Follow-Up of Neck and Shoulder Pain Among Sewing Machine Operators: The Los Angeles Garment Study

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Background *The aim of the present study is to explore factors affecting or modifying self-reported neck/shoulder pain in sewing machine operators.*
Methods *We investigated self-report neck/shoulder pain in 247 workers who participated in a 4-month prospective intervention study for musculoskeletal disorders. All participants were immigrants. We examine the influence of individual and work-related factors on changes in neck/shoulder pain during follow-up employing linear mixed models with time-spline functions.*
Results *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 min or more allowing for muscles to rest were associated with a larger pain reduction in the first month, but not thereafter.*
Conclusion *Our findings indicate that some work-related factors may be of clinical relevance for reducing neck/shoulder pain. Having lower physical workloads and less overtime work should be considered when treating patients or planning workplace interventions for managing work-related musculoskeletal disorders in this underserved immigrant population.* Am. J. Ind. Med. 53:352–360, 2010. *© 2009 Wiley-Liss, Inc.*

KEY WORDS: immigrant; sewing machine; garment industry; recovery; neck and shoulder pain; work organization; musculoskeletal disorder; ergonomic; psychosocial; sewing machine operator; garment industry

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INTRODUCTION

California is the home to the largest garment production center 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 [Chan et al., 2002]. Our previous study found high prevalence of work-related musculoskeletal pain for this population [Wang et al., 2007]. In summary, 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%. 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.

The persistency of and recovery from work-related musculoskeletal pain may depend on factors similar to or different from those contributing to the occurrence of work-related musculoskeletal disorders (WMSDs). Most studies published in the WMSDs literature have addressed occurrence of chronic or acute injury, but few studies have focused on the recovery from pain symptoms or illness related to WMSDs. Factors contributing to WMSDs recovery or lack thereof are largely unknown, and existing studies thus far have focused on recovery from low back pain.

Work tasks and physical activity modifications such as task reallocation and recreational physical activity may be important for improvement of neck and arm pain [Jonsson et al., 1988]. There is also evidence that older age may be associated with slow recovery from shoulder disorders and that psychosocial work-related factors including perception of high demands, high control, and lack of social support may delay recovery from shoulder pain [Bonde et al., 2003].

Furthermore, modeling and describing typical recovery patterns may encourage more realistic expectations of recovery in patients, thereby alleviating anxiety about the length of recovery time [Ferguson et al., 2001]. Knowledge about individual and work-related factors that can influence recovery from pain may be useful to both general medicine and occupational health physicians in suggesting appropriate treatment and intervention strategies to specific patients.

Previously we presented findings from a randomized controlled trial in which we provided ergonomic interventions (chairs) to garment workers and showed how they influenced neck/shoulder pain over a 4-month period [Rempel et al., 2007]. Here we assess whether demographic, ergonomic, and psychosocial work-related factors also affect or modify neck/shoulder pain intensity, while controlling for our interventions. To accomplish this, we constructed a measure of proportional change of pain intensity over a 4-month period and assessed how it was influenced by demographic/individual factors (including age, gender, ethnicity, and a history of musculoskeletal problems) and/or work-related factors such as the intensity and variety of work, total duration of daily rest time during work, and psychosocial factors (job strain, social support, job dissatisfaction).

METHODS

The source for this cohort of workers reporting neck and shoulder pain was an ergonomic intervention study for which we enrolled sewing machine operators from 13 garment shops in Los Angeles, California. All employees were eligible for participation if they performed sewing machine operations for more than 20 hr per week, were not in a probationary period, did not have an active workers' compensation claim, had worked for at least 3 months, and were not planning to quit their jobs within the next 6 months.

Between October 2003 and April 2005, 560 subjects were invited to participate in the intervention study. A total of 520 (93.7%) from 13 garment shops agreed to participate and completed the baseline interview. Within 1–2 months from the baseline interview, 480 (86.5%) of the subjects from 11 shops remained in the study and we randomly assigned them to one of the three interventions: (1) a basic modification group received a footrest, a small table-top storage box, a side table, a task lamp, and reading glasses; (2) an intermediate modification group received a conventional height adjustable task chair that can swivel in addition to the items given to the first group; and (3) the best modification group received an ergonomic chair custom designed for sewing machine operators with a curved seat pan, an adjustable lumbar-curved backrest, and a seat pan tilt mechanism in addition to the items given to the first group. Of these 480 subjects, 277 subjects self-reported neck/shoulder pain at baseline interview. A total of 30 subjects withdrew before receiving their assigned intervention package leaving us with 247 subjects who stayed in the study follow-up and responded to at least one follow-up survey.

In our previous study [Rempel et al., 2007; Wang et al., 2008], we demonstrated that neck/shoulder and back/hip pains were reduced in both the intermediate and best modification groups compared to the basic intervention group, and that the interventions provided to the best modifications group were more effective in reducing neck/shoulder pain than those given to the intermediate intervention group.

In accordance with National Institutes of Health (NIH) policy, approval for all study procedures was obtained from the Offices for the Protection of Research Subjects (OPRS) at the University of California, Los Angeles (UCLA) and the Committee on Human Research at the University of California, San Francisco (UCSF), and all participants provided written informed consent.

Data Collection

The baseline interview was conducted for all subjects 1–2 months ahead of the implementation of our interventions. After randomization, we administered four follow-up standardized surveys spaced 1 month apart, thus, we followed most workers over a 4-month period. During the follow-up, 62 monthly interviews (5% of all monthly interviews) could not be conducted (Fig. 1). Specifically, there were 7 subjects who missed the interview in the first month,

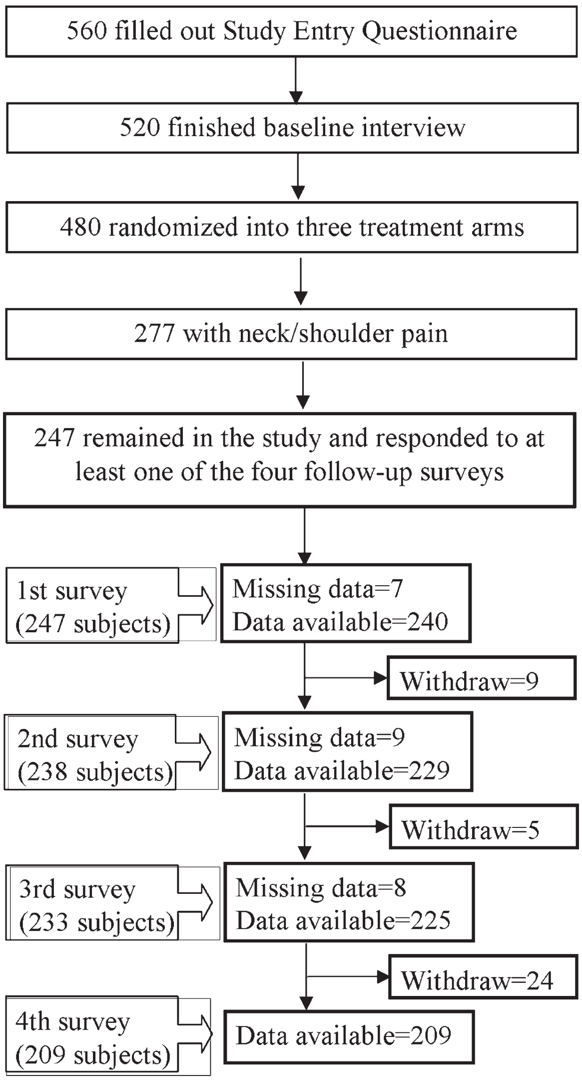

FIGURE 1. Flow chart of subjects included in this analysis.

18 in the second month, 13 in the third month, and 32 in the fourth month.

During the baseline interview we collected information about demographic factors (gender, age, ethnicity, weight, height, medical history of musculoskeletal problems, and smoking behavior) and work-related psychosocial factors. Data on work-related ergonomic factors, such as number of sewing tasks performed, number of sewing machines operated, number of workdays per week, total duration of daily rest time during work, and self-reported musculoskeletal pain (pain frequency and pain intensity), were collected at baseline and again each month during follow-up. The assessment of psychosocial factors has been described in detail in a previous publication [Wang et al., 2007]. Briefly, information on psychosocial factors was collected using a set of questions selected from Karasek's Job Content Questionnaire (JCQ) [Karasek, 1997]. Answer options ranged from 1 (''strongly disagree'') to 4 (''strongly agree''). The total score for each factor was computed by summing the weighted item scores for all questions related to that factor using the formula provided for the JCQ; the sum is expressed on a scale from 0 to 100. To implement Karasek's demand-control model, as recommended, we derived a variable for ''job strain'' from the factors ''job demand'' and ''job control,'' adopting a linear function by subtracting the score of job control from job demands such that the contributions of low control and high demands were equally weighted [Landsbergis et al., 1994]; that is, a subject scoring 3 for demands and 2 for control receives the same value for job strain as someone who scores 2 for demands and 1 for control. We dichotomized each psychosocial factor at the median in order to assign subjects to high and low levels of job strain.

Outcomes Definition

Musculoskeletal symptoms experienced in the past 4 weeks were assessed by asking each subject to self-report pain intensity (0 to 5-point scale with verbal anchors of ''a little painful'' for 1 and ''very painful'' for 5) [Dickinson et al., 1992]. To examine recovery patterns for neck and shoulder pain, we relied on a measure of proportional change of pain intensity over time; specifically, we calculated a pain score by dividing pain intensity reported at each survey by the baseline pain value for each worker. This allowed us to examine how the factors we measured influenced pain reduction or increase over the 4 months of observed period.

Statistical Methods and Analysis

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 nonlinearity 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 nonlinear 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, that is, 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. The first or our ''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 12 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 [National Institute for Occupational Safety and Health, 1997; Thomas et al., 2005; Wang et al., 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 words, 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 follows: 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 were performed using statistical software SAS version 9 [SAS Institute, Inc., 2002].

RESULTS

Of the 247 subjects reporting neck/shoulder pain during the baseline interview majorities were female (65.2%), Hispanic, or Asian (75.7% and 21.9%, respectively) and the mean age was 38 years (Table I). Only 28 workers (11.3%) reported a medical history of musculoskeletal problems prior to the interview. About half (54%) of all subjects reported taking less than 50 min of rest time in a workday. The three time-varying variables (workdays per week, number of sewing tasks performed, and number of sewing machines operated in the past 4 weeks) did not change appreciably during the 4 months follow-up period (Table II). We observed a sudden drop in reported pain intensity between baseline interview and the first follow-up survey, and the pain intensity remained constant from the first to the fourth survey (Table III).

Our analyses revealed that the patterns of pain score change were similar in the basic and the two adjusted models (results not shown). We observed a 72% reduction for the mean pain score from baseline to the first month and a non-discernible increasing trend in pain score from the first to fourth month (4% per month) of follow-up adjusting for baseline pain intensity, intervention type, four individual

TABLE I. Frequency Distributions of Demographic Characters for Subjects Who Reported Neck/Shoulder Pain at Baseline Interview ($n = 247$)*

Variables	Category	N	%
Gender	Female	161	65.2
	Male	86	34.8
Age group	Mean (SD)	37.5 (9.3)	
	<30	52	21.1
	30–39	91	36.8
	40–49	76	30.8
	≥50	28	11.3
Ethnicity	Asian/Pacific Islander	54	21.9
	Hispanic	187	75.7
	White	6	2.4
Medical history of	No	219	88.7
Musculoskeletal problems	Yes	28	11.3
Total rest period in a day (min)	Mean (SD)	49.2 (9.8)	
	0–35	34	13.8
	>35–50	101	40.9
	≥50	112	45.3
Job strain	High	136	55.1
	Low	111	44.9
Social support	High	164	66.4
	Low	83	33.6
Job dissatisfaction	High	144	58.3
	Low	103	41.7
Perceived physical workload	High	186	75.3
	Low	61	24.7

*Data included frequency in number [N] and %, and means with standard deviation (SD).

TABLE II. Frequency Distributions of Time-Varying Variables Among Sewing Machine Operators With Neck/Shoulder Pain at Baseline and Four Follow-Up Surveys

		Baseline (n = 247)		First survey (n = 240)		Second survey (n = 229)		Third survey (n = 225)		Fourth survey (n = 209)	
Variables	**Category**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Workdays per week	Mean (SD)	5.4 (0.5)		5.4 (0.6)		5.4 (0.5)		5.3 (0.5)		5.2 (0.5)	
	Over time (>5 days)	155	62.8	165	68.8	149	65.1	155	68.9	163	78.0
	Regular work schedule (5 days or less)	92	37.2	75	31.3	80	34.9	70	31.1	46	22.0
Numbers of task performed in each month	Mean (SD)	2.2 (1.2)		2.1 (1.2)		2.1 (1.4)		2.1 (1.1)		2.0 (1.2)	
	1	105	42.5	103	42.9	100	43.7	103	45.8	98	46.9
	2	46	18.6	45	18.8	45	19.7	44	19.6	38	18.2
	3	49	19.8	47	19.6	45	19.7	40	17.8	38	18.2
	4 and more	47	19.0	45	18.8	39	17.0	38	16.9	35	16.7
Numbers of machine operated in each month	Mean (SD)	1.2 (0.5)		1.1 (0.4)		1.1 (0.4)		1.1 (0.3)		1.1 (0.3)	
	1	215	87.0	219	91.3	207	90.4	212	94.2	199	95.2
	2	20	8.1	17	7.1	18	7.9	9	4.0	8	3.8
	3	11	4.5	4	1.7	2	0.9	4	1.8	2	1.0
	4 and more	1	0.4	0	0	2	0.9	0	0	0	0

level factors (age, gender, ethnicity, and history of musculoskeletal problems), four ergonomic factors (overtime work, number of sewing tasks performed, number of sewing machine operated, and total duration of daily rest time during work), and four psychosocial factors (high job strain, high social support, high job dissatisfaction, and high perceived physical workload).

Higher baseline pain intensity, being Hispanic (vs. Asian), work rest periods of 35 min or more per day, and perceived low physical workload were associated with greater mean pain score reduction in the first month, while our estimates of differences were imprecise thereafter (see Table IV for unadjusted models and Table V for adjusted models). Workers who took 35 min of rest or more during work per day experienced approximately a 20% more reduction in mean pain score compared to their counterparts. Workers who reported their physical workload as being low tended to have a 16% more reduction in mean pain score in the first month and a 2.5% more from the second to fourth month. No differences were observed in estimated

TABLE III. Frequency Distributions, Means, Median, and/or Range of Neck/Shoulder Pain Over Time

		Baseline (n = 247)		First survey (n = 247)		Second survey (n = 238)		Third survey (n = 233)		Fourth survey (n = 209)	
Variables	**Category**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Intensity of pain (0-5 scale)	Mean (SD)	2.4 (1.0)		0.7 (1.3)		0.8 (1.2)		0.8 (1.4)		1.0 (1.6)	
	Score = 0	0	0.0	188	78.3	168	73.4	169	75.1	142	67.9
	Score = 1	45	18.2	7	2.9	4	1.7	2	0.9	3	1.4
	Score = 2	78	31.6	13	5.4	14	6.1	12	5.3	16	7.7
	Score = 3	93	37.7	20	8.3	27	11.8	27	12.0	23	11.0
	Score = 4	22	8.9	7	2.9	12	5.2	10	4.4	19	9.1
	Score = 5	9	3.6	5	2.1	4	1.7	5	2.2	6	2.9
Proportional pain score[a]	Mean (SD)	100.0 (0.0)		27.7 (61.3)		31.8 (59.4)		33.1 (69.0)		41.0 (73.6)	

[a]Proportional pain score was defined as the proportional changes in pain intensity for each subject during the follow-up period. The pain score for each case is defined as 100% at baseline.

TABLE IV. Unadjusted 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)

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 months 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[a]	−6.5	(−12.9, 0.1)	1.8	(−1.6, 5.2)	−1.0	(−8.1, 6.1)
Age group						
30 to <40 vs. <30	11.5	(−6.3, 29.2)	−6.9	(−16.2, 2.5)	−9.1	(−28.8, 10.6)
≥50 vs. <30	19.6	(2.4, 36.9)	−4.6	(−13.8, 4.5)	5.8	(−13.5, 25.1)
Gender						
Male vs. female	−3.7	(−17.4, 9.9)	−2.8	(−10.0, 4.4)	−12.1	(−27.2, 3.0)
Ethnicity						
Hispanic vs. Asian	−20.0	(−35.9, −4.1)	7.0	(−1.3, 15.4)	1.1	(−16.3, 18.6)
White vs. Asian	8.9	(−34.6, 52.4)	2.1	(−20.1, 24.2)	2.1	(−20.1, 24.2)
History of musculoskeletal problems						
Yes vs. no	1.2	(−19.5, 21.8)	−1.4	(−12.2, 9.5)	−3.0	(−25.9, 19.9)
Overtime work						
>5 d/wk vs. ≤5 d/wk	12.7	(−0.3, 25.8)	2.2	(−5.2, 9.6)	19.2	(4.1, 34.4)
No. of tasks performed[a]	−1.3	(−5.3, 2.6)	0.5	(−1.7, 2.5)	0.0	(−4.4, 4.4)
No. of machines operated[a]	7.9	(−9.0, 24.8)	2.5	(−7.9, 12.9)	15.4	(−6.5, 37.3)
Total rest period in a day (min)						
35 to <50 vs. <35	−22.0	(−41.9, −2.0)	6.6	(−3.9, 17.1)	−2.2	(−24.4, 20.0)
≥50 vs. <35	−24.9	(−45.0, −4.7)	3.9	(−6.8, 14.6)	−13.2	(−35.7, 9.4)
Job strain						
High vs. low	−1.5	(−14.6, 11.6)	3.4	(−3.5, 10.2)	8.6	(−5.8, 23.0)
Social support						
High vs. low	−11.8	(−25.5, 2.0)	3.6	(−3.6, 10.7)	−1.1	(−16.1, 14.0)
Job dissatisfaction						
High vs. low	−9.9	(−23.1, 3.4)	0.6	(−6.3, 7.6)	−7.9	(−22.4, 6.5)
Perceived physical workloads						
High vs. low	13.8	(−1.3, 28.8)	1.9	(−6.0, 9.9)	19.6	(2.8, 36.4)

Negative indicates reduction and positive indicates increase
[a]Continuous variable estimating for one unit increase.

pain score change when stratifying according to the following factors: age, gender, medical history of MSD, workdays per week, number of task performed, number of machine operated, job stress, social support, and job dissatisfaction.

Although none of the interaction terms between any of these factors and time affected pain score changes over time, we observed that the mean pain score reduction was about 24% less for workers who reported high physical workload compared to workers who reported low physical workload and about 18% less for workers working overtime compared to workers who did not work overtime. No differences were observed in the overall pain reduction during our 4 months follow-up when stratifying according to any of the other 11 factors examined.

DISCUSSION

There is little research evaluating the follow-up of neck/shoulder pain in a work place setting. To the best of our knowledge, this is the first study to assess whether changes of neck/shoulder pain intensity are associated with personal and work-related factors. Within the setting of an ergonomic intervention study in garment workers, we employed a repeated measures approach and a multivariate model to examine recovery patterns based on longitudinal pain scores [Cole and Hudak, 1996; Bonacich and Appelbaum, 2000; Ferguson et al., 2001]. This approach allows for a sensitive assessment of changes in pain over time while accounting for repeated measurements in the same subject. We observed a non-monotonic trend for self-reported neck/shoulder pain

TABLE V. 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)

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 months minus 1 month)		The difference of overall change during 4 months (sum of the changes in the 1st month and the 1st to 4th months)	
	Mean difference	95% CI	Mean difference	95% CI	Mean difference	95% CI
Baseline pain severity[a]	−8.6	(−15.0, −2.2)	1.5	(−1.8, 4.8)	−4.1	(−11.1, 2.8)
Age group						
30 to <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						
>5 d/wk vs. ≤5 d/wk	10.4	(−2.9, 23.6)	2.6	(−4.7, 9.9)	18.2	(2.9, 33.5)
No. of tasks performed[a]	−2.3	(−6.2, 1.7)	0.4	(−1.6, 2.5)	−1.0	(−5.5, 3.5)
No. of machines operated[a]	8.2	(−8.6, 25.0)	2.5	(−7.8, 12.8)	15.7	(−6.1, 37.5)
Total rest period in a day (min)						
35 to <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)

Negative indicates reduction and positive indicates increase.
*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.
[a]Continuous variable estimating for one unit increase.

during the follow-up period. Specifically, pain scores dropped dramatically in the first month and then steadied or increased again with time. This drop can be interpreted in several ways. First, this may suggest that neck and should pain does improve considerably within a 1-month period in an actively working population for those workers who remain on the jobs. Second, it could have been due to postural improvements after the introduction of our ergonomic interventions in this workforce. Yet, the drop occurred in all subjects similarly no matter whether we assigned them to a control group or to one of two types of interventions. Alternatively, this early drop in pain scores may in part be due to a possible bias caused by changes in data collection procedures between baseline and follow-up surveys. Specifically, while we were allowed to conduct the baseline survey in a private interview room, the follow-up surveys had to be administered at each subject's workstation in order to interfere minimally with the flow of work in the garment shops. Even though the generally loud background noise in the shops minimized the possibility of being overheard, subjects may have been more concerned in these public settings, and, thus, underreported pain.

Nevertheless, we identified a number of factors to be associated with the extent of pain reduction in the first monthly follow-up survey independent of the intervention effects. These include baseline pain intensity, ethnicity, total duration of daily rest time during work, and perceived physical workload. We furthermore found that physical workload and overtime work modified the change in pain score during the 4-month follow-up period.

A randomized controlled trial examined follow-up of lateral epicondylitis in a general practice [Haahr and Andersen, 2003] and assigned 266 patients randomly to receive minimal occupational intervention or the usual approach in general practice. The minimal occupational intervention involves some education about the disorder, instruction on how to perform some exercises, and encouragement to remain active. After 1 year of follow-up, both intervention and control group received more than 80% of improvement in pain condition while intervention was not followed by any difference in pain score or perceived overall development compared with the control group. This study also reported that poor overall improvement in 1 year of follow-up was related to holding a manual job, experiencing high level of physical strain at work, and reporting high level of pain at baseline. Another longitudinal study suggested that subjects with at least two out of three biomechanical strains at work such as push/pull activities, working with the hands above shoulder level, and working with vibrating tools, experienced poorer neck or shoulder pain than the general working population [Grooten et al., 2007]. These findings support our own results that perceived high physical workload and overtime work (working more than 5 days per week) are associated with poorer neck and shoulder pain over time.

Work-related psychosocial factors such as job strain, social support, and job satisfaction have also been previously associated with reports of musculoskeletal pain [Ariens et al., 2001; Andersen et al., 2003; Helliwell and Taylor, 2004]. Furthermore, these factors may modify the state of disorders of the upper body region [Chard et al., 1988; Houtman et al., 1994; Cole and Hudak, 1996; Toomingas et al., 1997; Westgaard, 1999; Bonde et al., 2003]. Our previous cross-sectional analyses of these data found high job demands and low job satisfaction to be related to a higher prevalence of neck and shoulder pain at baseline [Wang et al., 2007] but our data were inconclusive with regard to whether these factors, measured at baseline only, also influence changes in neck/shoulder pain over time.

High baseline pain intensity, Hispanic race (vs. Asian), total duration of daily rest time during work of 35 min or more allowing for the muscle to rest, and perceived lower physical workload were all associated with larger pain reductions within the first month of follow-up, and the initial differences remained similar during the additional 3 months of follow-up except for ethnicity. We acknowledge that self-reporting of pain and work-related factors may have introduced some reporting bias. During follow-up especially between the second and fourth months, we observed that workers with higher work loads and job strain, and those taking less rest time during work tended to finish the monthly surveys more quickly to be able to return to work. This may have compromised data quality for pain measures during follow-up in a differential way, that is, under-reporting of pain may have occurred more often in the most highly exposed workers; the resulting misclassification is likely to have weakened effect estimates for these factors on pain severity. Also, the data presented here were collected in a convenience sample of 13 garment shops located in Los Angeles Basin willing to cooperate in an ergonomic intervention study. This type of convenience sampling may result in effects different from those one would estimate in a representative study of all garment workers, to the extent that the shops and employees are different from shops choosing not to participate in such a study. In fact, due to the rigorous eligibility criteria for our intervention study,[4] this population most likely represented a more stable garment worker population working in shops willing to participate in intervention research. Finally, several of the garment shops participating in our study had to close down during follow-up due to the impact of unexpected changes in international trade policies. Thus, we were unable to retain subjects in our study for more than a 4-month follow-up period. Studies with extended follow-up exploring a longer term follow-up of these types of pain are warranted and would need to target relatively stable working populations.

Our study also has several methodological strengths. We obtained detailed information for work-related and psychosocial factors over time, which allowed us to use a multilevel modeling approach and to relate repeated measures of key exposure factors to outcomes over time while adjusting for time-varying confounders. The use of a linear mixed model improves efficiency compared to traditional unconditional regression modeling [Greenland, 1992; Witte et al., 1994]. Since subjects may have different pain perception thresholds those reporting higher pain intensities at baseline would be able to improve more than subjects reporting a lower intensity at baseline. Using a pain score proportional to baseline pain intensity standardizes the range of pain scores for all subjects by assigning an equal pain level to every subject at baseline.

In conclusion, garment workers reporting neck/shoulder pain at baseline and perceiving their work as physically very demanding (high physical workload) or working overtime (more than 5 days per week on average) experienced less reduction in pain over the 4 months study period compared to workers who perceived their work as requiring a low physical effort or who worked 5 days per week or less. In addition, higher baseline pain intensity, being of Hispanic ethnicity (vs. Asian), and taking cumulative daily rest time during work of 35 min or more allowing for the muscle to rest lead to a larger pain reduction in the first month, and the difference remained the same over follow-up except for ethnicity. These findings may be useful for guiding medical management and expectations of recovery from work-related neck/shoulder pain among this underserved immigrant population.

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