Early Predictors of Chronic Work Disability Associated with Carpal Tunnel Syndrome: A Longitudinal Workers' Compensation Cohort Study

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Background *The study objectives were to identify early predictors of chronic work disability associated with carpal tunnel syndrome (CTS) and to test the hypothesis that variables from each of several domains (sociodemographic, clinical, work-related, and psychosocial) would add unique predictive information.*

Methods *Washington State workers were interviewed 18 days (median) after submitting a new workers' compensation claim for CTS. Baseline predictors of chronic work disability (≥180 days of work disability compensation in the year after claim submission) were examined for workers who had at least 1 day of disability compensation (N = 899).*

Results *Baseline demographic variables, symptom severity, functional limitations, lack of job accommodation, job physical demands, job psychosocial conditions, and worker psychosocial characteristics predicted chronic disability bivariately. Each domain of variables added significantly to the prediction of chronic disability. The final multivariable model had fair ability to discriminate individuals with versus without chronic disability (cross-validated area under the ROC curve = 0.76).*

Conclusions *Sociodemographic, clinical, work-related, and worker psychosocial factors early in a claim contribute unique information to the prediction of subsequent work disability associated with CTS.* Am. J. Ind. Med. 50:489–500, 2007. *© 2007 Wiley-Liss, Inc.*

KEY WORDS: carpal tunnel syndrome (CTS); prediction; prospective; disability; work; workers' compensation

INTRODUCTION

Work-related upper extremity disorders (WUEDs) are associated with substantial work productivity loss and

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costs [Rossignol et al., 1988; Tate, 1992; Cheadle et al., 1994], yet a minority of workers account for most of these costs. For example, in 1994 approximately 7% of workers with WUED claims had more than 1 year of work disability, and these workers were responsible for 60% of the costs and 75% of the total disability days [Hashemi et al., 1998]. If workers at high risk for chronic disability could be identified soon after claim initiation, interventions to prevent chronicity could be targeted towards those most likely to need special treatment. Furthermore, the identification of modifiable early risk factors could help focus treatments to address those factors.

One of the most common and disabling WUEDs is carpal tunnel syndrome (CTS) [Daniell et al., 2005], an entrapment neuropathy of the median nerve in the wrist that causes symptoms of hand pain, weakness, burning, tingling, and numbness. Despite the prevalence and impact of CTS, little is known about risk factors for the transition from acute to chronic CTS-related work disability. However, early predictors of chronic disability have been identified for other work-related injuries and warrant investigation in workers with CTS. These include older age [Turner et al., 2000], greater pain and functional disability [Crook and Moldofsky, 1996; Hazard et al., 1996; Crook et al., 1998; Fransen et al., 2002; Hogg-Johnson and Cole, 2003], and no employer offer of job accommodation [Hogg-Johnson and Cole, 2003].

Certain psychosocial factors also appear to be risk factors for chronic work disability. Worse outcomes have been found for workers who blamed work factors for their condition, rated their relations with coworkers as poor, reported psychological distress, or had low expectations of recovery [Hazard et al., 1996; Hogg-Johnson and Cole, 2003; Schultz et al., 2004; Schultz et al., 2005; Lotters and Burdorf, 2006]. Two other psychosocial variables warrant investigation, based on their association with disability among patients with other musculoskeletal pain problems: fear-avoidance (avoidance of work and other activities due to fear of increased pain or harm) [Lethem et al., 1983; Waddell et al., 1993; Crombez et al., 1999; Vlaeyen and Linton, 2000; Mannion et al., 2001; Grotle et al., 2004] and catastrophizing (excessive focus on pain and its threat, and feeling helpless to control pain) [Sullivan et al., 2001; Turner and Aaron, 2001]. Both fear-avoidance and catastrophizing, assessed early after a work-related back injury, have been reported to predict subsequent work disability [Turner et al., 2006].

Only a few studies have examined predictors of work outcomes among individuals with CTS. In a community-based study, individuals with worse baseline CTS symptom severity, functional status, and mental health, and those receiving workers' compensation benefits, were less likely to be working 6 months after carpal tunnel release surgery [Katz et al., 1997]. Furthermore, individuals who received workers' compensation or who at baseline had greater functional limitations, symptom severity, psychological distress, or upper extremity job physical demands were more likely to be off work at 18 months [Katz et al., 1998]. In a second community-based study, workers with less education, lower income, job exposures to force and repetition, low job control, low job social support, and high psychological job demands were less likely to have successfully returned to work 6 months after CTS surgery [Gimeno et al., 2005; Katz et al., 2005].

Literature searches identified only one study of predictors of work outcomes among individuals with workers' compensation claims for CTS. In a retrospective study of Washington State workers' compensation claimants who underwent carpal tunnel release surgery in 1987, age and gender were not related to clinical or work disability outcomes [Adams et al., 1994]. This study did not include assessment of risk factors in domains other than demographic.

In sum, the literature suggests that early risk factors in multiple domains predict chronic work disability and that assessment of factors across multiple domains may improve ability to predict chronic disability. The overall objective of the current study was to examine this prospectively among workers with recently submitted workers' compensation claims for CTS. Six potentially important domains were identified from the literature: (1) sociodemographic, (2) clinical, (3) offer of job accommodation, (4) job physical demands, (5) job psychosocial conditions, and (6) worker psychosocial characteristics. The first specific aim was to identify risk factors for chronic work disability in each domain. The second aim was to test the hypothesis that variables in each domain would add significantly to the prediction of chronic disability.

METHODS

Study Participants and Procedures

The Washington Workers' Compensation Disability Risk Identification Study Cohort (D-RISC) is a prospective, population-based study designed to identify risk factors for chronic disability due to musculoskeletal disorders [Turner et al., 2004]. Weekly reviews of the Washington State Department of Labor and Industries (DLI) State Fund claims database were conducted from July 2002 through May 2004. A health care provider-completed report of work-related accident form is required for claim initiation and the work injury/condition is described on this report. The accident report is sent to the DLI and information from the report, including the nature of the work injury/condition, is entered into the

electronic claims database. This description allowed new claims for work-related CTS to be identified. The State Fund insures approximately two thirds of non-federal Washington workers. The other third, covered by larger self-insured companies, were excluded due to insufficient administrative data.

Trained interviewers telephoned all workers aged 18 years and older who had submitted new claims for CTS in the past week, screened them for eligibility, and conducted computer-assisted telephone interviews with study enrollees. Workers were excluded from the study if they denied having a workers' compensation claim for CTS symptoms (i.e., indicated that they had another type of injury; this happened in rare cases due to our identification of claims very early after submission, before additional or updated diagnostic information was entered in the DLI claims database), or if they were unable to complete a telephone interview (e.g., due to hearing problem, serious illness, or inability to communicate in English or Spanish). In addition, for the first 7 weeks of the study enrollment period, workers were excluded if they reported they had not missed at least 4 days of work because of their CTS (the requirement for receiving work loss compensation through the Washington State workers' compensation system); this exclusion criterion was dropped after the seventh week of enrollment. For Spanish-speaking participants ($n = 23$), the U.S. Spanish Short Form-36 version 2 (SF-36v2) Mental Health scale [Ware et al., 2000] was used and the rest of the interview was translated into Spanish by an accredited professional translator. Medical records of each study participant were reviewed by a nurse, who verified that each participant had CTS. The study was approved by the University of Washington institutional review board, and all participants provided informed consent and were paid $10 for completing the interview.

Measures

Baseline predictors: sociodemographic and clinical

In the baseline interview, participants provided sociodemographic information and completed the Carpal Tunnel Syndrome Assessment Questionnaire (CTSAQ) [Levine et al., 1993]. The CTSAQ, which contains symptom severity (SS) and functional status (FS) scales, has been demonstrated to be valid, reliable, and responsive to clinical change [Levine et al., 1993; Amadio et al., 1996; Katz et al., 1996; Gay et al., 2003]. Workers were also asked whether their hand symptoms were unilateral or bilateral.

Baseline predictors: job measures

Workers were asked if their employer had offered them some type of job accommodation (e.g., light duty, part-time work, special equipment) to allow them to work. To assess job physical demands, items were adapted from a checklist developed to assess ergonomic risk factors for upper extremity disorders [Keyserling et al., 1993; Silverstein et al., 1997]. Workers were asked how often their jobs required forearm twisting (as in turning a doorknob), pinching together of fingers (e.g., to hold a part or use a tool), and work resulting in vibration to the whole body (e.g., work with a jackhammer, driving a forklift). Workers also were asked how they would describe the physical demands of their usual job in terms of lifting, carrying, pushing, and pulling: sedentary (sit most of the time, occasionally move up to a 10-pound load), light (walk or stand more than one-third of the time, often move up to 10 pounds), medium (often move up to 25 pounds, sometimes up to 50 pounds), heavy (often move up to 50 pounds, sometimes up to 100 pounds), or very heavy (often move over 50 pounds, sometimes over 100 pounds).

Job psychosocial conditions were assessed using a subset of the Job Content Questionnaire [Karasek et al., 1998] items as well as some additional items. Workers were asked how much they agreed that their job is very hectic, their job requires working very fast, they are asked to do an excessive amount of work, they can take a break when they want, and their supervisor is willing to listen to their work-related problems. Workers were also asked to rate their overall satisfaction with their jobs.

Baseline predictors: worker psychosocial characteristics

Mental health. The Mental Health (MH) scale of the SF-36v2 (1-week timeframe) [Ware et al., 2000], a widely used, valid, reliable quality of life measure, was scored based on general U.S. population norms. Low scores indicate psychological distress and high scores reflect psychological well-being.

Catastrophizing was assessed by three questions from the Pain Catastrophizing Scale [Sullivan et al., 1995]. Participants were asked to rate on 0–4 scales how much they had thoughts when in pain that they cannot stand it anymore, that it is awful and overwhelming, and about how badly they want it to stop. The three ratings were averaged; higher scores indicate greater catastrophizing.

Recovery expectations, co-worker relations, and blame. Questions from the Vermont Disability Prediction Questionnaire [Hazard et al., 1996] were used to assess participants' certainty that they would be working in 6 months (0–10 scale from 'not at all certain' to

'extremely certain'), relations with co-workers (0–10 scale from 'don't get along well at all' to 'get along extremely well'), and perceptions of blame for the injury (self, work factor, someone or something else, no one).

Work fear-avoidance was assessed by two items from the Fear Avoidance Beliefs Questionnaire (FABQ) [Waddell et al., 1993] work scale. Participants rated on 0–6 scales their agreement with statements that their work might be harmful to their condition and that their work makes, or might make, their pain worse. The two ratings were averaged; higher scores indicate higher work fear-avoidance.

Outcome: work disability

Chronic work disability was defined as 180 days or more of wage replacement compensation for temporary total disability in the first year after claim submission. Temporary total disability payments are stopped when the worker returns to work or is judged to be medically stable and able to work.

Statistical Analyses

Descriptive statistics and logistic regression analyses were used to summarize the baseline and outcome measures and their bivariate associations. A series of multivariable logistic regression analyses were then conducted to test the hypothesis that each domain would add significantly to the previous domain(s) in predicting chronic work disability. In each model, only predictor variables that had a P-value <0.20 in the bivariate model predicting work disability were included. A multivariable logistic regression model predicting work disability was constructed for the first domain (sociodemographic) and the likelihood ratio test was used to determine whether the next domain (clinical) added significantly ($P < 0.05$) to the model. The likelihood ratio test was also used to test whether each subsequent domain added significantly to all of the previous domains.

Next, analyses were performed to identify specific variables across all domains that added unique information to the prediction of chronic work disability. First, a multivariable logistic regression analysis predicting work disability was conducted for each domain of predictors, entering as independent variables all baseline measures in that domain. Variables that had a P-value ≤ 0.20 in these analyses were then entered in a single multivariable logistic regression model predicting work disability.

Although the primary goal of this study was to identify risk factors for chronic work disability, in order to compare the classification accuracy of the final multivariable model with that of models in other studies, the area under the receiver operating characteristic (ROC) curve was calculated. The area under the ROC curve measures the ability of the model to correctly classify individuals with versus without chronic work disability (percentage of randomly drawn pairs correctly classified). To ensure that predictive accuracy estimates were not optimistic, cross-validation was used to estimate the area under the ROC curve. Cross-validation was performed by randomly drawing 10% of the sample to serve as the test sample for evaluating the model estimated on the other 90% of the sample; this was repeated 10 times and average performance was calculated over the combined repetitions [Steyerberg et al., 2001]. The accuracy of the model can be considered poor if the area is 0.60–0.70, fair if 0.70–0.80, good if 0.80–0.90, and excellent if 0.90–1.00. Sensitivity and specificity in predicting chronic work disability were calculated using a predicted probability level cutpoint of 25% (i.e., worker classified as having chronic work disability if predicted probability $\geq$25%). This cutpoint was chosen because the base rate of chronic work disability in this population of workers with at least 1 day of paid work loss compensation for CTS is about 25%.

RESULTS

Sample Characteristics

Among 3,983 claimants identified, 811 (20.4%) could not be contacted within the 6-week window for baseline interviews, 234 (5.9%) were contacted but found to be ineligible (148 because they had not missed at least 4 days of work, an exclusion criterion during the first 7 weeks of the study; 50 due to language barriers; 15 because they denied having a claim for CTS symptoms; and 21 for other reasons, such as inability to complete an interview due to a hearing problem or illness), and 883 (22.2%) declined to participate. The remainder (n = 2,055; 51.6%) enrolled and completed the baseline interview. Claims ultimately not accepted by DLI for disability compensation for CTS and claims with no days of paid work loss compensation (in Washington State, compensation for work loss is paid after at least 4 days of work loss) were excluded from analysis, leaving a sample of 899. As compared with nonparticipants (those who could not be contacted or who declined to participate) who were accepted for disability compensation and had at least 1 day of paid work loss compensation (N = 659), the study sample was slightly older on average [age mean (SD) = 44.3 (9.7) years versus 43.1 (10.5) years; $t_{1,349} = 2.38$, $P = 0.017$] and had a larger proportion of females (63% vs. 54%, $\chi^2_1 = 13.01$, $P < 0.001$). However, participants did not differ from nonparticipants on the study outcome measure (proportion with $\geq$180 work disability days in the year after claim submission; 22% vs. 23%, $P = 0.44$).

Among the 899 workers (63% female, 78% white) in the sample, the median number of days between claim submission and the baseline interview was 18 (interquartile range [IQR], 15–25 days). Most participants (717; 80%) reported bilateral CTS symptoms. The median number of work disability days in the year after claim submission was 69 (IQR, 33–168 days). However, in the 210 workers (23%) who received $\geq$180 days of work disability compensation, the median (IQR) number of disability days was 279 (221–352). Among those who received $<$180 days of disability compensation (n = 689), the median (IQR) number of disability days was 48 (26–87).

Bivariate Associations of Baseline Worker Sociodemographic and Clinical Characteristics With Chronic Work Disability

Table I shows the sample sociodemographic and clinical characteristics, and their bivariate associations with chronic work disability. For descriptive purposes, the median number of work disability days in the year after claim submission is shown for the different subgroups. Workers aged 45 years and older had significantly lower odds of chronic work disability, whereas those with less than high school education, less income, and higher CTSAQ FS and SS scores had higher odds of chronic work disability. Because study participants and nonparticipants differed in age and gender, the relationship between chronic work disability and age and gender in the study nonparticipants was examined to explore whether there was selection bias in the study sample. The pattern of findings was similar: among the nonparticipants, older age was associated with significantly lower odds of chronic work disability and gender was not associated with work disability.

Bivariate Associations of Baseline Job Factors With Chronic Work Disability

Table II summarizes the responses of workers to questions about whether they were offered job accommodations to help them work, physical demands of their jobs, and job psychosocial conditions, as well as their bivariate associations with chronic work disability. No offer of accommodation, greater job physical demands, and worse job psychosocial conditions were associated with significantly higher odds of chronic work disability.

Bivariate Associations of Baseline Worker Psychosocial Characteristics With Chronic Work Disability

Table III summarizes the worker psychosocial measures and their bivariate associations with chronic work disability. Workers with less than very high recovery expectations (i.e., those with ratings of 0–8 on the 0–10 scale) or who declined to rate their recovery expectations, as well as those with greater psychological distress, tendency to catastrophize, and work fear-avoidance, had significantly higher odds of chronic work disability.

Additional Contribution of Each Domain in Predicting Chronic Work Disability

Table IV shows the results of the analyses testing the hypothesis that each domain would add significantly to the prediction of chronic work disability. As can be seen, the hypothesis was supported for each domain [$P \leq 0.001$ for all domains except job psychosocial conditions ($P = 0.05$)].

Baseline Variables Most Strongly Associated With Chronic Work Disability: Multivariable Model With All Domains

In the domain-specific multivariable models predicting work disability, a number of variables had P-values $\leq$0.20. These were age, education, income, CTSAQ SS and FS, bilateral versus unilateral symptoms, offer of job accommodation, twisting, pinching, job physical demands, fast work, excessive work, recovery expectations, the SF-36 Mental Health score, fear-avoidance, catastrophizing, and blame. All of these variables were entered in a multivariable logistic regression analysis in order to identify the strongest predictors across all domains.

This final model had fair accuracy in correctly predicting whether a worker would become chronically disabled (area under the ROC curve = 0.76, sensitivity = 74%, specificity = 76%). Three baseline variables remained statistically significant in the final model: age ($P = 0.04$), CTSAQ FS ($P = 0.001$), offer of job accommodation ($P < 0.001$), job physical demands ($P = 0.004$), and recovery expectations ($P < 0.001$). The odds of chronic work disability increased with increasing functional limitations at baseline. Workers with the greatest functional limitations, relative to those with the least, had 3.9 times the odds (95% CI = 1.9–8.0) of chronic work disability. Workers who had not been offered a job accommodation by the time of the baseline interview had twice the odds of chronic work disability (OR = 2.1, 95% CI = 1.4–3.3). The odds of chronic work disability also increased with increasing job physical demands. Relative to workers with sedentary jobs, those who rated their job demands as very heavy had 3.2 times the odds of chronic work disability (95% CI = 1.5–6.8). Finally, relative to workers with the highest recovery

TABLE I. Baseline Sociodemographic and Clinical Variables and Bivariate Associations With Chronic Work Disability (N = 899)

Baseline variable	n (%)	No. of disability days, median (IQR)	≥180 disability days, n (%)	Crude OR[a]	95% CI
Age (years)					
≤44	431 (48%)	87 (35–209)	123 (29%)	1.00	
45–54	325 (36%)	62 (33–136)	65 (20%)	**0.63**	0.44, 0.88
55+	143 (16%)	48 (30–104)	22 (15%)	**0.46**	0.28, 0.75
Gender					
Male	329 (38%)	83 (44–183)	83 (25%)	1.00	
Female	570 (62%)	59 (28–153)	127 (22%)	0.85	0.62, 1.17
Race					
White non-Hispanic	721 (80%)	67 (33–168)	168 (23%)	1.00	
Other	178 (20%)	76 (34–167)	42 (24%)	1.02	0.69, 1.50
Education					
College graduate	86 (10%)	40 (21–134)	17 (20%)	1.00	
Some college	350 (39%)	61 (30–145)	67 (19%)	0.96	0.53, 1.74
Vocational/technical	91 (10%)	82 (43–153)	19 (21%)	1.07	0.52, 2.23
High school	285 (32%)	74 (38–184)	75 (26%)	1.45	0.80, 2.62
Less than high school	86 (10%)	112 (48–254)	32 (37%)	**2.41**	1.21, 4.78
Marital status					
Married	537 (60%)	64 (32–154)	114 (21%)	1.00	
Living with partner	107 (12%)	95 (43–195)	30 (28%)	1.45	0.90, 2.31
Divorced	139 (15%)	69 (32–198)	39 (28%)	1.45	0.95, 2.21
Other	116 (13%)	84 (29–169)	27 (23%)	1.13	0.70, 1.82
Total annual household income					
>$70,000	126 (14%)	46 (23–101)	16 (13%)	1.00	
$45,000–70,000	234 (26%)	60 (27–131)	44 (19%)	1.59	0.86, 2.96
$30,000–45,000	241 (27%)	76 (37–171)	58 (24%)	**2.18**	1.19, 3.98
<$30,000	269 (30%)	94 (45–213)	85 (32%)	**3.18**	1.77, 5.70
Did not answer	29 (3%)	79 (28–169)	7 (24%)	2.19	0.81, 5.94
Bilateral versus unilateral CTS					
Unilateral	181 (20%)	48 (26–129)	34 (19%)	1.00	
Bilateral	717 (80%)	72 (35–178)	175 (24%)	1.40	0.93, 2.10
CTSAQ SS (score range)					
≤25th percentile (1–3)	217 (24%)	51 (26–90)	22 (10%)	1.00	
25–50th percentile (3.01–3.50)	200 (22%)	59 (28–145)	41 (21%)	**2.29**	1.31, 4.00
50–75th percentile (3.51–3.82)	209 (23%)	70 (33–189)	55 (26%)	**3.17**	1.85, 5.42
>75th percentile (3.83–5)	272 (30%)	112 (48–243)	92 (34%)	**4.53**	2.73, 7.52
CTSAQ FS (score range)					
≤25th percentile (1–2.25)	223 (25%)	46 (24–84)	20 (9%)	1.00	
25–50th percentile (2.26–2.99)	219 (24%)	61 (30–132)	36 (16%)	**2.00**	1.12, 3.57
50–75th percentile (3–3.30)	232 (26%)	85 (35–210)	70 (30%)	**4.39**	2.56, 7.51
>75th percentile (3.31–5)	223 (25%)	118 (50–259)	84 (38%)	**6.13**	3.60, 10.46

IQR, interquartile range; CTS, carpal tunnel syndrome; CTSAQ, Carpal Tunnel Syndrome Assessment Questionnaire; FS, functional status scale; SS, symptom severity scale.
One study participant declined to provide information on education, one was unsure whether CTS was unilateral or bilateral, and two CTSAQ FS and one CTSAQ SS scales could not be scored due to 'don't know' or 'unsure' responses to some items.
[a]Odds ratios (OR) and 95% confidence intervals (CI) obtained from logistic regression predicting chronic work disability (<180 vs. ≥180 disability days as of 1 year from claim submission). Statistically significant ($P < 0.05$) ORs are bolded.

TABLE II. Baseline Job Variables and Bivariate Associations With Chronic Work Disability (N = 899)

Baseline variables	n (%)	No. of disability days, median (IQR)	≥180 disability days, n (%)	Crude OR[a]	95% CI
Offered job accommodation					
Yes	315 (35%)	49 (24–112)	48 (15%)	1.00	
No[b]	584 (65%)	80 (41–187)	162 (28%)	**2.14**	1.50, 3.05
Job physical demands					
Forearm twisting					
Not at all—occasionally	287 (32%)	48 (25–120)	45 (16%)	1.00	
Frequently or constantly	610 (68%)	80 (38–195)	165 (27%)	**1.99**	1.38, 2.87
Pinching fingers					
Not at all—occasionally	189 (21%)	47 (24–104)	27 (14%)	1.00	
Frequently or constantly	709 (79%)	76 (35–183)	183 (26%)	**2.09**	1.34, 3.24
Whole body vibration					
Not at all—occasionally	723 (80%)	61 (30–153)	156 (22%)	1.00	
Frequently or constantly	174 (20%)	96 (49–218)	54 (31%)	**1.64**	1.13, 2.36
Physical demands					
Sedentary	203 (23%)	42 (21–95)	26 (13%)	1.00	
Light	220 (25%)	58 (28–137)	40 (18%)	1.51	0.89, 2.59
Medium	240 (27%)	78 (40–201)	69 (29%)	**2.75**	1.67, 4.52
Heavy	135 (15%)	84 (43–212)	38 (21%)	**2.67**	1.53, 4.66
Very heavy	93 (10%)	143 (70–240)	35 (38%)	**4.11**	2.28, 7.39
Job psychosocial conditions					
Very hectic					
Disagree	178 (20%)	63 (29–127)	28 (16%)	1.00	
Agree	718 (80%)	70 (34–180)	180 (25%)	**1.79**	1.16, 2.78
Requires working very fast					
Disagree	160 (18%)	54 (25–103)	19 (12%)	1.00	
Agree	339 (38%)	67 (27–155)	74 (22%)	**2.07**	1.20, 3.57
Strongly agree	396 (44%)	83 (38–208)	117 (30%)	**3.11**	1.84, 5.26
Excessive work					
Disagree	337 (38%)	52 (26–118)	55 (16%)	1.00	
Agree	324 (36%)	69 (32–154)	71 (22%)	1.44	0.97, 2.13
Strongly agree	227 (26%)	122 (46–246)	81 (36%)	**2.85**	1.91, 4.23
Take break when want					
Agree	385 (43%)	54 (25–129)	79 (21%)	1.00	
Disagree	513 (57%)	81 (42–183)	130 (79%)	1.32	0.96, 1.81
Supervisor listens					
Agree	696 (78%)	62 (30–154)	147 (21%)	1.00	
Disagree	193 (22%)	100 (47–214)	61 (32%)	**1.73**	1.21, 2.46
Overall satisfaction					
Very or somewhat satisfied	750 (84%)	62 (31–154)	161 (22%)	1.00	
Not very satisfied	144 (16%)	120 (48–229)	47 (33%)	**1.77**	1.20, 2.62

IQR, interquartile range.

For the following variables, some workers declined to answer, said they were unsure, or said the question did not apply: twist (n = 2), pinch (1), physical demands (8), vibrate (2), fast (4), excessive (11), hectic (3), supervisor listens (10), take a break when desired (1), overall satisfaction (5).

[a]Odds ratios (OR) and 95% confidence intervals (CI) obtained from logistic regression predicting chronic work disability (<180 vs. ≥180 disability days as of 1 year from claim submission). Statistically significant ($P < 0.05$) ORs are bolded.

[b]Included 11 workers who said they were unsure.

TABLE III. Baseline Worker Psychosocial Variables and Bivariate Associations With Chronic Work Disability (N = 899)

Baseline variable (score range)	n (%)	No. of disability days, median (IQR)	≥180 disability days, n (%)	Crude OR[a]	95% CI
Recovery expectations (0–10)					
Very high (9–10)	547 (61%)	52 (26–111)	77 (14%)	1.00	
High (7–8)	122 (14%)	72 (35–177)	29 (24%)	**1.90**	1.18, 3.08
Moderate (4–6)	93 (10%)	153 (47–252)	38 (41%)	**4.22**	2.61, 6.81
Low (0–3)	104 (12%)	179 (82–316)	51 (49%)	**5.87**	3.73, 9.25
Did not answer	33 (4%)	163 (78–283)	15 (46%)	**5.09**	2.46, 10.52
Mental Health (0–100)					
At/above population mean	471 (52%)	50 (26–110)	65 (14%)	1.00	
<1 SD below population mean	162 (18%)	70 (33–177)	39 (24%)	**1.98**	1.27, 3.09
1–2 SD below population mean	165 (18%)	128 (49–261)	64 (39%)	**3.96**	2.63, 5.95
>2 SD below population mean	100 (11%)	142 (59–254)	41 (41%)	**4.34**	2.69, 6.99
Catastrophizing (0–4)					
Low (<1)	180 (20%)	45 (23–93)	19 (11%)	1.00	
Moderate (1–2.9)	479 (53%)	70 (33–164)	109 (23%)	**2.50**	1.48, 4.20
High (3–4)	240 (27%)	97 (44–245)	82 (34%)	**4.40**	2.55, 7.59
Blame					
Work	729 (81%)	70 (34–168)	169 (23%)	1.00	
Self/no one/nothing	104 (12%)	56 (25–129)	18 (17%)	0.69	0.41, 1.19
Someone/something else	45 (5%)	100 (33–247)	16 (36%)	1.83	0.97, 3.45
Do not know/did not answer	21 (2%)	78 (48–242)	7 (33%)	1.66	0.66, 4.17
Relations with co-workers (0–10)					
Excellent (9–10)	672 (75%)	66 (31–159)	150 (22%)	1.00	
Poor–medium (0–8)	223 (25%)	83 (41–184)	58 (26%)	1.22	0.86, 1.74
Work fear—avoidance (0–6)					
Low (0–3.5)	103 (11%)	47 (22–91)	8 (8%)	1.00	
Moderate (3.6–4.9)	175 (20%)	54 (29–118)	30 (17%)	**2.46**	1.08, 5.59
High (5–5.9)	358 (40%)	71 (32–179)	88 (25%)	**3.87**	1.81, 8.28
Very high (6)	262 (29%)	96 (43–222)	84 (32%)	**5.60**	2.60, 12.06

IQR, interquartile range; SD, standard deviation.

For the following variables, some workers declined to answer, said they were unsure, or said the question did not apply: Mental Health (n = 1), relations with co-workers (4), work fear-avoidance (1).

[a]Odds ratios (OR) and 95% confidence intervals (CI) obtained from logistic regression predicting work disability (<180 vs. ≥180 disability days as of 1 year from claim submission). Statistically significant ($P < 0.05$) ORs are bolded.

expectations, those who had low recovery expectations or who declined to rate their expectations had significantly higher odds of chronic work disability (declined to rate: OR = 4.3, 95% CI = 1.6–11.8; ratings of 4–6 on the 0–10 scale: OR = 2.9, 95% CI = 1.7–5.1; ratings of 0–3: OR = 3.0, 95% CI = 1.8–5.2).

As compared with workers age 44 years and younger, those aged 45–54 years were significantly less likely to have chronic work disability (OR = 0.62, 95% CI = 0.41–0.94). Workers aged 55 years and older had a similar odds ratio, but wider variability in outcome (OR = 0.61, 95% CI = 0.33–1.11). Post hoc analyses were conducted to explore the effect of current job tenure on the relationship between age and work disability. Addition of job tenure to the final multivariable model resulted in a slight increase in the odds ratios for age [OR (95% CI) was 0.66 (0.44–1.01) for those aged 45–54 years and 0.64 (0.35–1.19) for those aged 55 years and older]. Adjusting for age and other variables in the final model, compared with workers with job duration less than 6 months, those with job duration 6–24 months did not differ in work disability [OR (95% CI) = 1.00 (0.58–1.73)], but those with job

TABLE IV. Additional Prediction of Work Disability by Each Domain When Added to Previous Domain(s)

Model/predictor domain	Likelihood ratio test[a], χ^2_{df}	*P*-value
1. Demographic[b]	43.05_{14}	<0.001
2. Model 1 + clinical[c]	66.51_{7}	<0.001
3. Model 2 + offered job accommodation	20.10_{1}	<0.001
4. Model 3 + job physical demands[d]	24.56_{7}	0.001
5. Model 4 + job psychosocial conditions[e]	15.41_{8}	0.05
6. Model 5 + worker psychosocial[f]	64.95_{15}	<0.001

[a]The likelihood ratio test indicates whether a block of variables adds significantly to the previous block(s) of variables in predicting work disability. (Test for the first block of variables is the comparison to the constant-only model.)
[b]Age, gender, education, income, marital status.
[c]Bilateral versus unilateral symptoms, CTSAQ FS and SS.
[d]Forearm twisting, pinching fingers, job physical demands, whole body vibration.
[e]Very hectic, requires working very fast, excessive work, take break when want, supervisor listens, satisfaction.
[f]Recovery expectations, Mental Health, catastrophizing, blame for injury, work fear-avoidance.

duration 2–5 years had significantly reduced odds of chronic disability [OR (95% CI) = 0.40 (0.21–0.76)]. Workers with job duration more than 5 years showed a trend towards significantly reduced odds [OR (95% CI) = 0.57 (0.32–1.01)].

Of course, multicollinearity among the predictors affects the values of individual predictors in the final model. For example, CTSAQ SS scores were not statistically significant in the final model, likely reflecting the overlap between the SS and FS scales in variance shared with work disability (FS and SS r = 0.63). In contrast, recovery expectations were not strongly correlated with symptom severity (r = −0.12) or functional limitations (r = −0.17), or with the other psychosocial measures (Mental Health r = 0.28, catastrophizing r = −0.17, fear-avoidance r = −0.20).

DISCUSSION

This is the first study that has examined risk factors, assessed soon after submission of a workers' compensation disability claim, for the transition from acute to chronic CTS-related work disability. Baseline measures from sociodemographic, clinical, job physical demand, job psychosocial condition, and worker psychosocial characteristic domains, as well as offer of job accommodation, predicted subsequent CTS-related work disability when examined individually. Furthermore, each domain made a statistically significant unique contribution to the prediction of chronic work disability. The final multivariable model that included predictors from all six domains had fair accuracy in correctly predicting whether a worker would become chronically disabled. These results suggest that a range of factors influence work status among individuals with CTS and support a multidimensional model of assessment and treatment of workers with CTS.

Very little is known about the extent to which job physical demands are associated with the transition from symptom development to chronic work disability in CTS [Faucett et al., 2000]. In the current study, the global rating of the physical demands of the worker's job in terms of lifting, carrying, pushing, and pulling was a particularly strong predictor. Relative to those with sedentary jobs, the 10% of the sample who described their job demands as very heavy had over three times the odds of chronic disability after adjusting for other job physical demands and variables in the other domains. Further research is needed to compare the relative importance of workers' self-report versus direct observation measures of job physical demands in predicting chronic work disability. However, there is evidence for fair to good agreement between self-reported and expert-observed work-related physical factors for workers with CTS [Nordstrom et al., 1998], and self-report is easier to obtain in studies and programs designed to identify workers at high risk for chronic disability. The finding of the importance of job physical demands points to the need for the development and evaluation of interventions aimed at improving long-term work outcomes for workers whose jobs involve heavy physical demands.

Results in the current study concerning the importance of job modifications in facilitating successful return to work confirm those of previous investigations [Faucett et al., 2000; Fransen et al., 2002; Shaw et al., 2005]. This suggests that interventions for individuals with work-related CTS should include not only medical or surgical therapies, but also collaboration with the employer to offer job accommodations such as reduced work hours, limiting of physical tasks involving the upper extremity, and equipment alterations. However, a challenge will be how to address situations where the employer does not offer job accommodations.

Worker psychosocial characteristics contributed significantly to the prediction of work disability, above and beyond all other domains. Within the psychosocial domain, recovery expectation was the strongest predictor. Recovery expectation remained a strong predictor in the final multivariable model, with workers in the lowest category of expectations having three times the odds of chronic disability. Studies of other work-related conditions have also found recovery expectations to predict disability [Hazard et al., 1996; Cole et al., 2002; Hogg-Johnson and Cole, 2003; Schultz et al., 2004; Dionne et al., 2005; Lotters and Burdorf, 2006]. The findings that recovery expectations predicted disability even after adjusting for all other predictors, and of weak associations between recovery expectations and symptom severity, functional limitations, and the other psychosocial measures, suggest that recovery expectations are not simply a marker for other risk factors. Rather, they may directly influence workers' decisions regarding return to work. Research is needed to determine why, only a few weeks after filing a workers' compensation disability claim, some workers believe that they will not successfully return to work. In addition, interventions to improve outcomes for this group need to be developed and tested. Expectations regarding return to work may be shaped not only by beliefs about ability to perform specific physical job tasks and availability of job modifications, but also by beliefs about ability to perform complex job roles and functions, obtain support, manage symptoms, and avoid re-injury [Shaw and Huang, 2005]; it may prove fruitful to examine such beliefs in future studies.

The association between worker age and risk of chronic work disability due to CTS has not been established. Some studies of other work-related musculoskeletal injuries (primarily, back injuries) have found poorer work outcomes among older workers [Turner et al., 2000]. However, previous studies of CTS have generally found no relationship between age and work outcomes. For example, age was not related to work disability outcomes among workers' compensation claimants who underwent carpal tunnel release surgery [Adams et al., 1994] or overall in the community-based Maine studies [Katz et al., 1997, 1998, 2005]. In the final multivariable model in the current study, workers aged 45–54 years were significantly less likely to have chronic work disability, and those aged 55 years and older did not differ, as compared with workers younger than 45 years. After controlling for current job tenure, the youngest and oldest age groups still did not differ and the finding that workers aged 45–54 years were significantly less likely to have chronic work disability was no longer statistically significant (although there was a trend towards significance). Adjusting for all other predictors in the final multivariable model, relative to workers with the shortest job tenure (<6 months), those with job tenure 2–5 years were significantly less likely to have chronic work disability and those with job tenure >5 years showed a trend towards significantly lower rates of chronic work disability. This pattern of findings suggests that although age and job tenure are associated with each other and both are important in risk of chronic work disability, workers aged 45–54 tend to be less likely to have chronic work disability, regardless of job tenure. Furthermore, regardless of age, workers who have been in their current job more than 2 years are less likely to have chronic work disability.

Other factors, not examined in the current study, may also affect the relationship between age and work disability. These may include setting (e.g., workers' compensation vs. community), length of follow-up, treatment (surgical vs. non-surgical), worker socioeconomic status, and job characteristics. Further research is needed to identify factors that moderate and mediate relationships found between age and work disability.

This study did not address some questions that are relevant to the understanding of factors influencing chronic work disability. For example, although work disability compensation is a proxy for work status, these two variables are not identical [Krause et al., 2001]. In Washington State, compensation is stopped when the worker returns to work or when the worker is judged to be medically stable and able to work; information is not available concerning how many workers in the current study ended compensation for each reason. Additional studies are needed to determine whether the associations of baseline predictors with chronic work disability as defined in the current study are similar when the outcome is defined as working or not, and when other definitions of chronic work disability are used. Preliminary inspection of the disability days data in the current study revealed that work disability often occurred in multiple episodes rather than as a single continuous episode. This led to the decision not to use proportional hazards survival analysis to predict a continuous measure of number of disability days. Definition of chronic disability as receipt of disability compensation at 1 year was also problematic because some workers received compensation for long periods before and after the 1-year point, but not at exactly 1 year, and some workers only began receiving compensation shortly before the 1-year mark and continued for only a short time after (e.g., due to surgery). However, research using other definitions or analytic approaches is needed to assess the robustness of the current findings.

Other relevant variables not addressed in the current study include treatments received. These were not examined because the study aim was to identify early (within approximately the first month of

claim submission) predictors of chronic work disability. However, it would be of interest in future research to examine how early risk factors interact with type and timing of treatment in predicting chronic disability. Further research is also needed to examine potential early risk factors in domains not examined for this report, such as medical and health behavior factors (e.g., electrodiagnostic and physical examination measures, body mass index, smoking status, and medical comorbidities).

One study limitation is that 20% of potential study participants could not be contacted and another 22% declined to participate. However, although participants were slightly older on average and more likely to be female, participants and non-participants did not differ in chronic work disability rates or patterns of associations between age and gender and work disability. Nonetheless, further research is needed to determine the generalizability of our findings to other workers' compensation settings.

Strengths of the study include a large, population-based sample; prospective design; worker-reported information obtained soon after claim submission; and objective administrative measures of work disability compensation with complete follow-up data. The results indicate the importance of factors in multiple domains in the transition from acute symptoms to chronic work disability due to CTS. The findings point to specific factors to consider in screening workers with new CTS claims for risk factors for chronic work disability and in designing early interventions to prevent chronic disability in this population.

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