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The association between pain and disability

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Abstract

A clearer understanding of how pain intensity relates to disability could have important implications for pain treatment goals and definitions of treatment success. The objectives of this study were to determine the optimal pain intensity rating (0–10 scale) cutpoints for discriminating disability levels among individuals with work-related carpal tunnel syndrome (CTS) and low back (LB) injuries, whether these cutpoints differed for these conditions and for different disability measures, and whether the relationship between pain intensity and disability was linear in each injury group. Approximately 3 weeks after filing work injury claims, 2183 workers (1059 CTS; 1124 LB) who still had pain completed pain and disability measures. In the LB group, pain intensity rating categories of 1–4, 5–6, and 7–10 optimally discriminated disability levels for all four disability measures examined. In the CTS group, no pain intensity rating categorization scheme proved superior across all disability measures. For all disability measures examined, the relationship between pain intensity and disability level was linear in the CTS group, but nonlinear in the LB group. Among study participants with work-related back injuries, when pain level was 1–4, a decrease in pain of more than 1-point corresponded to clinically meaningful improvement in functioning, but when pain was rated as 5–10, a 2-point decrease was necessary for clinically meaningful improvement in functioning. The findings indicate that classifying numerical pain ratings into categories corresponding to levels of disability may be useful in establishing treatment goals, but that classification schemes must be validated separately for different pain conditions.

Keywords: Pain intensity; Disability; Carpal tunnel syndrome; Low back pain; Workers' compensation

1. Introduction

Pain intensity is the outcome most widely assessed in clinical pain research and numerical rating scales (0–10 or 0–100) are commonly used for this purpose (Jensen et al., 2001). These scales are valid and sensitive to clinical change (Jensen and Karoly, 2001), and useful for measuring associations of pain with other variables. However, classification of numerical ratings into mild, moderate, and severe categories is useful for other purposes, such as describing the prevalence of different levels of pain intensity within a population or judging pain treatment success (e.g. proportion of patients whose pain decreases to mild levels). Currently, there is no consensus concerning how numerical ratings should be categorized for such purposes and there is a need for evidence regarding valid and reliable cutpoints for differentiating patients with mild, moderate, and severe pain.

One way to classify numerical pain ratings is based on pain impact on functioning. For patients, their families

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and employers, payers, and society, the extent to which pain interferes with ability to perform customary activities is highly important. Thus, various pain rating categorization schemes have been compared in ability to discriminate disability levels. Categorizing cancer patients' ratings of worst pain into groups of 1–4, 5–6, and 7–10 optimally discriminated activity interference levels (Serlin et al., 1995). The same scheme optimally discriminated activity interference levels among patients with amputations for back pain ratings, but not for ratings of pain in other sites (Jensen et al., 2001). Different cutpoints were also found for patients with chronic low back pain and patients with chronic osteoarthritis pain (Zelman et al., 2003). Jensen and colleagues (Jensen et al., 2001) called for further studies to investigate the relationship between pain intensity and functioning as assessed by different measures, especially the SF-36 (Ware et al., 2000b), among patients with different types of pain.

A related issue concerns the form of the association between pain and disability. It has been suggested that this relationship is nonlinear, such that pain rated <5 on 0–10 scales does not interfere much with activities whereas pain ratings ≥ 5 are associated with much greater disability (Jensen et al., 2001; Serlin et al., 1995; Von Korff, 2001). However, empirical research is needed to confirm this, using different measures of disability and different patient populations.

The relationship between pain and disability is of particular importance for injured workers and workers' compensation systems, for whom both pain relief and successful return to work are important goals. The objectives of this study were to determine: (1) the optimal classifications of pain intensity ratings for discriminating mild, moderate, and high levels of disability among individuals with work-related carpal tunnel syndrome (CTS) and low back (LB) injuries, (2) whether these classifications differ for these two conditions and for different disability measures, and (3) whether the relationship between pain intensity and disability is linear in each injury group. We hypothesized that, for both pain conditions, substantial disability would be manifest for the majority of workers only among those who rated their pain intensity ≥ 5.

2. Methods

2.1. Study participants and procedures

Workers aged 18 years or older who filed Washington State work-related CTS or LB injury claims July 2002 through June 2003 were identified through weekly reviews of a Washington State Department of Labor and Industries (DLI) claims database. We attempted to telephone all workers with new work disability claims (claim for compensation for ≥ 4 days of lost work time) for LB injuries and all workers with new CTS claims. Trained interviewers described the study and screened the workers to ensure they met the study eligibility criteria. Exclusion criteria were worker denial of work-related CTS or LB injury and inability to complete the telephone interview. Workers who submitted more than one claim during the study period were eligible to complete only an interview related to the first claim. The study was approved by the University of Washington institutional review board, and all participants provided informed consent. Study participants were compensated $10 for completion of the telephone interview.

At the time of data analysis for this report, among 4289 claims identified, 2297 (53.6%) injured workers enrolled in the study and completed the interview, 917 (21.4%) could not be contacted, 139 (3.2%) were ineligible, and 936 (21.8%) declined to participate. The 2297 study participants (1092 CTS and 1205 LB claimants; 1257 men and 1040 women) had a slightly lower proportion of men as compared with the nonparticipants (those who could not be contacted or who declined to enroll) (combined CTS and LB group: 54.7% vs 59.5%, $\chi^2=9.64$, $P=0.002$; CTS: 38.4% vs 44.3%, $\chi^2=7.12$, $P=0.008$; LB: 69.5% vs 72.8%, $\chi^2=2.88$, $P=0.09$). Participants were significantly older than were nonparticipants due to a difference among claimants with CTS, although the mean difference was very slight [total group mean (SD)=40.7 (10.8) vs 39.9 (11.2) years, $t=2.35$, $P=0.02$; CTS mean (SD)=42.4 (10.3) vs 41.0 (10.8) years, $t=3.00$, $P=0.003$; LB mean (SD)=39.2 (11.0) vs 38.9 (11.5) years, $t=0.43$, $P=0.67$]. Study participants who said they had no pain in the past week ($n=106$) or who declined to rate their pain ($n=8$) were excluded from analyses. Thus, data analyzed for this study came from 2183 injured workers (1059 CTS and 1124 LB).

2.2. Measures

Participants provided sociodemographic and work status information and completed pain and generic and condition-specific disability measures in a Computer-Assisted Telephone Interview (CATI) conducted by trained interviewers.

2.2.1. Pain intensity

Pain intensity was assessed by a 0–10 rating of average pain intensity in the past week, where 0=no pain and 10=pain as bad as could be (Von Korff, 2001; Von Korff et al., 1992).

2.2.2. Disability

We administered three generic disability measures in order to assess different aspects of disability and to enable comparisons of the two injury groups on the same measures as well as comparisons to groups of patients with other conditions and to healthy individuals. All participants completed the Short Form-36 Version 2 (SF-36v2) (Ware et al., 2000a) Physical Functioning (PF) and Role-Physical

(RP) scales. The SF-36 is a widely used, valid, reliable health status measure. The norm-based scoring method was used, based on 1998 SF-36 United States (US) population norms with a mean of 50 and standard deviation of 10 (Ware et al., 2000a). Lower scores on the PF scale indicate greater limitations in performing physical activities (e.g. walking, lifting) due to health. Lower scores on the RP scale indicate greater problems with work or other daily activities because of physical health. In addition, all participants rated pain interference with their ability to work on a scale from 0 = no interference to 10 = unable to carry on any activities (Von Korff, 2001; Von Korff et al., 1992).

Experts have recommended supplementing generic health status measures with condition-specific measures, which may be more responsive than generic measures to clinically important changes in the patient's health condition (Bombardier, 2000; Patrick et al., 1995). Furthermore, the generic SF-36v2 PF scale may be more sensitive to disability among individuals with back pain than among those with CTS. Of the 10 items on the PF scale, six would be expected to be affected more by back pain than by CTS: climbing several flights of stairs; climbing one flight of stairs; bending, kneeling, or stooping; walking more than one mile; walking several hundred yards; walking one hundred yards). For these reasons, we also administered a condition-specific physical disability measure to each injury group. Participants with back injuries completed the 24-item Roland–Morris disability questionnaire (RDQ) (Roland and Morris, 1983) and participants with CTS completed the 8-item Carpal Tunnel Syndrome Assessment Questionnaire Functional Status Scale (CTSAQ FS) (Levine et al., 1993). Scores on the RDQ can range from 0 to 24 and scores on the CTSAQ FS can range from 1 to 5; on both scales, higher scores indicate greater physical disability. Validity, reliability, and responsiveness to clinical change have been demonstrated for both the RDQ (Beurskens et al., 1996; Deyo, 1986; Jensen et al., 1992; Roland and Fairbank, 2000; Roland and Morris, 1983; Turner et al., 2003; Underwood et al., 1999) and the CTSAQ FS (Amadio et al., 1996; Gay et al., 2003; Katz et al., 1996; Levine et al., 1993).

2.3. Statistical analysis

To determine optimal pain rating cutpoints for discriminating disability severity, we followed the strategy used in previous studies (Jensen et al., 2001; Serlin et al., 1995). We grouped the numerical pain ratings into four possible categories of mild, moderate, and severe pain, labeling each category by the moderate range: (1) scheme 4–6: mild = 1–3, moderate = 4–6, severe = 7–10; (2) scheme 4–7: 1–3, 4–7, 8–10; (3) scheme 5–7: 1–4, 5–7, 8–10; and (4) scheme 5–6: 1–4, 5–6, 7–10. We then conducted an analysis of variance (ANOVA) for each of the four pain rating categorization schemes, with pain intensity classification as the group variable and disability as the dependent variable, for each disability measure, separately for the LB and CTS groups. We also calculated ANOVA F-statistics using the Huber–White robust variance estimator, which allows relaxation of the assumption of constant variance (White, 1980). The Huber–White based F-statistics led to the same conclusions regarding the best classification scheme with one minor exception, which we comment on in our presentation of the results. We also examined whether the conclusions changed after controlling for age, gender, race, and education.

To test the hypothesis that the relationship between pain and disability is nonlinear such that the relationship differs for pain levels of five or greater, we used a linear regression model that allows the slope of the fitted line to change at a pain level of five. In these analyses, we predicted disability measure scores in each injury group from the pain intensity rating (x_1) and a second predictor (x_2) that was set equal to 0 if the pain intensity rating was <5 and set equal to the pain intensity rating -4 if the pain intensity rating was ≥ 5. Including x_2 in the regression allows the slope to differ for pain <5 and pain ≥ 5 while maintaining a continuous fitted curve. If the estimated regression coefficient of x_2 is not significantly different from 0, this implies no change in the slope of the regression of disability scores on pain intensity ratings at pain ratings of 5 or greater. As another way of examining whether substantial physical disability is associated only with pain intensity ratings ≥ 5, we examined the proportion of individuals in each injury group with substantial levels of physical disability (defined as scoring more than 1 SD below the US population mean on the SF-36v2 scales) at each pain rating.

3. Results

3.1. Participant characteristics

Table 1 summarizes the demographic characteristics of the sample. As can be seen, the LB sample was somewhat younger than the CTS sample, had a smaller proportion of females, and was less highly educated. In addition, the LB group had a higher proportion of workers reporting Hispanic ethnicity and a lower proportion of non-Hispanic Caucasians. The CTS and LB groups did not differ significantly in the time between workers' compensation claim submission and the baseline interview (mean (SD) = 21 (10) days and median = 18 days in both groups).

Table 2 summarizes scores on the study measures in the two injury groups. Although the LB group had significantly lower pain intensity ratings and higher pain-related work interference ratings as compared with the CTS group, these differences were very small and of dubious clinical significance. The LB group was also significantly more disabled in physical and role functioning, as assessed by the PF and RP scales.

Table 1
Demographic characteristics of the CTS and LB samples

Characteristic	Work-related disorder		P-value[a]
	CTS, N=1059	LB, N=1124	
Age mean (SD, years)	42.4 (10.3)	39.2 (10.8)	<0.001
Gender (%)			<0.001
Female	61.3	31.0	
Male	38.7	69.0	
Education (%)			<0.001
Less than high school	9.1	14.1	
High school/GED	30.4	34.1	
Vocational/technical	11.0	10.2	
Some college	37.1	33.3	
College or higher	12.3	8.2	
Race/ethnic group (%)			<0.001[b]
Caucasian, non-Hispanic	78.7	70.8	
Hispanic	9.4	16.8	
More than one race	5.6	5.7	
American Native	2.4	2.1	
African–American	2.0	3.0	
Asian, Pacific Islander	1.9	1.5	

CTS, carpal tunnel syndrome; LB, low back; GED, general equivalency diploma.
[a] From t-test or χ^2 analysis.
[b] Comparison of Caucasian (non-Hispanic), Hispanic, and other.

3.2. Optimal pain intensity cutpoints for discriminating disability severity

Table 3 shows the F-ratios from the ANOVAs comparing the four different three-category pain rating classification schemes. For the LB group, the 5–6 classification scheme was the best at discriminating disability levels for all four disability measures. However, for the CTS group, no one scheme was optimal across the different disability measures. In the CTS sample, the F-ratio was highest for the 4–7 scheme for the two generic disability measures (PF and RP), but only slightly higher than that of the 4–6 scheme for the RP scale. The 5–7 scheme was best for the CTS-specific measure (CTSAQ FS), although only slightly better than the 4–7 scheme. For the CTS work interference measure, the F-ratio was highest for the 5–6 scheme, but only somewhat higher than that of the 4–6 scheme. For both the CTS and LB groups, adjusting for age, gender, race, and education did not alter any conclusions concerning the best scheme for each disability measure.

Table 2
Scores on the measures of pain and functioning

Measure (possible range)	CTS, N=1059		LB, N=1124		t-test, P-value
	Mean	SD	Mean	SD	
Pain intensity (0–10)	5.95	2.09	5.65	2.37	0.002
Work interference (0–10)	5.09	2.84	5.38	3.26	0.03
SF-36v2 PF (0–100)	45.77	8.75	37.66	12.38	<0.001
SF-36v2 RP (0–100)	41.27	11.53	36.51	12.84	<0.001
RDQ (0–24)	–	–	13.09	6.79	
CTSAQ FS (1–5)	2.72	0.84	–	–	

CTS, carpal tunnel syndrome; LB, low back; SF-36v2 PF, Short Form-36v2 Physical Functioning scale, norm-based scoring, 1998 SF-36 US population norms; SF-36v2 RP, Short Form-36v2 Role-Physical scale, norm-based scoring, 1998 SF-36 US population norms; RDQ, Roland–Morris Disability Questionnaire; CTSAQ FS, Carpal Tunnel Syndrome Assessment Questionnaire Functional Status scale.

Table 3
Discrimination of disability measure scores by four pain intensity classification schemes: F-ratios from ANOVAs

Disability measure	Classification[a]			
	4–6	5–6	4–7	5–7
Work interference				
CTS	215.9	**219.4**	193.8	213.9
LB	387.4	**400.8**	331.1	379.4
SF-36v2 PF				
CTS	57.9	53.5	**74.7**	70.9
LB	186.4	**205.4**	158.0	194.3
SF-36v2 RP				
CTS	62.9	57.7	**63.7**	60.4
LB	205.6	**216.9**	173.2	202.8
CTSAQ FS (CTS only)	128.9	125.5	133.0	**135.7**
RDQ (LB only)	278.5	**310.7**	238.8	297.0

CTS, carpal tunnel syndrome; LB, low back; SF-36v2 PF, Short Form-36v2 Physical Functioning scale, norm-based scoring, 1998 SF-36 US population norms; SF-36v2 RP, Short Form-36v2 Role-Physical scale, norm-based scoring, 1998 SF-36 US population norms; CTSAQ FS, Carpal Tunnel Syndrome Assessment Questionnaire Functional Status scale; RDQ, Roland–Morris Disability Questionnaire. Highest F-ratios for each disability measure are bolded. The F-ratios shown assume equal variance. Relaxing the assumption of equal variance did not change the highest F-ratio for any scale in either injury group except in one situation: for the RP scale in the CTS group, the F-ratio for scheme 4–6 was slightly higher (0.9) than that for scheme 4–7 using the Huber–White adjustment, whereas the F-ratio for scheme 4–7 was slightly higher (0.8) than that for scheme 4–6 when equal variance was assumed.
[a] 4–6 = mild 1–3, moderate 4–6, severe 7–10; 5–6 = mild 1–4, moderate 5–6, severe 7–10; 4–7 = mild 1–3, moderate 4–7, severe 8–10; 5–7 = mild 1–4, moderate 5–7, severe 8–10.

3.3. Is the association between pain and functioning nonlinear?

The regression analyses showed no statistically significant change in the slope of the regression of PF ($P=0.83$), RP ($P=0.62$), work interference ($P=0.87$), or CTSAQ FS ($P=0.67$) scores on pain intensity ratings at ratings of 5 or higher for the CTS group. However, for the LB group, there was a statistically significant change in slope at pain intensity ratings of 5 or higher compared with less than 5 on all four disability measures (PF: x_2 coefficient = 1.91, $P=0.001$; RP: x_2 coefficient = 2.62, $P<0.001$; work interference: x_2 coefficient = −0.65, $P<0.001$; RDQ: x_2 coefficient = −1.42, $P<0.001$), indicating nonlinear relationships between pain intensity and physical and role functioning. Because greater disability is indicated by lower scores on the PF and RP scales but by higher scores on the work interference rating and the RDQ, the signs of all coefficients indicate a decline in the rate of worsening of disability as pain intensity ratings increase after ratings of 4. The slope of the relationship between pain and functioning was significantly steeper for pain levels of 1–4 than for pain levels of 5–10. For example, at pain levels of 1–4, a 1-point decrease in pain corresponded to a 4.2-point improvement in PF scores, but at pain levels of 5–10, a 1-point decrease in pain corresponded to a 2.3-point improvement in PF scores. On the back pain-specific measure of physical disability (RDQ), there was a 2.8-point improvement for every 1-point decrease in pain if pain was rated 1–4, but improvement of only half that of (1.4-points) for every 1-point decrease in pain if pain was rated 5–10.

To illustrate these relationships, Fig. 1 shows the average observed norm-based PF score at each level of pain intensity (1–10) for the CTS and LB samples, as well as the lines of regression showing the predicted scores for each level of pain intensity. For the LB group, the predicted scores reflect the significant change in the regression line at pain intensity ratings of five or higher (regression coefficient for x_1+ regression coefficient for x_2). Fig. 1 provides an opportunity to examine physical disability at different pain levels in terms of the 1998 SF-36 US general population norms. For the LB group, the average observed PF scores are less than 1 SD below the US population mean at pain levels 1–4, 1–1.5 SD below the US population mean at pain levels 5 and 6, and 1.5–2.0 SD less than the US population mean at pain levels 7–10. For the CTS group, the pain ratings cannot be categorized as easily because the relationship between pain and physical function is more flat and linear. The average observed PF scores are within 0.5 SD above the US population mean for pain ratings of 1–3, within 0.5 SD below the US population mean for pain ratings of 4–7, and almost 1 SD below the US population mean for pain ratings of 8–10.

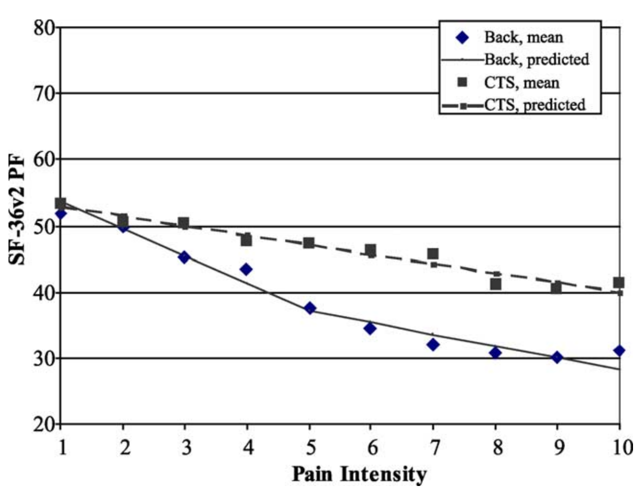

Fig. 1. Mean SF-36v2 PF norm-based score at each level of pain intensity for workers with CTS and LB injuries and lines of regression showing predicted scores. For the CTS group, the slope of the regression line does not change significantly at pain ratings ≥5. For the LB group, predicted scores reflect the significant change in the slope of the regression line at pain ratings ≥5.

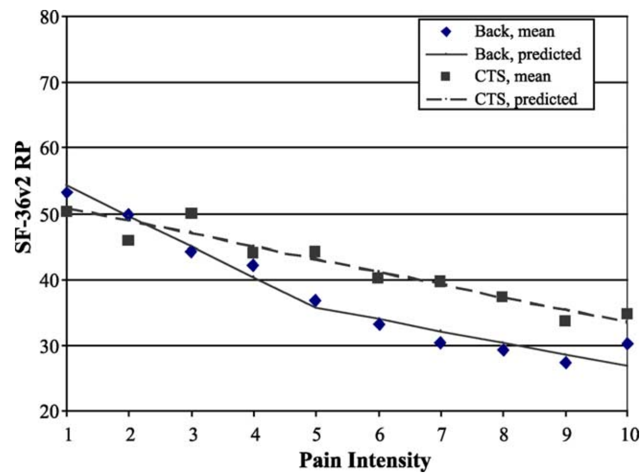

Fig. 2. Mean SF-36v2 RP norm-based score at each level of pain intensity for workers with CTS and LB injuries and lines of regression showing predicted scores. For the CTS group, the slope of the line of regression does not change significantly at pain ratings ≥5. For the LB group, predicted scores reflect the significant change in the slope of the line of regression at pain ratings ≥5.

Fig. 2 shows the observed and predicted RP scores. For the LB group, the average observed RP scores are within 1 SD of the US general population mean at pain levels 1–4, 1–2 SD less than the US population mean at pain levels 5–7, and ≥2 SD below the US population mean at pain levels 8–10. For the CTS group, the relationship between pain and role disability, similar to that seen between pain and physical functioning, is more gradually declining. Average observed RP scores are within 0.5 SD of the US population mean for pain ratings of 1–3, 0.5–1 SD below the US population mean for pain ratings of 4–6, and 1–2 SD below the US population mean for pain ratings of 7–10.

Fig. 3 shows the mean observed scores on the other disability measures for each level of pain in each injury group. On the back pain-specific physical disability measure (RDQ), there is a marked increase in scores between pain levels of 4 and 5, and little difference between pain levels 7–10, consistent with the regression results and the ANOVA finding of pain categorization scheme 5–6 being optimal for discriminating disability levels. On the CTS-specific functional disability measure, there is a very gradual increase in disability as pain levels increase. In general, work interference increases as pain level increases for both injury groups.

Although Figs. 1–3 show the mean level of physical disability for each pain intensity level, they do not provide information concerning the proportion of injured workers with substantial physical disability at each pain intensity

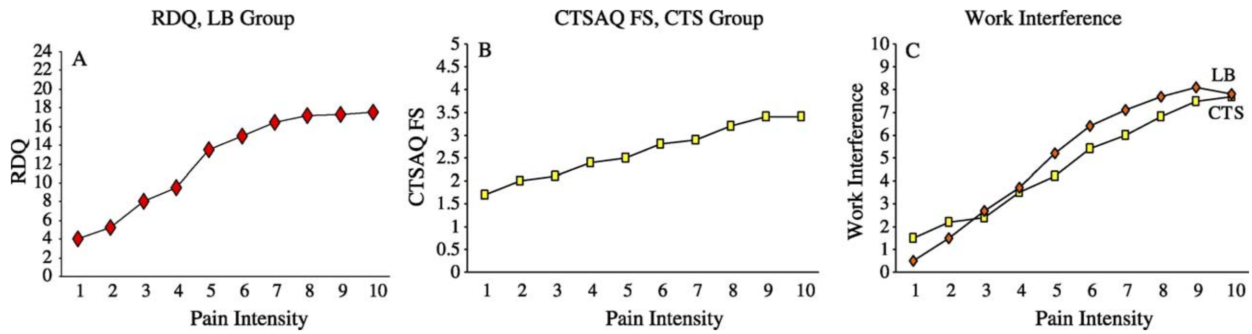

Fig. 3. Mean observed disability measure scores at each pain level.

rating. Fig. 4 shows the proportion of study participants at each pain level in each injury group with substantial physical activity limitations, defined as scoring more than 1 SD below the population mean on the PF scale. In the LB group, fewer than 15% of claimants had substantial disability at pain levels of 1 or 2, 25% had substantial disability at a pain level of 3, 37% at level 4, 57% at level 5, and 72–77% at levels 6–10. In the CTS group, fewer than 40% of study participants at each pain intensity level had substantial physical activity limitations and there is not a sizeable increase in the proportion substantially disabled until pain intensity is rated at 8 (34–39% of study participants at each pain level from 8 through 10 reported substantial physical activity limitations). This difference in disability rates between the two injury groups likely reflects to some extent the PF scale's emphasis on activities that would be more affected by back pain than by upper extremity problems.

Fig. 5 shows the proportion of study participants at each pain level in each injury group with substantial levels of physical health-related role disability, defined as scoring >1 SD below the population mean on the RP scale. Unlike the pattern for the PF scale, at low pain levels (1 and 2), more CTS than LB claimants had substantial role disability. At pain levels of 3 and higher, lower proportions of CTS as compared with LB claimants had substantial role disability, although the differences between the two groups were not as large as for the PF scale. Among the CTS claimants, proportions with substantial role disability increased steadily from pain ratings of 5–9. Among the LB claimants, only at pain levels of five and higher did the majority meet the definition of substantial role disability.

4. Discussion

The study findings indicate a pattern of differences in the relationship between pain ratings and disability levels among workers with new work-related back injury claims as compared with workers with new claims for work-related CTS. For the LB group, the pain intensity rating classification scheme of mild = 1–4, moderate = 5–6, and severe = 7–10 was the best at discriminating disability levels for all four disability measures examined. This was the same scheme previously found to best discriminate levels of activity interference among cancer pain patients from diverse populations (Serlin et al., 1995) and back pain interference with activities among individuals with amputations who also had back pain (Jensen et al., 2001).

The suggestion (Jensen et al., 2001; Serlin et al., 1995; Von Korff, 2001) that pain ratings ≥ 5 are associated with much greater disability was supported for workers with back injuries. Substantial physical and role disability (defined as scores 1 SD below the US general population mean) were not observed for the majority of workers with back injuries until pain ratings were 5 or higher. The hypothesis that the relationship between pain and disability is not linear was also supported for the workers with back injuries. In the LB group, the slope of the relationship between back pain and functioning was significantly steeper for pain levels of 1–4 than for pain levels of 5–10. The results have implications

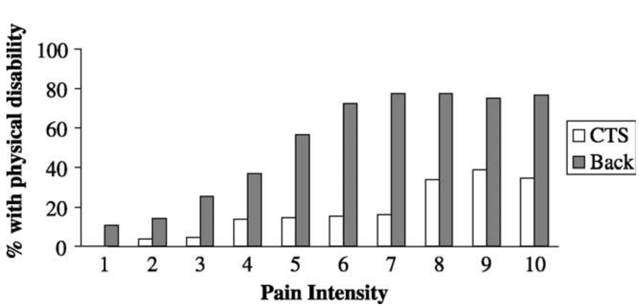

Fig. 4. For each pain level, percent of workers with work-related CTS and back injuries who have SF-36v2 PF physical disability scores >1 SD below the US population mean.

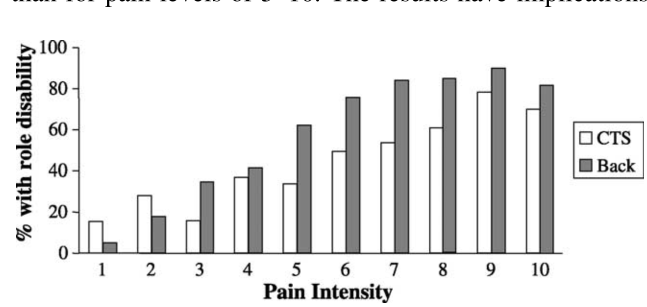

Fig. 5. For each pain level, percent of workers with work-related CTS and back injuries who have SF-36v2 RP role disability scores >1 SD below the US population mean.

for definitions of clinically meaningful change in back pain in terms of associated change in functioning. Clinically meaningful improvement in physical disability has been defined as improvement of 0.5 SD on health status measures such as the SF-36 (Norman et al., 2003) and of 2–4-points on the RDQ (Beurskens et al., 1996; Bombardier et al., 2001; Roland and Fairbank, 2000). Using these standards, for back pain ratings of 1–4, a decrease in pain level of more than 1-point corresponded to a clinically meaningful improvement in physical functioning (>0.5 SD on the SF-36v2 PF scale and >2–4-points on the RDQ). However, for pain ratings of 5–10, a pain decrease of more than 2-points was needed to have a clinically meaningful impact on functioning using these definitions.

For individuals with work-related CTS, the relationship between pain and disability is quite different than that for back pain. In the CTS group, no pain rating categorization scheme emerged as best across disability measures and the slope of the relationship between pain and disability did not change significantly at a pain level of 5. In contrast to the LB group, the relationship between pain and disability was more gradual and linear for the workers with CTS, resulting in no clear grouping of pain levels into categories of mild, moderate, and severe. It was beyond the scope of this study to examine dichotomous pain rating classification schemes. However, in the absence of a clear three-level pain rating categorization scheme, a dichotomous categorization may be possible. It may be fruitful in future research to examine whether a single cutpoint pain rating can be identified that optimally and reliably classifies individuals with CTS into low versus high disability groups.

Previous research has also found different optimal pain rating classification schemes depending upon site of pain rated (Jensen et al., 2001). Other sample characteristics may also affect cutpoints for pain ratings in discriminating disability levels. For example, a recent study's finding of different optimal classification schemes, compared with those found in other studies, for patients with chronic low back pain and for patients with chronic osteoarthritis pain may have been due, at least in part, to the study's inclusion criteria of average daily pain level of at least 4 and daily analgesic medication use (Zelman et al., 2003).

Our study findings also suggest that the SF-36v2 PF scale should not be used as a primary outcome measure of activity limitations in studies of patients with CTS. There was not a sizeable increase in the proportion of workers with CTS claims who were substantially physically disabled as assessed by the PF scale until pain intensity ratings of 8–10, and even at the highest pain intensity levels, only a minority met the definition of substantial disability on this scale. This was likely due to the PF scale's emphasis on activities more affected by back pain than by upper extremity problems, an explanation supported by the observation that at each level of pain, more workers with CTS showed substantial disability on the RP scale (which does not assess activities less affected by upper extremity problems) than on the PF scale.

A clearer understanding of how pain intensity ratings are associated with functioning could have important implications for treatment goals and for the ability to draw clinically meaningful conclusions from studies of pain treatments and from program evaluation or quality improvement efforts. Treatments could be evaluated not only in terms of average pain reductions (either in absolute or percent changes), but also in terms of proportions of patients whose pain is reduced from one category of pain intensity to another (e.g. severe to moderate, or to a level corresponding to low disability). Such knowledge could be particularly important for common work-related conditions such as back pain and CTS, which are often associated with substantial disability. For patients with back pain, evidence now seems sufficient to indicate that an average pain intensity rating less than 5 on a 0–10 scale generally corresponds to low physical and role disability. For patients with chronic moderate-severe low back pain, where a goal of no pain may be unrealistic, a goal of pain level <5 may be a reasonable target.

It should be emphasized that many factors in addition to pain intensity play a role in disability. Pain site, patient age, how much of the time pain is experienced, use of pain medication, and number of pain locations have all been found to be associated with disability (Scudds and Robertson, 2000). We did not evaluate other contributors to disability in the current study, the focus of which was the association between different pain intensity levels and disability. However, our findings held even when we adjusted for age, gender, race, and education. We recommend that future studies of the association between pain intensity and disability include assessment and analysis of other potentially important variables such as pain frequency, location(s), medication use, depression, pain-related beliefs and fears, and chronic comorbid diseases. It is possible, for example, that moderate pain experienced all or almost all of the time may be more disabling than severe pain experienced intermittently.

A study limitation is that both pain intensity and physical disability were assessed using self-report measures; thus, shared method variance might contribute to the associations found between the measures. There is a need to extend this research by examining the relationship between pain and disability as assessed using other sources of information (for example, spouse ratings, performance on objective measures of functioning, administrative records of work absence). The study is also limited by a response rate of 54%. It is possible that sample selection bias may have affected the study findings. Further research is needed to determine the generalizability of the current findings to workers with other types of painful injuries, workers with chronic pain, and workers in other workers' compensation settings, as well as to various populations of individuals with non-work-related pain problems. Finally, we did not examine differences in slopes at pain level cutpoints other than 5, and studies are needed to determine whether this is the optimal (and only) cutpoint for changes in slope in different patient samples.

In sum, our findings in these large, population-based samples of workers with recent work injury claims support previous work indicating that, for individuals with back pain, categorizing 0–10 pain ratings of 1–4 as mild, 5–6 as moderate, and 7–10 as severe is useful in discriminating levels of pain severity associated with physical and role disability. Our results also support prior suggestions that back pain is much more likely to be disabling when rated at levels of 5 or higher. However, for other pain problems, other pain intensity rating categorization schemes may be better, and the form of the relationship between pain and disability may differ. Longitudinal research is needed to directly test the implication of our findings that when back pain improves to a level under 5, there is a substantial, clinically meaningful improvement in function, whereas patients who still have pain levels of 5 or higher at the end of treatment remain substantially disabled. Finally, it might prove fruitful to compare the utility of various definitions of pain treatment success for patients with disabling moderate-severe pain; e.g. a 30% improvement in pain, which has been demonstrated to be clinically meaningful (Farrar et al., 2001), versus improvement to a pain level <5, in terms of patient ability to engage in customary activities. Ultimately, a common standard used across studies would prove invaluable in meta-analyses and in integrating various research findings across populations, treatments, and settings.

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