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Self-reported pain and physical signs for musculoskeletal disorders in the upper body region among Los Angeles garment workers

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Abstract. Reports of pain and physical exam findings for musculoskeletal disorders (MSDs) are two common outcome measures independently used to assess work-related MSDs in the scientific literature. How these measures correlate with each other, however, is largely unknown. We recruited 520 sewing machine operators to describe the correlation between subjective self-reported pain and physical findings of MSDs in three upper body regions including the neck/shoulder, elbow/forearm, and hand/wrist. Self-reports of pain and physical findings resulted in different and partly non-overlapping classifications of subjects as MSD cases in our study. Both outcome measures were found to be consistently associated with 'having a medical history of MSDs', 'perceived physical exertion', 'perceived job insecurity' (neck/shoulder), being of older age (arm/forearm), and female gender (arm/forearm and hand/wrist); 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'. Because to date no agreed upon "gold standard" for diagnosing MSDs exists, our findings suggest that research results can be very different when using self-reported measures versus physical exam findings. Also, in order to evaluate the success of an intervention, screening, or surveillance program for work related MSDs, it is important to define clearly which outcome measure best to employ.

Keywords: Agreement, correlation, physical sign, physical examination, work organization

1. Introduction

Musculoskeletal pains are common complaints that can have a major impact on health related quality of life as well as performance and productivity at work [12, 18,19,32]. Work-related musculoskeletal disorders (MSDs) account for a large number of disabilities and workers' compensation days in many countries [5]. During the past decade, disabilities due to work-related MSDs have steadily increased, making them one of the most expensive health problems in modern industrial societies [17]. In 2002, work-related MSDs accounted for 34% (487,900) of all injuries and illnesses resulting in absences from work in the United States [7].

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Results from MSD studies have raised controversies among researchers. A controversy in part fueled by the lack of agreement about how to measure the outcome appropriately, since currently no agreed-upon system of MSD classification for epidemiologic research exists [2]. Depending on the particular concern or nature of the study, investigators mostly employed subjective self-reported pain or objective medical diagnoses as two major measures [18].

Diagnoses derived from physical examination are deemed more valid measures of MSDs and may be given preference over subjective self-reported pain and symptoms [1,18]. Although the pathology of several MSD conditions has been well-defined, the generally small proportion of available diagnostic categories constrains the comparability of a wide variety of symptoms and signs reported by affected workers [15,33]. On the other hand, the reliability of physical examination results for specific MSDs, such as Carpal Tunnel Syndrome (CTS) and rotator cuff tendonitis, is also variable [16]. Standardized examination techniques still do not exist that can serve as a gold standard for many of the symptoms reported in workplace studies [22]. A lack of standardized diagnostic criteria further limits the diagnostic technologies available for MSDs [15, 33]. The low expense and the simplicity of recording self-reports of pain made this measure the most common health outcome investigated in work-related MSD studies in the scientific literature [29]. However, symptom reporting is influenced by a number of demographic and cultural factors in addition to the underlying biological state, and the relation between biological factors, psychological factors, and symptom reports is complex [8,9,35].

To date, physical examination and subjective self-reports of pain are the most widely used approaches to define outcome of work-related musculoskeletal disorder (WMSD). How these measures correlate with each other is largely unknown. Our objective is to describe the correlation between subjective self-report of pain in the past one month and physical signs identified in a physical examination performed by trained nurse practitioners. We employed data from a survey and physical examination of sewing machine operators conducted during 2003–2005. We hypothesized that there is relatively little overlap in the two outcome measures and that they are differentially associated with demographic and work-related factors within a working population.

2. Materials and methods

The data employed in this study have been collected as part of a prospective ergonomic intervention study. Recruitment of subjects has been described previously [34]. Briefly 520 subjects, on average 38 years of age (range 18–65), were recruited from 13 garment shops located in the Los Angeles Basin, California, between October 2003 and March 2005. All subjects first completed a baseline interview and then participated in a physical examination on the same day. Subjects were largely female (335; 64.4%), Hispanic (349; 67.1%), and Asian/Pacific Islanders (147; 28.3%) with a minority of Caucasians (24; 4.6%). All of the subjects were immigrants and most reported long work hours, insecure employment, and high job strain. 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 at the University of California, Los Angeles (UCLA) and the Committee on Human Research at the University of California, San Francisco (UCSF). All participants provided written informed consent.

2.1. Data collection

Data were collected via a standardized interview and a physical examination at the time subjects entered our study; data collection procedure and the treatment of variables have been described in detail previously [34]. Briefly, the following twelve factors were collected in face-to-face interviews and will be used for comparisons here, including: (1) individual characteristics of subjects [age, gender, ethnicity, and medical history of a musculoskeletal disorder (MSD)]; (2) work-related ergonomic factors, which include types of sewing machines used, years employed in the garment industry, number of work hours per week etc.); (3) work-related psychosocial factors assessed according to the Karasek's Job Content Questionnaire (JCQ) [five scales: job control, job demands, social support (combined supervisor and coworker support), job insecurity, and physical exertion; the total score for each scale was computed by summing the weighted item scores for all questions related to that factor according to the formula provided for the JCQ and expressing the sum on a 0 to 100 scale.] [13].

Musculoskeletal pain experienced in the past 4 weeks was assessed by asking each subject to self report pain frequency (1 or 2 days in the last month, 1 day per week, several days per week, or every day) and pain intensity (0 to 5-point scale with verbal anchors of ‘a little painful’ represented by 1 and ‘very painful’ by 5) during the past one month period and for three upper body regions: neck/shoulder, arm/forearm, and hand/wrist. We defined cases of self-reported pain as subjects who experienced pain in a body region for at least 1 or 2 days in the month before interview.

The physical examination protocol included inspection, palpation, standard provocation maneuvers, and measurement of active and passive ranges of motion for six anatomic sites, including neck, shoulders, arms, forearms, hands, and wrists. This protocol was developed after a comprehensive literature review [10] and has previously been applied by one of the authors (D.R.) in an intervention study of computer operators [27]. Four occupational nurse practitioners were trained by an occupational physician who also participated in designing the physical examination protocol. All physical examinations were conducted independently from the baseline interview; that is, the nurses performed physical examinations and were assisted by an interpreter while they ascertained areas of discomfort and discomfort levels. The nurses then arrived at a diagnosis without knowledge of the contents of the baseline interview that ascertained pain experienced in the past month. Specifically, we targeted 15 types of soft-tissue and neural physical signs, including: (1) rotator cuff tendonitis (which included physical signs of supraspinatus tendonitis and subscapularis tendonitis), (2) bicipital tendonitis, (3) medial epicondylitis, (4) lateral epicondylitis, (5) posterior interosseous nerve entrapment, (6) anterior interosseous nerve compression, (7) pronator syndrome, (8) ulnar neuritis/neuropathy at the elbow, (9) flexor carpi radialis (FCR) tendonitis, (10) flexor carpi ulnaris (FCU) tendonitis, (11) digital flexor tendonitis, (12) trigger finger, (13) extensor tendonitis [including physical signs of dorsal compartment 1 (APL and EPB), dorsal compartment 2 (ECRL and ECRB), intersection syndrome, dorsal compartment 3 (EPL), dorsal compartment 4 (EDC and EIP), dorsal compartment 5 (EDM)], (14) CTS, and (15) ulnar neuritis/neuropathy at the wrist. The nurses also conducted functional tests of the neck and shoulder to ascertain 4 signs: (1) radicular pain syndrome, (2) somatic pain syndrome, (3) thoracic outlet syndrome, (4) and shoulder dysfunction. Overall, this protocol was designed to identify 19 physical signs based on 25 specific tests. We assigned the 19 physical signs to three body regions (neck/shoulder, arm/forearm, and hand/wrist). A physical finding of MSDs thus is defined as at least one physical sign present in a body region of interest during the physical examination.

2.2. Data analysis

First, we will describe pain frequencies reported for the three body regions when one of the 19 physical signs was present during the physical examination. We also explore the frequency and intensity dimensions of pain reports with and without physical findings of MSD in the three body regions.

Second, we investigate the reliability of the two MSD measures (self-reported pain and physical finding of MSDs) by body region since a study subject may belong to either or both groups. 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 correlation of the two MSD measures when using alternative criteria to identify cases according to symptom reports. We 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 potential risk factors for cases with self-reported pain (according to our primary definition see ‘Data Collection’) and 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 signs during the examinations.

3. Results

Physical signs were more commonly found for the neck/shoulder (12.9%) regions than the hand/wrist (6.9%) and arm/forearm (3.7%) in our population of garment workers. The most frequent physical signs observed in the neck/shoulder region were rotator cuff tendonitis (7.3%), somatic pain syndrome (6.9%), radicular pain syndrome (6.0%), and thoracic outlet syndrome (4.6%). Few physical signs were identified in the arm/forearm and hand/wrist regions (0.2%–3.5%).

Cases exhibiting physical signs were likely to report having experienced pain for at least 1 or 2 days during the past 30 days (Table 1) when they had been diagnosed with physical signs in the neck/shoulder region, on average, about 90% of the cases. On the other hand, only half of the cases diagnosed with signs in the arm/forearm and hand/wrist reported having expe-

Table 1
Frequency of self-reported pain in subjects with a physical sign by specific site and sign*
(N = 520)

Specific physical sign	Physical sign† N	Self-reported pain‡ N (%)§
Neck/shoulder region		
Radicular Pain Syndrome	31	29 (93.5)
Somatic Pain Syndrome	36	33 (91.7)
Thoracic Outlet Syndrome	24	21 (87.5)
Rotator cuff tendonitis	38	34 (89.5)
Bicipital tendonitis	7	6 (85.7)
Shoulder dysfunction	2	2 (100.0)
Arm/forearm region		
Medial epicondylitis	9	6 (66.7)
Lateral epicondylitis	11	6 (54.5)
Ulnar neuritis	3	2 (66.7)
Post Interosseus	5	3 (60.0)
Anterior Interosseus	1	0 (0.1)
Pronator syndrome	10	3 (30.0)
Hands/wrist region		
Flexor Carpi Radialis (FCR) Tendonitis	13	10 (76.9)
Flexor Carpi Ulnaris (FCU) Tendonitis	6	5 (83.3)
Digital Flexor Tendonitis	5	3 (60.0)
Trigger finger	2	1 (50.0)
Extensor tendonitis	14	9 (64.3)
Carpal Tunnel Syndrome	18	9 (50.0)
Ulnar Neuritis/Neuropathy at Wrist	6	4 (66.7)

*Physical signs identified by trained nurses during the physical examination.
†Note: a subject may have had more than one physical sign.
‡Self-reported musculoskeletal pain experienced in the same body region for at least 1 or 2 days during one month before interview for subjects with physical signs only.
§The percentage of subjects with pain for each specific physical sign.

Table 2
Mean (SD) of self-reported pain frequency and intensity by physical sign in one of three body regions

Self-reported pain by site	Physical sign: None (N = 453) Mean (SD)	Physical sign: One or more per site (N = 67) Mean (SD)	P-value*
Neck/shoulder region			
Pain frequency (0–4)	1.38 (1.49)	2.28 (1.25)	< 0.001
Pain intensity (0–5)	1.30 (1.42)	2.27 (1.29)	< 0.001
Arm/forearm region			
Pain frequency (0–4)	0.40 (1.01)	1.16 (1.46)	0.002
Pain intensity (0–5)	0.39 (1.01)	1.32 (1.77)	< 0.001
Hand/wrist region			
Pain frequency (0–4)	0.68 (1.27)	1.58 (1.54)	< 0.0001
Pain intensity (0–5)	0.66 (1.26)	1.47 (1.44)	< 0.001

*Pairwise comparison test p-value from analysis of variance (ANOVA).

rienced pain (47.4% and 58.3%, respectively). However, more than 80% of subjects who self-reported pain in one of the three body regions were not assigned a physical sign (data not shown). Very few subjects had a physical sign identified during the exam especially in the elbow/forearm region compared to the large number of subjects reporting pain in the past month. Nevertheless, subjects with physical findings of MSDs had higher mean pain frequencies and intensities in all three regions (Table 2).

Our two measures to classify subjects as MSD cases (i.e., using either the physical examination results or self-reported pain) were poorly correlated with each other (Table 3) 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

Table 3
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)	XMcN (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 (< 0.0001)
Arm/forearm	None	424	10		
	Pain reported	77	9	0.15 (0.01, 0.29)	51.60 (< 0.0001)
Hand/wrist	None	359	15		
	Pain reported	125	21	0.24 (0.12, 0.36)	86.43 (< 0.0001)
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.

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 4a and 4b). Both types of cases (with problems in all three body regions) were more likely to report a medical history of MSDs, and to perceive higher physical exertion; both types of cases with neck/shoulder problems perceived higher job insecurity; and both types of cases with arm/forearm problems were older and more often female; finally, those with hand/wrist problems were also more often female.

On the other hand, cases defined by pain versus physical signs differed with regard to such work related factors as 'operating a single machine' and 'number of work hours per week' for neck shoulder problems (Table 4a and 4b); i.e. cases with physical findings less frequently operated a single machine but on average worked longer hours compared to cases with self-reported pain.

4. Discussion

There is no agreement in the scientific community what constitutes a work-related MSD. In the past, researchers used a variety of criteria to define MSDs and this largely limited the comparability across studies [6]. It is not clear how self-reports of pain are related to physicians' diagnoses and physical signs obtained during an examination and how both could be best employed to define MSD cases in epidemiologic studies. In our study, we found that self-reported pain poorly corresponds to diagnoses assigned by specially trained nurse practitioners for problems in the regions of neck/shoulder, arm/forearm, and hand/wrist; substantially more subjects reported having experienced pain than were assigned diagnoses by our nurses. On the other hand, we found that some physical signs identified by our nurses were not accompanied by reports of a recent pain experience, especially signs identified in the arm/forearm and hand/wrist. The data for both outcome measures were collected on the same day. The discrepancy between the two outcome measures, thus, may be due to a difference in the timing of events and, in addition, may also reflect differences in answers that subjects provided to a nurse experienced in probing pa-

Table 4a
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* N (%)	(B) Subjects with physical sign at exam N (%)	(C) Neither pain nor physical signs N (%)	P-value† for 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).

tients versus an interviewer without a medical education.

Thus, while one would expect discomfort or pain to result from such disorders, the pain may have been reinterpreted or not reported to our interviewers. Substantial under-reporting of pain when physical signs were present has been described previously [26,30] and were interpreted as being due to differences in pain thresholds, and work-related psychosocial factors including job security, and labor relations with employers and co-workers [3,21,28]. Our findings suggested that both outcomes were associated with higher job insecurity, especially physical signs; however, we did not find differences with our measures of 'social support', and we did not examine pain thresholds. A previous study also suggested that MSD symptoms are often intermittent and episodic, especially in the early stages; therefore, symptom reports may not correspond well to defined clinical syndromes [22]. Alternatively, cases with physical findings that did not correspond to self-reported pain may represent an MSD that existed for a long enough time such that a worker may not consider it unusual or noteworthy any more. For example, radiographically confirmed knee osteoarthritis linked to functional limitation may no longer be experienced as painful and, thus, is referred to as 'asymptomatic' [11].

In contrast, we found that physical signs of functional disorders were absent in most symptomatic cases, especially in garment workers reporting neck/shoulder pain. It has been suggested that about 30% to 80% of patients in clinical practice who see a physician suffer from conditions for which no physiological or organic correlate can be identified during routine examinations [4,14,20]. This might mean that pain is the sole problem or that MSDs may progress through stages that begin with pain only [22]. Certain critical biological and physiological measures can be profoundly abnormal without the patient experiencing or reporting symptoms or even discomfort. Behavioral and emotional factors may also contribute to the awareness of pain whether or not physical sign can be identified [8]. For example, some individuals suffer severe pain and disability even though their findings do not conform to specific diagnostic entities such as CTS, rotator cuff tendonitis, or de Quervain's diseases [22]. Another explanation is that the examination protocol we adopted

Table 4b
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.

did not cover the wide range of symptoms that are frequently reported in workplace [33]. Thus, when relying on medical diagnoses based on physical signs only, researchers would miss work-related conditions that nevertheless cause a lot of discomfort or pain [8].

Although our two MSD measures did not correlate well with each other, cases defined according to self-reported pain or to physical findings in all three body regions showed very similar prevalences for having a medical history of MSDs, and for perceiving physical exertion; also gender was generally related to problems of the arm/forearm and hand/wrist; and job insecurity with neck/shoulder problems. In contrast, monotonous tasks (operating a single machine) and work hours did not correspond well to both outcome measures. Thus, our findings only partially confirmed previous reports that suggested that both self-reported pain and physical findings were similarly associated with job-related ergonomic characteristics [23–25,31]. Moreover, findings from our study illustrate that a large study population is needed when evaluating the association of work related factors with physical signs alone and to improve our understanding of what the discrepancy between both outcomes means in the context of work organization longitudinal data are needed.

Our study has several limitations. First, personal biases may have interfered with the observers' judgments although we used a series of measures to ensure reliability within and between observers (i.e., for the nurses and interviewers, separately), including standardized training before the study began and rigorous periodic checks of examination procedure. Second, workers' knowledge of an existing MSDs and their medical history prior to the start of our study may have influenced their reporting of pain. Furthermore, our study subjects were of three very different ethnic backgrounds and cultures and mostly spoke Spanish or Chinese. Translating questions about symptoms during the examination to aid the communication between nurses and interviewees may have potentially increased the variability of symptom reports elicited during the physical examination. Second, our study population included only stable workers in garment shops; to be eligible for participating in our intervention study, workers had to perform sewing machine operations for more than 20 hours per week, could not be in a probationary period, or have an active workers' compensation claim, had to have worked for at least three months and were not planning to quit their jobs within six months. These inclusion criteria may limit the generalizability of our findings to stably employed garment workers only. For example, injured or less healthy workers may have a higher turnover rate or work part time and, thus, would have been missed in our study.

Our results show that using self-reported pain versus physical findings of MSDs may result in different classifications of subjects as MSD cases; in fact there seems to be little agreement between these two measures in general. Some but not all individual and work-related potential risk factors showed associations with both outcome measures. No agreed upon "gold standard" for diagnosing MSDs exists and our findings suggest that researchers should be aware of potentially large discrepancies between self-reported measures and physical exam findings when designing a study. Since the correlations between these two measures are low, an intervention effective at improving one measure might be shown to be ineffective at improving the other. Thus, when evaluating the success of an intervention, screening, or surveillance program for work-related MSDs, it is important to define clearly which measure might be most adequate and should be employed.

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Author contributions

Ritz, and Wang had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Ritz and Wang.

Acquisition of data: Ritz, Wang, Rempel, Harrison, and Janowitz.

Statistical analysis and interpretation of data: Ritz, Wang, and Hurwitz.

Drafting of the manuscript: Wang.

Critical revision of the manuscript for important intellectual content: Ritz, Wang, Rempel, Hurwitz, Harrison, and Janowitz.

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