. We controlled for the type of intervention package each worker received in all models. In addition, because our outcome variable - neck/shoulder pain recovery pattern - was measured at multiple time points for each subject i.e. longitudinally, we specified a first-order autoregressive [AR(1)] covariance structure for all linear mixed effects models. The AR(1) covariance structure allows us to account for the potential correlations among outcome measures at different time points within each subject, and to specify the correlations of two consecutive outcome measures between increasing time intervals. Our primary analysis included three linear mixed effects models to examine the main effect of intervention over follow-up time while controlling for potential confounders. Our first or ‘basic’ model included a time factor in addition to the intervention effect term to establish the unadjusted pattern of pain score change over time for all subjects. We adjusted for baseline pain intensity in our ‘simple’ second adjusted model, and in the third ‘fully’ adjusted model, we added twelve additional covariates to the second model. These covariates were chosen based on reports in the literature and because in our previous cross-sectional study we found that they were important (Thomas, 2005;National Institute for Occupational Safety and Health, 1997;Wang ,2007); these were gender, age, ethnicity, medical history of musculoskeletal problems, overtime work, number of tasks performed, number of sewing machines operated in the past 4 weeks, total rest time per day, job strain, social support, job dissatisfaction, and

perceived physical workload. Information about all of these factors was collected at baseline, except for workdays per week and number of tasks performed in the past 4 weeks, which were collected longitudinally throughout follow-up. For the fully adjusted model described above we assume that each factor of interest has a constant effect on pain reduction over follow-up time. Thus, we further investigated the interaction between follow-up time and each factor separately, adjusting for all other covariates already included in the fully adjusted model. In other word, we examined whether each of these factors altered recovery from neck/shoulder pain over follow-up time. Because our outcome variable was defined as the proportion of pain at baseline, this variable was by definition set to 100% at baseline for each subject. Thus, in our interaction models, the difference in intercept (or baseline pain) between categories of each factor cannot be estimated, instead the slope for each category was estimated. The difference between these interaction models and the fully adjusted model can be viewed as following: in the fully adjusted model, the pattern of pain reduction over follow-up time is assumed to be parallel for each category of a factor, while in the interaction models the pattern of pain reduction over follow-up time allows for different slopes at each level of that factor. All statistical analyses (from 1 to 5) were performed using statistical software SAS version 9 (SAS Institute Inc. 2002).

E. Results

We completed the intervention field study and published papers and results evaluating our interventions and additional risk factors for musculoskeletal disorders including work-related psychological factors and work-organizational factors. We are also in the process of completing a brochure for the California Department of Public Health that applies our findings and provides work-related health information to sewing machine operators. Key study findings and references to published papers are provided below.

1. Study to evaluate the effects of ergonomic interventions on neck/shoulder pain (Rempel, 2007)

This is a 4 month randomized controlled trail to evaluate the effect of chair design on neck/shoulder pain among sewing machine operators. 277 sewing machine operators with neck/shoulder pain were assigned to receive (1) miscellaneous items (control group), (2) a chair with a flat seat pan plus miscellaneous items, or (3) a chair with a curved seat pan plus miscellaneous items. Participants completed a monthly questionnaire assessing neck/shoulder pain severity. The mean pain score at baseline was 2.4 (± 1.0); 50.2% reported a pain score of 3 or more and 11.9% reported a pain score of 4 or more. All participants were immigrant workers, with a mean age of 37.4 years (range 18-65); the majority were female (65.7%), Hispanic (73.3%) or Asian (23.8%). Other characteristics of the participants were that 57.8% were overweight (BMI > 25), only 5.4% were current smokers, 43% had less than high school education, 85.6% had no health insurance, 81.2% had lived in the US for more than 5 years, and 92.3% could speak only a few words or less of English. Differences in the demographic characteristics of the participants by treatment group were generally small (Table 1 in appendix 1). The unadjusted change in neck/shoulder pain severity scores over time by treatment group are presented in Figure 1a (appendix 1). The treatment group data adjusted to the pain score changes in the control group (slope = 0) are presented in Figure 1b (appendix 1). In the unadjusted analysis, the mean pain score in the control group increased over the follow-up period. In the flat chair intervention group, the pain also worsened over the follow-up period but the magnitude of increase was less than in the control group. In the curved chair intervention group, there was an improvement in mean pain scores during the follow-up period. Based on estimates of pain score changes from a repeat-measures linear regression, participants who received the flat seat chair experienced a decline in pain of 0.14 (95% CI: 0.07 to 0.22) points per month compared to those in the control group, while those who received the curved seat experienced a decline of 0.34 (95% CI: 0.28 to 0.41) points per month compared to those in the control group. These estimates did not change after adjustment for potential covariates. The results from the post-hoc stratified analyses (table 2 in appendix 1) showed that participants in the curved chair intervention group with baseline pain score ≤ 2 had slightly more pain improvement than those with a baseline pain score >2. Participants with a history of systemic illness had larger improvement in mean pain scores in both intervention groups than those without a history of systemic illness. Participants in the curved chair intervention group who had less total rest time, low job control, low job demands, low social support and high perceived physical isometric workload (all examined separately) had larger pain improvement, compared to their counterparts. No significant differences in the estimates for the intervention effects on pain improvement were found when stratifying according to the following factors: ethnicity, medical history of MSD, workdays per week, perceived physical workload, number of rests in a day, pay method, job stress, job dissatisfaction, job security, perceived physical exertion, and perceived physical workload (data not shown in table).

At the end of the study, subjects completed a brief exit interview. Most subjects reported that it took less than 5 days to get used to the study workstation setup (control group, 90.1%; flat seat group, 50.0%; curved seat group, 67.3%). When asked how they felt about the new workplace design compared with their old setup, almost all reported that it was better or much better (control group, 91.2%; flat seat group, 92.7%; curved seat group, 89.8%).

2. Study to evaluate the effects of interventions on back/hip pain (Wang, 2008)

This 4-month intervention study randomized 293 sewing machine operators with back/hip pain to one of two interventions or a control group. All participants received a placebo intervention package of miscellaneous items; participants in the two intervention arms also received either a height adjustable flat-seat-pan (flat) chair or a fully adjustable curved-seat-pan (curved) chair. The mean pain score at baseline was 2.58 (± 1.1). All participants were immigrant workers, with a mean age of 38 years (range 18-68); most were female (61.1%) and Hispanic (77.8%). Other notable characteristics were that 63% of the participants were overweight (BMI > 25), only 5% were current smokers, 45% had less than high school education, 86% had no health insurance, 78% had lived in the US for more than 5 years, but 93% could speak only a few words or less of English (table 1 in appendix 2). The unadjusted and adjusted change in back/hip pain severity scores over time and by treatment group are presented in Figure 1 (appendix 2). The raw data indicate that pain scores in the control group worsened over the follow-up period, while the pain scores did not change much for the curved chair group. However, there was an improvement in pain scores in the flat chair group (Figure 1A in appendix 2). After adjusting for pain changes in the control group both intervention groups showed a consistent decrease in pain score over the follow-up period (Figure 1B in appendix 2). We evaluated pain score changes over 4 months of follow-up in the two intervention groups compared to the control group using repeated measure linear regression models. Compared to the control group, the pain improvement for the flat chair intervention was 0.43 points (95% CI: 0.34, 0.51) per month, while the pain improvement for the curved chair intervention was 0.25 points (95% CI: 0.16, 0.34) per month.

The results from the post-hoc stratum-specific analyses using the repeat-measures linear regression model are shown in (table 2 in appendix 2). Subjects with greater baseline pain (pain score > 2) reported more pain improvement with the flat seat pan compared to the curved chair. Males also reported more pain improvement with the flat seat pan compared to the curved chair; while females reported more pain improvement with the curved pan. Those with a BMI over 25 reported a greater reduction in pain with the flat pan while those with a normal BMI reported greater improvement with the curved pan. Subjects with a history of systemic illness had less pain improvement in both intervention groups than those without a history of systemic illness. Subjects perceived high job strain and low physical isometric load had more pain improvement with flat pan, and the improvement were greater compared to curved pain. No differences were observed in the estimates for the intervention effects on pain improvement when stratifying on the following factors: age, medical history of MSD, workdays per week, perceived physical workload, number of rests in a day, pay method, job stress, job dissatisfaction, job security, and perceived physical workload (data not shown in table).

3. Study to evaluate work-related risk factors for upper body musculoskeletal disorders in sewing machine operators (Wang, 2007)

This is a cross-sectional study of self-reported musculoskeletal symptoms among 520 sewing machine operators from 13 garment industry sewing shops. We assessed the contribution of work-organizational and personal factors to the prevalence of WMSDs among garment workers in Los Angeles. Details of work tasks, shops, and subject characteristics were presented in table 1 in appendix 3. The prevalence of moderate or severe musculoskeletal pain in the neck/shoulder region was 24.0% and for distal upper extremity it was 15.8% (table 2 in appendix 3). 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 musculoskeletal disorder 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 (table 3 in appendix 3). Work-organizational and personal factors were associated with increased prevalence of moderate or severe upper body musculoskeletal pain among garment workers (table 4 in appendix 3).

4. Correlation between subjective self-reported pains and physical findings of WMSDs in three upper body regions including the neck/shoulder, elbow/forearm, and hand/wrist. (Wang: in press)

We evaluated the correlation between self-reported pain experienced in the past one month period and signs identified in a physical examination by trained nurse practitioners among 520 sewing machine operators. We also describe association between potential individual and work-related risk factors and these two different outcome measures of WMSDs. Reports of pain and physical exam findings for WMSDs are two common outcome measures independently used to assess WMSDs in the scientific literature. How these measures correlate with each other, however, is largely unknown.

In our study self-reports of pains and physical findings resulted in different and partly non-overlapping classifications of subjects as WMSDs cases. Our two measures to classify subjects as MSD cases, (ie., using either the physical examination results or self-reported pain) were poorly correlated with each other (Table 1 in appendix 4) according to the McNemar test (Probability of homogeneity <0.0001 indicated heterogeneity between the two MSD classifications for all three body regions). There was also poor agreement beyond chance between the two outcomes according to the Kappa measure (Kappa=0.23 for neck/shoulder, 0.15 for arm/forearm and 0.24 for hand/wrist). Even though marginal homogeneity improved when we adopted alternative case definition strategies, such as requiring that subjects reported having experienced pain every day in past 30 days with an intensity of more than 1 or 2, agreement for the two MSD measures remained low for all three body regions.

When comparing individual and work-related potential risk factors, we found that cases defined according to either of our two outcome measures were more similar and differed from non-cases (Table 2-1and 2-2 in appendix 4). Both outcome measures were found to be consistently associated with 'having a medical history of musculoskeletal disorders' and 'perceived physical exertion'; however, we observed inconsistency for the measures for a number of other job related factors such as 'operating a single machine' and 'number of work hours per week'.

5. Assessment of demographic, ergonomic and psychosocial work-related factors affecting or modifying self-reported neck/shoulder pain (Unpublished)

We investigated self-reported neck/shoulder pain in 247 workers who participated in a 4 months prospective intervention study for musculoskeletal disorders. Here, we examined the influence of additional factors on changes in neck/shoulder pain during follow-up while controlling for ergonomic interventions. Work-related information and musculoskeletal pain reports were gathered in a standardized interview at baseline and in four monthly follow-up surveys. Employing linear mixed models with time-spline functions we examined whether and how individual characteristics and work-related factors influenced self-report neck/shoulder pain. We observed a dramatic decline (72%) in self-reported pain intensity in the first month of follow-up, followed by a small increase from the first to fourth month (4% per month). Workers who perceived and reported their physical workload as high or worked overtime experienced less overall pain reduction. Higher baseline pain intensity, being of Hispanic ethnicity (vs Asian), and taking cumulative daily rest time during work of 35 minutes or more allowing for muscles to rest were associated with a larger pain reduction in the first month, but not thereafter (table 1 in appendix 5). We observed a non-monotonic trend for self-reported neck/shoulder pain during the study's follow-up period some of which may have been due to the interventions we provided. However, independent of our ergonomic intervention, having lower physical workloads and less overtime work also reduced neck/shoulder pain.

F. Discussion

Our randomized control trial demonstrated that garment workers experience a decline in neck, shoulder, back and hip pain if they are provided height-adjustable task chairs that can swivel. A chair with a curved seat pan can reduce pain severity in the neck and shoulder region.

However, we observed a greater reduction in back and hip pain for the chair designed with the flat seat pan compared with the curved seat pan for men and garment workers who are overweight or obese. These findings suggest that the curved seat is not as effective for physically larger garment workers. One possible reason for this may be that the size of seat pans used in this study differed between the two chairs. The curved seat pan was 43 cm deep and 46 cm wide, and the flat pan was 46 cm deep and 48 cm wide. The curved chair may require further refinements to accommodate the physical needs of larger garment workers or the concept may not be effective for all larger workers. Further studies evaluating the effectiveness of curved chairs with several seat pan and backrest sizes applied to workers of different anthropometric types are warranted.

The findings from our baseline cross-sectional analyses suggested that owners of sewing companies may be able to reduce or prevent WMSDs among employees by adopting rotations between different types of workstations, i.e. by increasing task variety; and by either shortening work periods or increasing rest periods to reduce the work-rest ratio; and by improving the work organization to control psychosocial stressors.

We identified inconsistency for associations between measures of job related factors and self-reported pain *versus* clinical signs identified during the physical examinations that suggested that research results in studies of WMSDs may depend on whether they relied on self-reported pain measures or physical exam findings.

We also identified two prognostic factors, having lower physical workloads and less overtime work, that were associated with reductions in neck/shoulder pain independent of our ergonomic intervention.

The data we collected and analyzed in sewing machine workers allowed us to evaluate upper body WMSD the influence that our interventions and factors related to the physical and psychosocial workplace, and some individual characteristics had on the risk of developing or recovering from work-related musculoskeletal disorders.

We also collaborated with the UCLA labor Occupational Safety and Health (LOSH) program to create a two pages brochure and a poster in three languages based on the findings from this study. These materials have been distributed to garments shops in the Los Angeles Basin. Currently our research team is also working with the LOSH, Hazard Evaluation System and Information Service (HESIS), and the Occupational Health Surveillance and Evaluation Program (OHSEP) to update a pre-existing factsheet for sewing machine operators.

G. Conclusion

Garment workers are a vulnerable working population, since they are primarily immigrants of low socio-economic status, low educational level, and without union representation. Our findings suggest that a number of work-organizational 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.

The findings from our randomized control trial may be generalizable to other seated jobs that are visually demanding and involve the repetitive manipulation of material or parts. Healthcare providers should consider recommending an adjustable height task chair with a swivel function for patients with neck, shoulder, back and hip pain who are garment workers or who perform forward sitting tasks. Finally, owners of sewing companies should consider providing such a task chair for their employees as a way of reducing pain and loss of trained workers due to impaired health.

Because to date no agreed upon "gold standard" for diagnosing musculoskeletal disorders exists, our findings suggest that research results can be very different when using self-reported measures versus physical exam findings. In order to evaluate the success of an intervention, screening, or surveillance program for WMSDs, it is important to define clearly which outcome measure should best be employed.

Our findings also suggest that two work-related factors - having lower physical workloads and less overtime work - may be of clinical relevance for reducing neck/shoulder pain and should be considered when promoting treatment or intervention regimens for work-related musculoskeletal disorders.

Publications

A. Published in peer reviewed journals

1. Rempel DM, Wang PC, Janowitz I, Harrison RJ, Yu F, and Ritz BR. A randomized controlled trial evaluating the effects of new task chairs on shoulder and neck pain among sewing machine operators: the Los Angeles garment study. Spine 2007;32:931-8.

<*Related to specific aim1 and 2*>

2. Wang PC, Rempel DM, Harrison RJ, Chan J, and Ritz BR. Work-organizational and personal factors associated with upper body musculoskeletal disorders among sewing machine operators. Occup.Environ Med 2007 May 23 [Epub ahead of print].

<*Related to specific aim 3*>

3. Wang PC, Ritz BR., Janowitz I, Harrison RJ, Yu F, Chan J, and Rempel DM. A Randomized Controlled Trial of Task Chair Interventions for improvement of Back and Hips Pain among Sewing Operators. J Occup Environ Med. 2008;50:255-62.

<*Related to specific aim1 and 2*>

4. Wang PC, Rempel DM, Hurwitz EL, Harrison RJ, Janowitz I, and Ritz BR. Correlation Between Self-report Pain and Physical Examination for Musculoskeletal Disorders of Upper Body in the Garment Workers Study. Work 2009; 34:79-87.

<*Related to specific aim4*>

5. Wang PC, Ritz BR, Rempel DM, Harrison RJ, Janowitz I. Follow up of Neck And Shoulder Pain among Sewing Machine Operators: The Los Angeles Garment Study. AJIM 2009 (in press).

<*Related to specific aim5*>

B. Presentation and Poster

1. Wang PC, Ritz BR, Rempel DM, Harrison RJ, Chan J, Janowitz I. Work Organization and Work-Related Musculoskeletal Disorders for Sewing Machine Operators in Garment Industry. *Society for Epidemiologic Research 2005 meeting, Poster Sessions 2, Toronto, Ontario, Canada, Jun. 27-30, 2005. American Journal of Epidemiology 2005; 161 Supplement, p S84*

<*Related to specific aim3*>

2. Rempel D, Wang PC, Rempel D, Harrison R, Janowitz I, Ritz B. A Randomized Controlled Trial Evaluating the Effects of Two Task Chair Designs on Shoulder and Neck Pain among Sewing Operators. Human Factors and Ergonomics Society 2006, San Francisco.

<*Related to specific aim1 and 2*>

3. Rempel D, Wang PC, Harrison R, Janowitz I, Ritz B. Recovery Pattern of Neck and Shoulder Pain among Sewing Machine Operators. International Congress on Occupational Health, 2006 Milan.

<*Related to specific aim5*>

4. Rempel D, Wang PC, Rempel D, Harrison R, Janowitz I, Ritz B. Recovery Pattern of Neck and Shoulder Pain among Sewing Machine Operators. National Occupational Research Agenda 2006, Washington, DC.

<*Related to specific aim5*>

5. Wang PC, Ritz BR, Rempel DM, Harrison RJ, Chan J, Janowitz I. Work Organization and Job Stress in Sewing Machine Operators. Work, Stress, and Health conference, *Poster Sessions of Stress/mental health in specific occupations, Miami, Florida, Mar. 1-4, 2006. American Psychological Association.*
<Related to specific aim3>

6. Wang PC, Ritz BR, Rempel DM, Harrison RJ, Chan J, Janowitz I. Using Appropriate Outcome Measure for Musculoskeletal Disorders. *Presentation in work measurement session, Addison, Texas, Mar. 12-15, 2007. 10th Applied Ergonomic Conference.*
<Related to specific aim4>

7. Rempel D, Wang PC, Harrison R, Janowitz I, Yu F, Chan J, Ritz B. A randomized controlled trial of chair interventions on back/hip pain among sewing machine operators. Recovery Pattern of Neck and Shoulder Pain among Sewing Machine Operators. Annual Meeting of the American Academy of Orthopaedic Surgeons, 2008, San Francisco.
<Related to specific aim1, 2, and 5>

Publications in preparation

1. Wang PC, Ritz BR, Rempel DM, Harrison RJ, Chan J, Janowitz I. Work Organization and Job Stress in Sewing Machine Operators.
<Related to specific aim3>

Citation

International Labour Office Geneva: [2004] Labour Practices in the Footwear, Leather, Textiles, and Clothing Industries. 10-16-2000. Geneva, International Labour Organization (ILO). TMLFI/2000.

Chan J, Janowitz I: [2002] Preventing musculoskeletal disorders in garment workers: preliminary results regarding ergonomics risk factors and proposed interventions among sewing machine operators in the San Francisco Bay Area. Appl.Occup.Environ.Hyg17:247-53.

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Program Director/Principal Investigator (Last, First, Middle): Ritz, Beate R

Inclusion Enrollment Report

This report format should NOT be used for data collection from study participants.

Study Title: Ergonomic Interventions for Sewing Machine Operators

Total Enrollment: 520 **Protocol Number:**

Grant Number: 5R01OH007779-03

PART A. TOTAL ENROLLMENT REPORT: Number of Subjects Enrolled to Date (Cumulative) by Ethnicity and Race					
	Sex/Gender				
Ethnic Category	**Females**	**Males**	**Unknown or Not Reported**	**Total**	
Hispanic or Latino	173	176		349	**
Not Hispanic or Latino	162	9		171	
Unknown (individuals not reporting ethnicity)				0	
Ethnic Category: Total of All Subjects*	335	185		520	*
Racial Categories					
American Indian/Alaska Native					
Asian	141	6		147	
Native Hawaiian or Other Pacific Islander					
Black or African American					
White	21	3		24	
More Than One Race	173	176		349	
Unknown or Not Reported					
Racial Categories: Total of All Subjects*	335	185		520	*

PART B. HISPANIC ENROLLMENT REPORT: Number of Hispanics or Latinos Enrolled to Date (Cumulative)					
Racial Categories	**Females**	**Males**	**Unknown or Not Reported**	**Total**	
American Indian or Alaska Native					
Asian					
Native Hawaiian or Other Pacific Islander					
Black or African American					
White					
More Than One Race	173	176		349	
Unknown or Not Reported					
Racial Categories: Total of Hispanics or Latinos**	173	176		349	**

* These totals must agree.

** These totals must agree.

Appendix

Appendix 1. *Study to evaluate the effects of ergonomic interventions on neck/shoulder pain (Rempel, 2007)*

Table Table 1. Demographic Characteristics of Subjects by Intervention Group.

		Control Intervention (n = 105)		Flat Seat Intervention (n = 100)		Curved Seat Intervention (n = 72)	
Variable	Category	No.	%	No.	%	No.	%
Gender	Female	71	67.6	67	67.0	43	59.7
	Male	34	32.4	33	33.0	29	40.3
Age group (yr)	Mean (SD)	38.1	(8.5)	37.2	(9.2)	36.5	(10.7)
	<30 yr	19	18.1	18	18.0	26	36.1
	30–39 yr	42	40.0	41	41.0	14	19.4
	40–49 yr	33	31.4	30	30.0	22	30.6
	≥50 yr	11	10.5	11	11.0	10	13.9
Ethnicity	Asian/Pacific Islander	0	0.0	40	40.0	26	36.1
	Hispanic	103	98.1	55	55.0	45	62.5
	White	2	1.9	5	5.0	1	1.4
Marital status	Live alone	26	25.7	20	23.0	14	24.1
	Cohabitating but not married	38	37.6	20	23.0	9	15.5
	Married but separated	20	19.8	13	14.9	13	22.4
	Married and lives with spouse	17	16.8	34	39.1	22	37.9
Children at home	None	23	21.9	24	24.0	19	26.4
	≤5 yr	34	32.4	31	31.0	22	30.6
	>5 yr	48	45.7	45	45.0	31	43.1
BMI (kg/m^2)	Mean (SD)	27.4	(4.4)	24.8	(4.2)	26.1	(4.0)
	Underweight (<18.5)	0	0.0	2	2.2	0	0.0
	Normal (18.6–24.9)	30	28.8	52	57.1	25	39.7
	Overweight (25–29.9)	51	49.0	29	31.9	28	44.4
	Obese (>29.9)	23	22.1	8	8.8	10	15.9
Physical activity	None	42	40.0	38	38.0	24	33.3
	Less than once per week	5	4.8	8	8.0	8	11.1
	Once or twice per week	34	32.4	33	33.0	27	37.5
	Three or more times per week	24	22.9	21	21.0	13	18.1
Smoking	None	88	83.8	91	91.0	59	81.9
	Past smoker	11	10.5	6	6.0	7	9.7
	Current smoker	6	5.7	3	3.0	6	8.3
Medical history of systemic illness	No	86	81.9	82	82.0	57	79.2
	Yes	19	18.1	18	18.0	15	20.8
Medical history of musculoskeletal disorders	No	96	91.4	87	87.0	62	86.1
	Yes	9	8.6	13	13.0	10	13.9
Health insurance	No	88	83.8	88	88.0	61	84.7
	Yes	17	16.2	12	12.0	11	15.3
Education	Primary	61	58.1	31	31.0	27	37.5
	High school	39	37.1	63	63.0	41	56.9
	University or above	5	4.8	6	6.0	4	5.6
Years in United States	Mean (SD)	15.9	(8.0)	10.8	(5.9)	9.6	(5.4)
	<5 yr	12	11.4	21	21.0	19	26.4
	5–10 yr	10	9.5	20	20.0	21	29.2
	10–20 yr	25	23.8	37	37.0	21	29.2
	>20 yr	58	55.2	22	22.0	11	15.3
English ability	None at all	14	13.3	19	19.0	13	18.1
	Only a few words	84	80.0	74	74.0	49	68.1
	Enough to get by	5	4.8	7	7.0	10	13.9
	Very well	2	1.9	0	0.0	0	0.0

Figure 1. Pain score changes between months 1 and 4. Crude pain score changes (A) and model of pain score slope relative to control group (B).

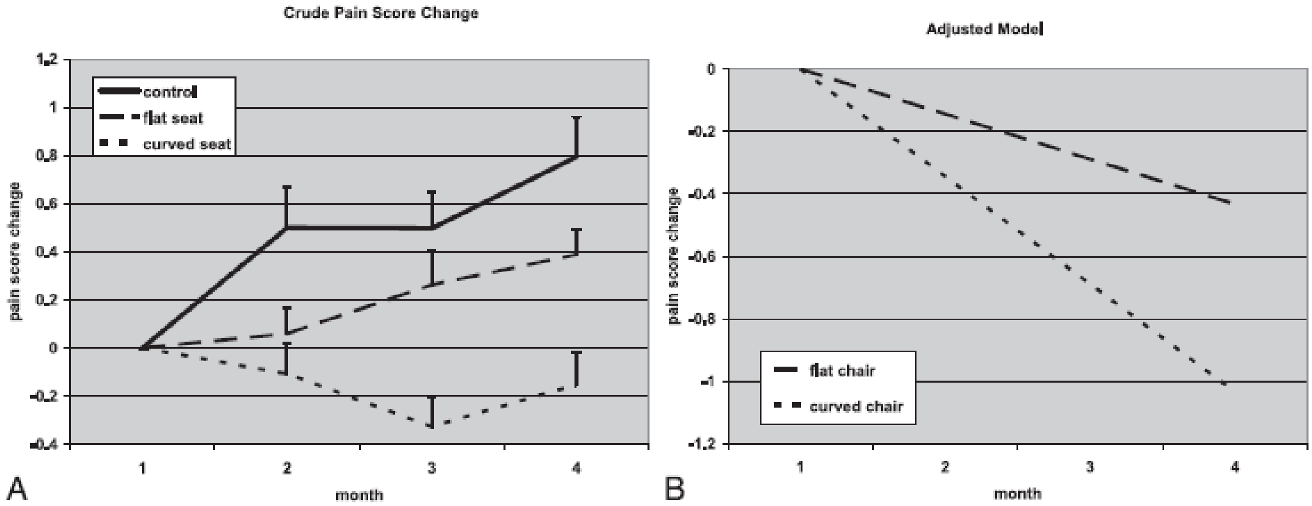

Table 2. Estimates (95% CI) of Difference in Slopes of Neck Pain Score Change Over Time Based on the *Post Hoc* Stratified Analyses.

Covariate	Flat Seat Intervention	Curved Seat Intervention	Difference Between Curved and Flat Seat
Baseline pain score			
≤2 (n = 138)	−0.13 (−0.28, 0.01)	−0.37 (−0.51, −0.24)	−0.24 (−0.38, −0.10)
>2 (n = 139)	−0.14 (−0.31, 0.03)	−0.31 (−0.45, −0.16)	−0.17 (−0.34, 0.01)
History of systemic illness			
With (n = 52)	−0.21 (−0.45, −0.01)	−0.51 (−0.72, −0.30)	−0.29 (−0.61, −0.02)
Without (n = 225)	−0.13 (−0.20, −0.05)	−0.31 (−0.37, −0.25)	−0.18 (−0.27, −0.09)
Total rest time per day			
≤35 min (n = 40)	−0.09 (−0.28, −0.09)	−0.42 (−0.59, −0.26)	−0.32 (−0.55, −0.10)
>35 min (n = 237)	−0.14 (−0.22, −0.06)	−0.31 (−0.37, −0.24)	−0.17 (−0.27, −0.06)
Job control			
High (n = 141)	−0.12 (−0.21, −0.04)	−0.27 (−0.35, −0.20)	−0.15 (−0.27, −0.03)
Low (n = 136)	−0.17 (−0.29, −0.05)	−0.45 (−0.55, −0.35)	−0.27 (−0.43, −0.12)
Job demands			
High (n = 135)	−0.09 (−0.19, 0.01)	−0.30 (−0.38, −0.21)	−0.21 (−0.34, −0.07)
Low (n = 142)	−0.21 (−0.31, −0.11)	−0.41 (−0.49, −0.32)	−0.20 (−0.33, −0.06)
Social support			
High (n = 178)	−0.14 (−0.24, −0.05)	−0.30 (−0.37, −0.22)	−0.15 (−0.28, −0.03)
Low (n = 99)	−0.15 (−0.26, −0.03)	−0.44 (−0.55, −0.33)	−0.29 (−0.46, −0.14)
Perceived physical isometric workload			
High (n = 118)	−0.18 (−0.28, −0.08)	−0.44 (−0.53, −0.35)	−0.26 (−0.40, −0.13)
Low (n = 158)	−0.07 (−0.18, 0.03)	−0.22 (−0.31, −0.14)	−0.15 (−0.28, −0.02)

The first two columns show the estimates of difference in slopes of pain score change over time between two intervention groups and the control group. The last column shows the difference in slopes between two intervention groups (*i.e.*, slope of control group was set to 0).

Appendix 2. *Study to evaluate the effects of interventions on back/hip pain (Wang, 2008)*

Table 1. Demographic Characteristics of Subjects by Intervention Group Reporting Back and Hip Pain at Baseline (*N* _ 293).

Variables	Control (*N* = 111)		Curved Chair (*N* = 84)		Flat Chair (*N* = 98)	
	n	%	*n*	%	*n*	%
Gender						
Female	71	64.0	54	64.3	54	55.1
Male	40	36.0	30	35.7	44	44.9
Age group						
Mean (SD)	36.9 (9.0)		37.5 (10.5)		34.9 (9.5)	
<30	26	23.4	21	25.0	34	34.7
30–39	42	37.8	29	34.5	32	32.7
40–49	34	30.6	21	25.0	24	24.5
≥50	9	8.1	13	15.5	8	8.2
Ethnicity						
Asian/Pacific Islander	0	0.0	30	35.7	28	28.6
Hispanic	109	98.2	51	60.7	68	69.4
White	2	1.8	3	3.6	2	2.0
Marital status						
Live alone	29	26.9	17	23.3	23	31.1
Cohabitating but not married	37	34.3	15	20.5	18	24.3
Married but separated	23	21.3	13	17.8	14	18.9
Married and live with spouse	19	17.6	28	38.4	19	25.7
Children at home						
None	22	19.8	20	23.8	21	21.4
≤5 yr	41	36.9	28	33.3	35	35.7
>5 yr old	48	43.2	36	42.9	42	42.9
Body mass index						
Mean (SD)	27.4 (3.8)		25.1 (3.6)		26.5 (4.1)	
Underweight (<18.5 kg/m^2)	0	0.0	9	10.7	0	0.0
Normal (18.6–24.9 kg/m^2)	28	25.2	39	46.4	32	32.7
Overweight (25–29.9 kg/m^2)	57	51.4	29	34.5	49	50.0
Obese (>29.9 kg/m^2)	26	23.4	7	8.3	17	17.3
Physical activity (not work related)						
None	45	40.5	29	34.5	31	31.6
Less than once per week	5	4.5	7	8.3	8	8.2
Once or twice per week	36	32.4	29	34.5	41	41.8
Three or more times per week	25	22.5	19	22.6	18	18.4
Smoking						
None	92	82.9	75	89.3	75	76.5
Past smoker	13	11.7	6	7.1	18	18.4
Current smoker	6	5.4	3	3.6	5	5.1
Medical history of systemic illness*						
No	91	82.0	66	78.6	85	86.7
Yes	20	18.0	18	21.4	13	13.3
Medical history of musculoskeletal disorders						
No	101	91.0	73	86.9	86	87.8
Yes	10	9.0	11	13.1	12	12.2
Health insurance						
No	97	87.4	72	85.7	83	84.7
Yes	14	12.6	12	14.3	15	15.3
Education						
Primary	58	52.3	33	39.3	40	40.8
High school	49	44.1	46	54.8	52	53.1
University or above	4	3.6	5	6.0	6	6.1
Years in the United States						
Mean (SD)	14.9	(7.4)	11.2	(6.8)	8.7	(5.0)
<5 yr	12	10.8	20	23.8	33	33.7
5–10 yr	16	14.4	13	15.5	25	25.5
10–20 yr	24	21.6	31	36.9	29	29.6
>20 yr	59	53.2	20	23.8	11	11.2
English ability						
None at all	12	10.8	15	17.9	22	22.4
Only a few words	91	82.0	61	72.6	70	71.4
Enough to get by	6	5.4	8	9.5	6	6.1
Very well	2	1.8	0	0.0	0	0.0
Work (hr/wk); mean (SD)	42.2 (5.2)		43.9 (7.3)		44.8 (8.2)	

*The list of systemic illnesses or diseases included medical diabetes (excluding pregnancy-related diabetes), rheumatoid arthritis, lupus erythematodes, degenerative arthritis (osteoarthritis), hyper- or hypothyroidism, chronic renal failure, and gout.

Figure 1. Pain score changes between months 1 and 4. Crude pain score changes (A) and model of pain score slope relative to control group (B).

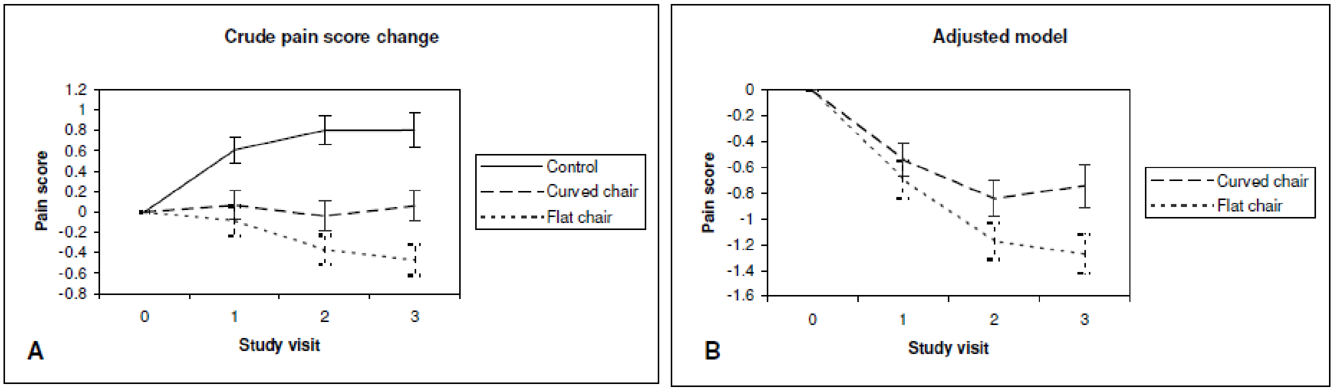

Table 2. Estimates (95% CI) of Pain Improvement Over Time Based on the Post Hoc Stratified Analyses Using the Repeat-Measures Linear Regression Models Adjusted for the Changes in Control Groups Over Time (ie, Slope of Control Group Was Set to 0).

	Flat Chair			Curved Chair		
Covariates	***N***	**Estimate**	**95% CI**	***N***	**Estimate**	**95% CI**
Baseline pain						
Score ≤2	46	0.3	(0.2, 0.41)	46	0.27	(0.17, 0.37)
Score >2	52	0.53	(0.38, 0.68)	38	0.23	(0.06, 0.4)
Age group						
<30	34	0.51	(0.37, 0.64)	21	0.27	(0.13, 0.4)
30–39	32	0.34	(0.2, 0.48)	29	0.07	(0.08, 0.22)
40–49	24	0.78	(0.49, 1.07)	21	0.27	(0.04, 0.49)
≥50	8	0.42	(0.3, 0.54)	13	0.53	(0.37, 0.68)
Gender						
Female	54	0.36	(0.22, 0.5)	54	0.42	(0.27, 0.58)
Male	44	0.48	(0.36, 0.6)	30	0.15	(0.03, 0.28)
Ethnicity						
Asian/Pacific Islander	28	0.41	(0.04, 0.87)	30	0.65	(0.28, 1.02)
Hispanic	68	0.47	(0.38, 0.56)	51	0.35	(0.24, 0.45)
White	2	0.44	(0.3, 0.58)	3	0.14	(0, 0.27)
Medical history of systemic illness						
No	85	0.65	(0.44, 0.86)	66	0.5	(0.28, 0.72)
Yes	13	0.4	(0.31, 0.49)	18	0.22	(0.12, 0.31)
Job strain						
Low	44	0.38	(0.27, 0.49)	36	0.27	(0.16, 0.38)
High	54	0.52	(0.41, 0.64)	48	0.27	(0.14, 0.4)
Physical exertion						
Low	39	0.46	(0.35, 0.57)	34	0.23	(0.11, 0.35)
High	59	0.41	(0.3, 0.52)	50	0.33	(0.21, 0.45)
Physical isometric loads						
Low	46	0.53	(0.42, 0.64)	38	0.27	(0.15, 0.38)
High	52	0.35	(0.23, 0.46)	45	0.28	(0.16, 0.41)
Body mass index						
Normal (18.6–24.9 kg/m^2)	32	0.36	(0.22, 0.5)	39	0.34	(0.21, 0.47)
Overweight/obese (>25 kg/m^2)	66	0.49	(0.59, 0.38)	36	0.22	(0.36, 0.09)

Appendix 3. *Study to evaluate work-related risk factors for upper body musculoskeletal disorders in sewing machine operators (Wang, 2007)*

Table 1. Demographic characteristics for all subjects working as sewing machine operators in Los Angeles, California (n = 520)

Variable	Category	Number	%*
Gender	Female	335	64.4
	Male	185	35.6
Age group	Mean (SD)	37.7	(9.9)
	<30	121	23.3
	30–39	176	33.8
	40–49	153	29.4
	⩾50	70	13.5
Ethnicity	Asian/Pacific Islander	147	28.3
	Hispanic	349	67.1
	Caucasian	24	4.6
Educational level	Primary	235	45.2
	High school	261	50.2
	University or more	23	4.4
Marital status	Living alone	110	21.2
	Cohabitating but not married	110	21.2
	Married but separated	75	14.4
	Married and living with spouse	166	31.9
Living with children	No children	120	23.1
	Equal or less than 5 years of age	157	30.2
	More than 5 years of age	243	46.7
Supporting other family members outside of their own household	No	235	45.2
	Yes	285	54.8
Body mass index (BMI)	Mean (SD)	26.2	(4.8)
	Underweight (<18.5 kg/m^2)	6	1.2
	Normal (18.6–24.9 kg/m^2)	195	37.5
	Overweight (25–29.9 kg/m^2)	203	39.0
	Obese (>29.9 kg/m^2)	83	16.0
Non-work-related physical activity	None	194	37.3
	Less than once per week	34	6.5
	Once or twice per week	171	32.9
	Three or more times per week	121	23.3
Smoking behaviour	Non-smoker	441	84.8
	Past smoker	54	10.4
	Current smoker	25	4.8
Medical history of systemic illness†	None	443	85.2
	Any	77	14.8
Medical history of musculoskeletal disorders	None	468	90.0
	Any	52	10.0
Years lived in the United States	Mean (SD)	12.0	(7.2)
	<5 years	109	21.0
	5–10 years	103	19.8
	10–20 years	148	28.5
	>20 years	160	30.8
English-speaking ability	None at all	117	22.5
	Only a few words	357	68.7
	Enough to get by or very well	46	8.8
Years of employment in garment industry	Mean (SD)	11.1	(7.3)
	<7	154	29.6
	7–10	106	20.4
	11–15	152	29.2
	>15	108	20.8

* Some percentages do not total 100 because of rounding; † the list of systemic illnesses or diseases included: diabetes (excluding diabetes solely related to pregnancy), rheumatoid arthritis, lupus erythematodes, degenerative arthritis (osteoarthritis), low thyroid or overactive thyroid, chronic renal failure, and gout.

Table 2. Intensity and frequency of upper body musculoskeletal pain for the 30 days prior to the interview (n = 520)

	Symptoms by anatomical site		
	Neck/ shoulders	Arms/ elbows	Hands/ wrists
Pain	**n (%*)**	**n (%*)**	**n (%*)**
Frequency			
No pain	218 (41.9)	434 (83.5)	374 (71.9)
One or 2 days/month	58 (11.2)	14 (2.7)	25 (4.8)
One day/week	73 (14.0)	26 (5.0)	34 (6.5)
Several days/week	108 (20.8)	28 (5.4)	53 (10.2)
Every day	63 (12.1)	18 (3.5)	34 (6.5)
Intensity (0–5 scale)			
Mean score (SD)	1.4 (1.4)	0.4 (1.1)	0.7 (1.3)
0	218 (41.9)	434 (83.5)	374 (71.9)
1–2	156 (30.0)	46 (8.8)	73 (14.0)
3–5	146 (28.1)	40 (7.7)	73 (14.0)

	Prevalence by anatomical regions	
Prevalence of moderate or severe pain†	Neck/shoulders	Distal upper extremities‡
	n (%)	n (%)
	125 (24.0)	82 (15.8)

*Some percentages do not total 100 because of rounding or some missing value; † defined as subjects experiencing pain at least 1 day per week, with pain intensity of 3 or more out of a maximum score of 5; ‡ subjects who experience musculoskeletal pain in any part of the arms/elbows, and hands/wrists.

Table 3. Generated odds ratio estimates (95% CIs) for selected personal factors on neck/shoulder and distal upper extremity pain

		Neck/shoulder pain				Distal upper extremity pain			
		Number		Crude	Adjusted*	Number		Crude	Adjusted*
Variable	Category	No pain	With pain	OR (95% CI)	OR (95% CI)	No	Yes	OR (95% CI)	OR (95% CI)
Gender	Female	250	85	1.00	1.00	272	63	1.00	1.00
	Male	145	40	0.81 (0.53 to 1.24)	0.50 (0.28 to 0.90)	166	19	0.49 (0.29 to 0.85)	0.55 (0.28 to 1.09)
Age group	<30	84	37	1.00	1.00	105	16	1.00	1.00
	30–39	140	36	0.58 (0.34 to 0.99)	0.50 (0.27 to 0.94)	154	22	0.94 (0.47 to 1.87)	1.03 (0.46 to 2.28)
	40–49	119	34	0.65 (0.38 to 1.12)	0.61 (0.3 to 1.27)	123	30	1.60 (0.83 to 3.1)	1.64 (0.69 to 3.92)
	>49	52	18	0.79 (0.41 to 1.52)	0.79 (0.31 to 2.06)	56	14	1.64 (0.75 to 3.6)	1.61 (0.53 to 4.93)
	p_{trend}†			0.38	0.55			0.07	0.24
Ethnicity	Asian/Pacific Islander	123	24	1.00	1.00	129	18	1.00	1.00
	Hispanic	253	96	1.94 (1.18 to 3.19)	2.00 (0.94 to 4.25)	289	60	1.49 (0.84 to 2.62)	1.47 (0.63 to 3.46)
	Caucasian	19	5	1.35 (0.46 to 3.96)	1.37 (0.43 to 4.34)	20	4	1.43 (0.44 to 4.67)	1.51 (0.43 to 5.31)
Educational level	Primary	179	56	1.00	1.00	197	38	1.00	1.00
	High school	196	65	1.06 (0.70 to 1.60)	1.12 (0.69 to 1.81)	222	39	0.91 (0.56 to 1.48)	0.94 (0.54 to 1.64)
	University or above	19	4	0.67 (0.22 to 2.06)	0.54 (0.15 to 1.93)	18	5	1.44 (0.5 to 4.11)	1.35 (0.40 to 4.52)
Marital status	Living alone	78	32	1.00	1.00	92	18	1.00	1.00
	Cohabitating but not married	77	33	1.04 (0.59 to 1.86)	0.99 (0.52 to 1.91)	93	17	0.93 (0.45 to 1.92)	0.93 (0.42 to 2.06)
	Married but separated	56	19	0.83 (0.43 to 1.61)	0.68 (0.32 to 1.44)	58	17	1.50 (0.71 to 3.14)	1.26 (0.55 to 2.89)
	Married and live with spouse	141	25	0.43 (0.24 to 0.78)	0.51 (0.24 to 1.08)	143	23	0.82 (0.42 to 1.61)	1.16 (0.50 to 2.69)
Living with children	No children	89	31	1.00	1.00	104	16	1.00	1.00
	⩽5 years	115	42	1.05 (0.61 to 1.80)	1.01 (0.55 to 1.87)	134	23	1.12 (0.56 to 2.22)	1.07 (0.49 to 2.32)
	>5 years old	191	52	0.78 (0.47 to 1.30)	0.79 (0.44 to 1.42)	200	43	1.40 (0.75 to 2.60)	1.32 (0.66 to 2.64)
Supporting families outside of household	No	199	36	1.00	1.00	186	49	1.00	1.00
	Yes	239	46	1.38 (0.92 to 2.08)	1.34 (0.82 to 2.20)	209	76	1.06 (0.66 to 1.71)	1.26 (0.71 to 2.21)
BMI	Underweight (<18.5 kg/m^2)	6	0	–	–	6	0	–	–
	Healthy (18.6–24.9 kg/m^2)	150	53	1.00	1.00	167	38	1.00	1.00
	Overweight (25–29.9 kg/m^2)	150	45	1.18 (0.75 to 1.86)	0.94 (0.56 to 1.57)	165	28	1.37 (0.81 to 2.34)	1.15 (0.64 to 2.07)
	Obese (>29.9 kg/m^2)	67	16	0.80 (0.42 to 1.51)	0.60 (0.30 to 1.21)	72	11	0.91 (0.43 to 1.93)	0.71 (0.31 to 1.61)
Physical activity	None	149	45	1.00	1.00	159	35	1.00	1.00
	<once per week	27	7	0.86 (0.35 to 2.10)	0.74 (0.27 to 2.05)	31	3	0.44 (0.13 to 1.52)	0.37 (0.08 to 1.71)
	Once or twice per week	126	45	1.18 (0.73 to 1.90)	1.07 (0.61 to 1.89)	151	20	0.60 (0.33 to 1.09)	0.72 (0.37 to 1.41)
	⩾times per week	93	28	1.00 (0.58 to 1.71)	0.87 (0.48 to 1.58)	97	24	1.12 (0.63 to 2.00)	0.93 (0.49 to 1.76)
	p_{trend}†			0.78	0.82			0.88	0.73
Smoking behaviour	None	339	102	1.00	1.00	368	73	1.00	1.00
	Past smoker	40	14	1.16 (0.61 to 2.22)	1.77 (0.81 to 3.89)	47	7	0.75 (0.33 to 1.73)	1.17 (0.45 to 3.04)
	Current smoker	16	9	1.87 (0.80 to 4.36)	2.20 (0.82 to 5.89)	23	2	0.44 (0.10 to 1.90)	0.57 (0.12 to 2.69)
Physician diagnosed MSDs	No	352	91	1.00	1.00	387	56	1.00	1.00
	Yes	43	34	2.60 (1.44 to 4.70)	3.08 (1.59 to 5.95)	51	26	2.17 (1.12 to 4.21)	2.37 (1.13 to 5.00)
Physician diagnosed systemic illness‡	No	365	103	1.00	1.00	400	68	1.00	1.00
	Yes	30	22	3.06 (1.85 to 5.07)	3.45 (1.88 to 6.30)	38	14	3.52 (2.03 to 6.10)	3.43 (1.81 to 6.51)
Years of employment in garment industry	Quartile 1 (<7)	101	16	1.00	1.00	138	16	1.00	1.00
	Quartile 2 (7–10)	262	95	1.00 (0.55 to 1.80)	0.93 (0.48 to 1.82)	94	12	1.10 (0.50 to 2.43)	1.32 (0.56 to 3.13)
	Quartile 3 (11–15)	31	13	1.13 (0.67 to 1.92)	1.12 (0.60 to 2.07)	121	31	2.21 (1.15 to 4.24)	2.69 (1.26 to 5.73)
	Quartile 4 (>15)	31	13	1.19 (0.67 to 2.11)	1.21 (0.58 to 2.53)	85	23	2.33 (1.17 to 4.67)	2.22 (0.93 to 5.33)
	p_{trend}†			0.49	0.55			0.004	0.02

* Adjusted models included: age, gender, ethnicity, BMI, medical history of MSD, smoking behaviour, shop size, years of employment in garment industry, number of sewing machines operated, number of rest breaks, job strain, and social support; † p value for trend across categories (Pearson's chi-squared test) ;‡ the list of systemic illnesses or diseases included: diabetes (excluding pregnancy-related diabetes), rheumatoid arthritis, lupus erythematodes, degenerative arthritis (osteoarthritis), Hyper- or hypo-thyroidism, chronic renal failure, and gout.

Table 4. Generated odds ratio estimates (95% CIs) for work-organisational factors on neck/shoulder and distal upper extremity pains

		Neck/shoulder pain				Distal upper extremity pain			
		Number		Univariate	Multivariate *	Number		Univariate	Multivariate *
Variable	Category	No pain	With pain	OR (95% CI)	OR (95% CI)	No	Yes	OR (95% CI)	OR (95% CI)
Number of machines operated in the past month	1	323	108	1.00	1.00	359	72	1.00	1.00
	2	37	14	1.13 (0.59 to 2.17)	1.11 (0.53 to 2.31)	44	7	0.79 (0.34 to 1.83)	0.87 (0.35 to 2.14)
	3 and more	35	3	0.26 (0.08 to 0.85)	0.11 (0.01 to 0.89)	35	3	0.43 (0.13 to 1.43)	0.37 (0.08 to 1.73)
	P_{trend}†			0.06	0.07			0.15	0.22
Shop size	Small shops	135	27	1.00	1.00	144	18	1.00	1.00
	Large shops	260	98	1.88 (1.17 to 3.03)	2.42 (1.13 to 5.17)	294	64	1.74 (1 to 3.05)	2.60 (1.1 to 6.17)
Pay method	Small shops								
	Hourly rate	59	7	1.00	1.00	62	4	1.00	1.00
	Piece rate	76	20	2.22(0.88 to 5.60)	2.35 (0.66 to 8.30)	82	14	2.65 (0.83 to 8.43)	1.75 (0.45 to 6.73)
	Large shops								
	Hourly rate	71	36	1.00	1.00	81	26	1.00	1.00
	Piece rate	189	62	0.65 (0.40 to 1.06)	0.54 (0.29 to 1.00)	213	38	0.56 (0.32 to 0.97)	0.63 (0.31 to 1.27)
Work–rest ratio	<9.2	160	40	1.00	1.00	174	26	1.00	1.00
	9.2–11.6	116	52	1.79 (1.11 to 2.89)	1.87 (1.05 to 3.36)	133	35	1.76 (1.01 to 3.07)	1.27 (0.63 to 2.55)
	>11.6	67	25	1.49 (0.84 to 2.65)	2.10 (0.84 to 5.28)	79	13	1.10 (0.54 to 2.26)	1.04 (0.33 to 3.27)
	P_{trend}†			0.08	0.05			0.47	0.77
Physical exertion	Quartile 1 (<7)	124	18	1.00	1.00	128	14	1.00	1.00
	Quartile 2 (7–7.9)	102	31	2.09 (1.11 to 3.96)	1.95 (0.98 to 3.86)	115	18	1.43 (0.68 to 3.01)	1.38 (0.62 to 3.09)
	Quartile 3 (8–8.9)	95	37	2.68 (1.44 to 5.00)	2.15 (1.09 to 4.23)	106	26	2.24 (1.11 to 4.51)	2.08 (0.97 to 4.46)
	Quartile 4 (>8.9)	74	39	3.63 (1.94 to 6.81)	3.30 (1.63 to 6.71)	89	24	2.47 (1.21 to 5.03)	2.92 (1.31 to 6.52)
	P_{trend}†			<0.0001	0.001				
Physical isometric loads	Quartile 1&2 (<5)	258	63	1.00	1.00	274	47	1.00	1.00
	Quartile 3 (5–5.9)	113	46	1.67 (1.07 to 2.59)	1.82 (1.07 to 3.1)	132	27	1.19 (0.71 to 2.00)	1.45 (0.79 to 2.68)
	Quartile 4 (>5.9)	23	16	2.85 (1.42 to 5.71)	3.60 (1.6 to 8.06)	31	8	1.51 (0.65 to 3.47)	1.72 (0.68 to 4.36)
	P_{trend}†			<0.001	<0.001				
Job demands	Quartile 1 (<30)	111	29	1.00	1.00	123	17	1.00	1.00
	Quartile 2 (30–32)	118	30	0.97 (0.55 to 1.72)	1.18 (0.58 to 2.39)	123	25	1.47 (0.76 to 2.86)	1.62 (0.73 to 3.58)
	Quartile 3 (32–35)	83	27	1.25 (0.69 to 2.26)	1.64 (0.72 to 3.73)	96	14	1.06 (0.50 to 2.25)	1.15 (0.43 to 3.04)
	Quartile 4 (>35)	83	39	1.80 (1.03 to 3.14)	2.77 (1.06 to 7.28)	96	26	1.96 (1.01 to 3.82)	2.67 (0.88 to 8.13)
	P_{trend}†			0.02	0.03				
Job satisfaction	Not satisfied	10	7	1.00	1.00	12	5	1.00	1.00
	Somewhat satisfied	180	54	0.43 (0.16 to 1.18)	0.33 (0.11 to 1.01)	198	36	0.44 (0.14 to 1.31)	0.44 (0.13 to 1.42)
	Very satisfied	205	64	0.45 (0.16 to 1.22)	0.34 (0.11 to 1.05)	228	41	0.43 (0.14 to 1.29)	0.31 (0.09 to 1.08)
	P_{trend}†			0.51	0.35			0.42	0.08

* Full model controlled: age, gender, ethnicity, BMI, medical history of MSD, smoking behaviour, shop size, years of employment in garment industry, number of sewing machine operated, number of rest break, job strain, and social support; † p value for trend across categories (Pearson chi-squared test).

Appendix 4. *Correlation between subjective self-reported pains and physical findings of WMSDs in three upper body regions including the neck/shoulder, elbow/forearm, and hand/wrist. (Wang: in press)*

Table 1. Lack of agreement between two MSD outcome measures of self-reported pain and physical sign at exam.

Body regions	Self-reported pain*	Physical sign		Independence test§	Marginal Homogeneity test†
		None	One or more per site	Kappa (95% CI)	*X*McN (Probability)
Any pain for at least 1 or 2 days in the month before interview					
Neck/shoulder	None	211	7		
	Pain reported	242	60	0.23 (0.15, 0.30)	221.79 (<.0001)
Arm/forearm	None	424	10		
	Pain reported	77	9	0.15 (0.01, 0.29)	51.60 (<.0001)
Hand/wrist	None	359	15		
	Pain reported	125	21	0.24 (0.12, 0.36)	86.43 (<.0001)
Pain everyday & with intensity >1 in the month before interview?					
Neck/shoulder	None	402	55		
	Pain reported	51	12	0.07 (-0.03, 0.17)	0.15 (0.68)
Arm/forearm	None	485	17		
	Pain reported	16	2	0.08 (-0.07, 0.22)	0.03 (0.86)
Hand/wrist	None	455	31		
	Pain reported	29	5	0.08 (-0.04, 0.20)	0.07 (0.80)
Pain everyday & with intensity >2 in the month before interview?					
Neck/shoulder	None	408	57		
	Pain reported	45	10	0.05 (-0.04, 0.15)	1.41 (0.23)
Arm/forearm	None	486	17		
	Pain reported	15	2	0.08 (-0.06, 0.22)	0.13 (0.72)
Hand/wrist	None	458	32		
	Pain reported	26	4	0.06 (-0.05, 0.17)	0.62 (0.43)

* Self-reported pain represents a two-dimensional factor that combines pain frequency and pain intensity.
§ Kappa test of independence of the two outcome measures. Values <0.5 are generally interpreted as a lack of agreement beyond chance.
† McNemar (XMcN) test of marginal homogeneity of the two outcome measures. Higher probabilities indicate that the two outcome measures classify similar proportions of subjects into the MSD category.

Table 2-1. Frequency distribution of individual and work-related potential risk factors for MSDs by self-reported pain and physical signs.

Variables	Categories	(A) Subjects with self-reported pain*	(B) Subjects with physical sign at exam	(C) Neither pain nor physical signs	P-value† for	
		N (%)	N (%)	N (%)	A vs. C	B vs. C
Neck/shoulder		(n=302)	(n=67)	(n=211)		
Gender	Female	200 (66)	45 (67)	131 (62)	0.33	0.45
	Male	102 (34)	22 (33)	80 (38)		
Ethnicity	Asian	75 (25)	19 (28)	71 (34)	0.07	0.36
	Hispanic	215 (71)	42 (63)	130 (62)		
	White	12 (4)	6 (9)	10 (5)		
Medical History of MSDs		38 (13)	15 (22)	13 (6)	0.02	<0.01
Operated a single machine		286 (95)	60 (90)	189 (90)	0.03	1.00
Arm/Forearm		(n=86)	(n=19)	(n=424)		
Gender	Female	66 (77)	16 (84)	261 (62)	0.01	0.05
	Male	20 (23)	3 (16)	163 (38)		
Ethnicity	Asian	26 (30)	9 (47)	116 (27)	0.26	0.15
	Hispanic	59 (69)	9 (47)	286 (68)		
	White	1 (1)	1 (5)	22 (5)		
Medical History of MSDs		14 (16)	5 (26)	34 (8)	0.02	0.01
Operated a single machine		82 (95)	17 (90)	391 (92)	0.31	0.66
Hand/Wrist		(n=146)	(n=36)	(n=359)		
Gender	Female	108 (74)	27 (75)	215 (60)	<0.01	0.08
	Male	38 (26)	9 (25)	144 (40)		
Ethnicity	Asian	30 (21)	13 (36)	111 (31)	0.06	0.75
	Hispanic	108 (74)	21 (58)	232 (65)		
	White	8 (5)	2 (6)	16 (4)		
Medical History of MSDs		27 (19)	8 (22)	24 (7)	<0.01	<0.01
Operated a single machine		137 (94)	30 (83)	333 (93)	0.67	0.05

* Self-reported pain in a body region for at least 1 or 2 days in the month before interview.

† Pairwise test based on Chi-square or Fisher's exact test (for sparse data).

Table 2-2. Mean (SD) of individual and work-related potential risk factors for MSDs by self-reported pain and physical signs.

Variables	(A) Subjects with self-reported pain*		(B) Subjects with physical signs at exam		(C) Neither pain nor physical signs		P-value† for	
	Mean	(SD)	Mean	(SD)	Mean	(SD)	A vs. C	B vs. C
Neck/shoulder region	(n=302)		(n=67)		(n=211)			
Age	37.3	(9.4)	36.0	(9.9)	38.5	(10.5)	0.17	0.09
Years worked in garment industry	11.2	(7.0)	11.2	(7.2)	10.9	(7.7)	0.62	0.74
# of work hours per week	44.9	(6.4)	46.9	(7.5)	45.9	(7.7)	0.12	0.41
Job control‡	36.8	(8.6)	38.0	(8.7)	38.2	(9.3)	0.09	0.92
Job demands‡	42.6	(9.7)	43.6	(9.9)	41.6	(9.3)	0.23	0.12
Social Support‡	46.8	(10.0)	47.4	(10.0)	48.0	(9.6)	0.18	0.67
Job insecurity‡	24.0	(12.5)	27.1	(15.1)	21.1	(11.2)	0.01	<0.01
Physical Exertion‡	38.2	(12.8)	41.3	(12.6)	34.5	(13.0)	<0.01	<0.01
Arm/forearm region	(n=86)		(n=19)		(n=424)			
Age	39.8	(10.1)	41.3	(10.2)	37.3	(9.8)	0.03	0.08
Years worked in garment industry	13.5	(8.0)	12.1	(7.4)	10.9	(7.1)	<0.01	0.39
# of work hours per week	45.5	(6.9)	51.1	(6.8)	45.9	(7.0)	0.72	<0.01
Job control‡	35.7	(8.1)	37.3	(8.1)	37.6	(9.1)	0.07	0.88
Job demands‡	43.6	(10.4)	45.8	(11.4)	41.8	(9.3)	0.11	0.07
Social Support‡	46.9	(10.1)	48.2	(10.7)	47.4	(9.7)	0.64	0.74
Job insecurity‡	23.0	(11.8)	23.7	(12.2)	23.0	(12.1)	0.96	0.82
Physical Exertion‡	39.1	(13.0)	39.0	(19.1)	36.1	(12.8)	0.04	0.33
Hand/wrist region	(n=146)		(n=36)		(n=359)			
Age	37.1	(8.9)	37.5	(10.5)	38.0	(10.2)	0.35	0.78
Years worked in garment industry	11.0	(6.6)	10.3	(6.8)	11.1	(7.6)	0.92	0.59
# of work hours per week	44.7	(6.5)	48.0	(6.5)	45.4	(7.2)	0.29	0.06
Job control‡	36.7	(9.7)	37.6	(8.5)	37.5	(8.6)	0.32	0.96
Job demands‡	43.1	(9.9)	42.8	(8.7)	41.8	(9.4)	0.17	0.53
Social Support‡	46.1	(10.1)	45.6	(11.9)	47.8	(9.6)	0.07	0.20
Job insecurity‡	23.9	(11.5)	23.8	(13.2)	22.7	(12.2)	0.28	0.58
Physical Exertion‡	39.6	(12.7)	39.6	(17.1)	35.3	(12.6)	<0.01	0.06

* Self-reported pain in a body region for at least 1 or 2 days in the month before interview.
† Pairwise test from analysis of variance (ANOVA).
‡ Five work-related psychosocial factors assessed according to the Karasek's Job Content Questionnaire (JCQ) and expressing on a 0-100 scale.

Appendix 5. *Assessment of demographic, ergonomic and psychosocial work-related factors affecting or modifying neck/shoulder pain intensity (in press)*

Table 1. Adjusted* time-effect-interaction model that compared the difference of longitudinal change in mean pain score across groups (categorical variables) or for one unit increase (continuous variables). Negative indicates reduction and positive indicates increase.

Covariates		The difference of change in the 1st month (1 month minus baseline)		The difference of monthly change from the 1st to 4th month (mean of 4 month minus 1 month)		The difference of overall change during 4 months (sum of the changes in the 1st month and the 1st to 4th month)	
		Mean difference	95% CI	Mean difference	95% CI	Mean difference	95% CI
Baseline pain severity †		-8.6	(-15.0, -2.2)	1.5	(-1.8, 4.8)	-4.1	(-11.1, 2.8)
Age group							
30- <40	vs. <30	7.0	(-10.8, 24.7)	-7.1	(-16.3, 2.1)	-14.5	(-34, 5.1)
>=50	vs. <30	14.9	(-2.7, 32.5)	-4.2	(-13.1, 4.8)	2.5	(-17.2, 22.1)
Gender							
Male	vs. Female	-0.4	(-14.2, 13.5)	-3.0	(-10, 4.0)	-9.4	(-24.7, 5.9)
Ethnicity							
Hispanic	vs. Asian	-17.2	(-33.9, -0.5)	6.7	(-1.5, 14.9)	2.9	(-15.8, 21.6)
White	vs. Asian	11.7	(-31.1, 54.4)	2.2	(-19.5, 23.9)	18.2	(-26.4, 62.9)
History of musculoskeletal problems							
Yes	vs. No	3.7	(-16.7, 24.2)	-0.2	(-10.9, 10.4)	3.1	(-19.5, 25.6)
Overtime work							
>5d/wk	vs. ≤5d/wk	10.4	(-2.9, 23.6)	2.6	(-4.7, 9.9)	18.2	(2.9, 33.5)
No. of task performed†		-2.3	(-6.2, 1.7)	0.4	(-1.6, 2.5)	-1.0	(-5.5, 3.5)
No. of machine operated†		8.2	(-8.6, 25.0)	2.5	(-7.8, 12.8)	15.7	(-6.1, 37.5)
Total rest period in a day (minute)							
35- <50	vs. <35	-21.2	(-41.5, -0.9)	3.4	(-7.1, 13.9)	-10.9	(-33.7, 11.8)
>=50	vs. <35	-20.9	(-41.1, -0.8)	6.0	(-4.4, 16.3)	-3.1	(-25.8, 19.7)
Job strain							
High	vs. Low	-4.3	(-17.2, 8.6)	3.6	(-3.1, 10.3)	6.4	(-7.6, 20.4)
Social support							
High	vs. Low	-10.9	(-24.5, 2.7)	3.4	(-3.6, 10.5)	-0.6	(-15.4, 14.1)
Job dissatisfaction							
High	vs. Low	-9.1	(-22.1, 4.0)	0.6	(-6.2, 7.3)	-7.4	(-21.6, 6.8)
Perceived physical workloads							
High	vs. Low	16.4	(1.4, 31.3)	2.5	(-5.4, 10.3)	23.8	(7.2, 40.5)

* The adjusted model included time, the effect by time interaction, and all other variables in this table. The interaction between each factor and time was added in the model one at a time.

† Continuous variable estimating for one unit increase.