Occupational and Biopsychosocial Risk Factors for Carpal Tunnel Syndrome

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Objective: To investigate a biopsychosocial model of risk for carpal tunnel syndrome (CTS). In addition, a host of exploratory psychosocial variables was investigated as potential risk factors for CTS. **Methods:** A case–control design was used comparing 87 CTS and 74 sex-matched general orthopedic patients from an outpatient orthopedic clinic. All participants underwent the same diagnostic protocol (ie, physical evaluation and electrodiagnostic testing) and completed a self-report questionnaire assessing a wide range of potential occupational, personological, and psychosocial risk factors. **Results:** Multiple logistic regression analyses revealed that occupational repetition, not engaging in vigorous exercise, physical activities with wrist strain, poorer physical health, and lower job satisfaction were significantly related to the presence of CTS. Obesity was borderline significantly related to the presence of CTS. **Conclusions:** The biopsychosocial model provides a useful heuristic for conceptualizing CTS risk among injured workers.

Carpal tunnel syndrome (CTS) is an entrapment neuropathy of the median nerve at the carpal canal. The typical clinical picture of CTS is pain and paresthesias of the hand in the median nerve innervated digits (thumb, index finger, middle finger, and half of the ring finger).[1] It is also common for patients to complain of pain that radiates into the forearm, upper arm, and even into the shoulder.[2] Pain and paresthesias are typically worse at night, and CTS patients often report nighttime pain episodes that awaken them from sleep.[2]

Carpal tunnel syndrome is estimated to affect 3.1% of the national population annually,[3] and longitudinal research has documented an increase in CTS incidence both in the industrial sector[4] and in the general population.[2,5] One study estimated the incidence of CTS in the industrial sector to be 10.5% when assessing whether clinical criteria were met, and 3.5% when confirming CTS using nerve conduction studies.[4] Carpal tunnel syndrome is currently one of the most common disabling conditions[6] and is responsible for medical costs exceeding 1 billion dollars per year when considering occupational and nonoccupational patients.[7]

Despite a large body of research on risk factors for CTS, a cohesive set of replicable risk factors has yet to emerge from the research literature. Many researchers maintain that CTS is primarily an occupational disorder,[8] whereas other investigators propose that medical or demographic variables (ie, medical and personal) are the chief risk factors for CTS.[9,10] Furthermore, several recent studies have found psychosocial variables such as "psychological problems" (eg, depression and anxiety) and low job satisfaction to be associated with increased CTS rates.[11–13]

The occupational risk factors for CTS most commonly studied have been repetition, force, combined repetition and force (ie, repetitive and forceful work), and vibration. Of these factors, repetition, combined repetition and force, and vibration have been consistently supported in the research literature,[4,8,14] whereas mixed support exists for force.[8–10] Assessment methods for repetition and force have varied widely, from direct workstation observation to indirect inferences on the basis of job types. Most commonly, repetition and force have been assessed with self-report measures, which assess the amount of time engaged in these activities and/or categorize workers according to exposure risk (eg, high repetition–high force and low repetition–low force).

Numerous demographic variables have been investigated as risk factors for CTS. Female sex, age, and obesity have been consistently linked with CTS.[15–17] In addition, diabetes, gynecological surgery, menstrual problems/disorders, and exercise levels have been associated with CTS, although less consistently.[17–22] Psychological and social/contextual variables have been found to be risk factors for CTS in previous literature as well, including distress and the presence of an anxiety disorder.[12–13,23] Studies investigating psychological risk factors for CTS have been quite broad in their definitions of psychological problems, however, and additional research is needed to clarify which specific psychological constructs, if any, are associated with CTS. One study, for example, described psychological problems only as patients having "no problems," "some problems," or "problems,"[12] leaving a lack of specific psychopathology that may be related to CTS.

The literature suggests that CTS is a multidetermined condition with a wide range of associated risk factors.[1,3,5] Specifically, several occupational, social, and psychological risk factors were found to be related to CTS. Accordingly, a biopsychosocial model may provide a useful heuristic in conceptualizing the pathogenesis of CTS. The biopsychosocial model suggests that biological, psychological, and social factors all influence an individual's state of health or illness.[24] Finally, this review found that little research identifies specific psychological issues that may associated with CTS.

The purposes of this study were twofold. The first purpose was to test the relationship of a biopsychosocial model of CTS. The second purpose was to identify which, if any, specific psychological constructs are associated with CTS. The primary hypothesis of the study reflects a biopsychosocial conceptualization of CTS and proposes that CTS risk would be best assessed through consideration of occupational, social, and psychosocial variables. No *a priori* predictions were made concerning differential risk magnitudes associated with different categories (ie, occupational, social, and psychosocial) of risk factors.

MATERIALS AND METHODS

This study used a case–control design to compare a sample of CTS participants with a sex-matched sample of non-CTS participants. All participants were recruited from a multipurpose outpatient orthopedic clinic located in the western United States. The CTS participants were patients seeking a medical evaluation for CTS, whereas control participants were patients seeking a medical evaluation unrelated to CTS or any work-related musculoskeletal disorders of the upper extremities. All study participants underwent the same diagnostic procedures.

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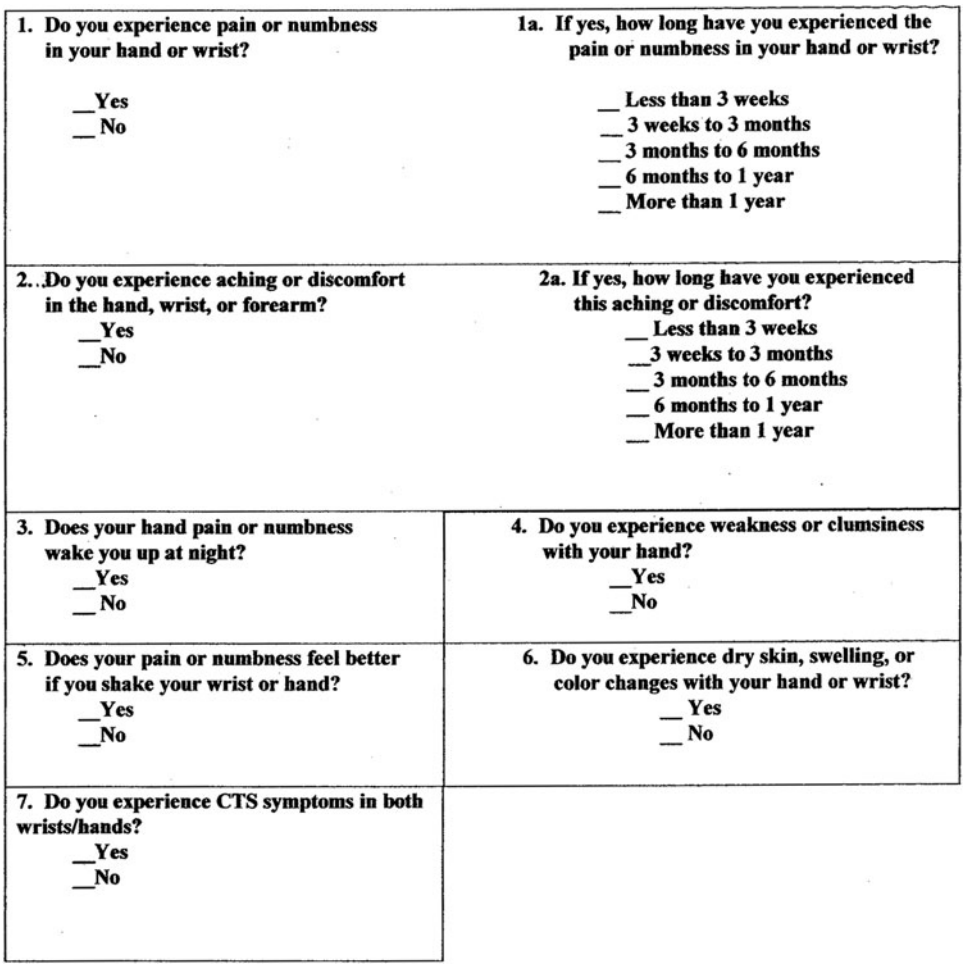
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For potential CTS participants, the following case definition was used to determine eligibility for study inclusion: (1) electrodiagnostic (EDX) testing results suggestive of abnormal slowing of the median nerve, (2) the presence of clinical symptoms of CTS, and (3) no confounding syndromes/disorders. With respect to the EDX testing, differences in peak latencies between median and ulnar nerves were used (1.5 ms for the motor fiber and 0.30 ms for the sensory fibers). In addition, participants were tested using the NEUROMextrix NC-Stat Median Motor/Sensory Biosensor Device (NEUROMetrix, Waltham, MA), which compared motor and sensory fiber latencies with general population norms. The presence of clinical symptoms was met if participants endorsed at least two symptoms on the CTS self-report measure. For inclusion in the control group, it was required that participants (1) be free of CTS symptomatology (ie, no symptom of CTS during the clinical assessment, and EDX testing reveals normal conduction values), and (2) be free of work-related musculoskeletal problems.

All study participants underwent the same diagnostic protocol, which included a self-report measure of CTS symptoms, a clinical assessment for CTS and confounding syndromes, and EDX testing. The self-report assessment of CTS symptoms is a nine-item measure of CTS symptoms put together by the researchers for the purposes of this study (Fig. 1). The symptoms listed in the measure were taken directly from the American Academy of Neurology, the American Association of Neuromuscular and Electrodiagnostic Medicine, and the American Academy of Physical Medicine and Rehabilitation guidelines for the clinical assessment of CTS.[25] The clinical assessment for CTS was carried out by a hand surgeon experienced in the evaluation and treatment of CTS. The assessment included a physical examination and review of CTS symptoms, administration of provocative and sensory discrimination tests, and assessment of confounding conditions (eg, arthritis of the small joints, flexor and extensor tenosynovitis, and ulnar neuropathy at Guyon's canal).

Study participants completed a battery of seven self-report risk factor measures. The battery included the following assessments: (1) the Occupational Hand Use Scale,[26] (2) a physical health risk factor questionnaire, (3) a measure of physical activities, (4) the Brief Symptom Inventory–18,[27] (5) the Multidimensional Health Locus of Control Scale,[28] (6) the Short Form–36 (SF-36; version 1),[29] and (7) Evans' measure of job satisfaction.[30] Table 1 provides a complete presentation of risk factors and the respective measures used in this study.

A total of 161 participants were recruited from an outpatient medical clinic located in a large referral market in the western United States. The CTS case participants were a sample of consecutively recruited patients, seeking a medical evaluation for CTS. Control participants were a sample of nonrandomly recruited patients, seeking a medical consultation for conditions other than CTS (or another musculoskeletal disorder of the upper extremities). Despite the nonrandom recruitment, similar refusal rates across groups



1. Do you experience pain or numbness in your hand or wrist?
__Yes
__No

1a. If yes, how long have you experienced the pain or numbness in your hand or wrist?
__ Less than 3 weeks
__ 3 weeks to 3 months
__ 3 months to 6 months
__ 6 months to 1 year
__ More than 1 year

2. Do you experience aching or discomfort in the hand, wrist, or forearm?
__Yes
__No

2a. If yes, how long have you experienced this aching or discomfort?
__ Less than 3 weeks
__ 3 weeks to 3 months
__ 3 months to 6 months
__ 6 months to 1 year
__ More than 1 year

3. Does your hand pain or numbness wake you up at night?
__Yes
__No

4. Do you experience weakness or clumsiness with your hand?
__Yes
__No

5. Does your pain or numbness feel better if you shake your wrist or hand?
__Yes
__No

6. Do you experience dry skin, swelling, or color changes with your hand or wrist?
__ Yes
__ No

7. Do you experience CTS symptoms in both wrists/hands?
__Yes
__No

FIGURE 1. General carpal tunnel syndrome symptoms.

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TABLE 1. Study Variables and Risk Factor Measures

Variables	Measures
Occupational	
Repetition Force Combined repetition and force Vibration Total occupational exposure	Occupational Hand Use (OHU) scale: This scale provides a measure of exposure on the basis of the presence of each risk factor, job type, number of hours worked per week, and number of years on the job. The OHU has shown adequate internal reliability (0.79 Spearman–Brown formula) and correlates with direct observation of work stations.
Personological	
BMI Diabetes Arthritis Gynecological surgery Hormonal/menstrual problems Vigorous exercise Physical activities w/wrist strain Physical activities w/o wrist strain Total physical activity	Physical activities assessment: This assessment is a 13-item self-report measure designed by the authors for the purpose of this study. Participants are asked to indicate if they engage in regular physical activity, the average number of days per week, and the average duration of typical exercise sessions. The measure includes an inventory of common types of physical activities and allows them to add their own type of activity.
Psychosocial	
Somatization Depression Anxiety Total psychological distress	BSI-18: The BSI-18 has demonstrated high internal consistency (Cronbach $\alpha = 0.89$), adequate item-to-total correlations (0.34–0.70), and factor analyses consistent with the subscales.
Internal health locus of control	Multidimensional Health Locus of Control scale: The MHLC is an 18-item measure that assesses perceptions regarding amounts of control individuals believe to have over their health. Internal consistency alphas range from 0.60–0.75 and ample evidence exists to support its validity
External-powerful others health locus of control	SF-36: The SF-36 is a well-known and widely used self-report measure of physical and mental health with well-accepted psychometrics.
External-chance health locus of control	Job satisfaction assessment: This is a single-item measure using a seven-point Likert scale, asking participants to rate the degree of which they are satisfied with their job. This assessment is based on research that single-item measures of job satisfaction are comparable multiple-item measures in validity and reliability.[30]
Good health locus of control Physical health functioning Mental health functioning Job satisfaction	

BSI-18, Brief Symptom Inventory-18; SF-36, Short Form–36.

enhanced confidence that characteristics across groups recruited in the clinic were similar (eg, socioeconomic status and ethnicity). All participants needed to be English literate. Potential participants read and signed an informed consent document and were then administered the diagnostic protocol. Those participants who met study criteria were assigned to their respective groups and provided with the battery of risk factor measures, along with an addressed stamped envelope to be mailed on completion. If participants had questions or concerns about completing the study packet, they were able to contact a study coordinator, who worked at the outpatient clinic.

RESULTS

Inferential and descriptive statistics were reported for sex, age, education levels, ethnicity, and EDX testing results. Means/proportions, standard deviations, and effect sizes (Cohen's *d*) are presented in Table 2. There were no significant differences in sex ratios across groups ($\chi^2 = 0.684$; $P = 0.408$). The CTS participants were significantly older than control participants; however (t [159] $= 2.67$; $P = 0.008$), and as such, age was statistically controlled in the multivariate analyses. The groups also differed on educational attainment, with CTS participants endorsing significantly lower levels of education than control participants (t[157] $= -2.74$; $P = 0.007$). Finally, CTS participants had significantly greater conduction values on all the following four EDX assessments: NEUROMetrix distal motor latency: (t[127] $= -4.965$; $P = 0.000$); NEUROMetrix distal sensory latency: (t[101] $= -3.521$; $P = 0.001$); standard median–ulnar motor comparison latency: (t[89] $= -4.975$; $P = 0.000$); and standard median–ulnar sensory comparison latencies: (t[102] $= -3.95$; $P = 0.000$).

The independent-samples t tests and chi-square tests for independence were used to assess between-group differences on occupational, personological, and psychosocial variables. Means/proportions, standard deviations, and effect sizes/odds ratios (OR) are presented for the significant findings in Table 3.

Two stages of multiple logistic regression analyses were conducted. In the first stage, three separate logistic regressions were carried out with the occupational, personological, and psychosocial variables, which reached statistical significance in univariate analyses ($P < 0.05$). In the second stage, bivariate correlations were also carried out between predictor variables and ranged from -0.84 to 0.33. The significant variables from these analyses were then entered into a final logistic regression model. Age was statistically controlled for in all regression analyses.

The logistic coefficients, standardized errors, Wald statistics, degrees of freedom, significance values, and OR are provided in Table 4. Results of the analyses suggested that all three models significantly improved prediction over no variable models. The occupational model accurately classified 67% of the study participants, the personological model accurately classified 73% of the study participants, and the psychosocial model accurately classified 76% of the study participants.

Repetition was the only significant independent variable in the occupational model. The OR for repetition was 1.74 (nonoverlapping confidence intervals [CIs]). In the personological regression, body

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TABLE 2. Group Demographics

Variables	Means (SD)/Actual: (Expected) Proportions	SEM	*t* Value/χ^2 Value	*P*	ES/OR
Sex					
CTS group					
Females	61: (58.5)		0.684	0.408	0.877
Males	26: (28.5)				
Control group					
Females	48: (50.5)				1.15
Males	27: (20.7)				
Age, yr					
CTS group	49.01 (15.01)	1.61	2.67	0.008	0.42
Control group	42.97 (13.33)	1.55			
Education					
CTS group	3.41 (1.33)	0.145	− 2.740	0.007	0.43
Control group	4.00 (1.35)	0.159			
NEUROMetrix distal motor latency					
CTS group	4.79 (1.04)	0.1.04	4.69	0.000	0.83
Control group	3.77 (0.455)	0.063			
NEUROMetrix distal sensory latency					
CTS group	4.31 (1.00)	0.128	3.52	0.001	0.70
Control group	3.73 (0.455)	0.070			
Comparison motor EDX median–ulnar difference					
CTS group	1.99 (1.17)	0.163	4.97	0.000	1.03
Control group	1.00 (0.49)	0.079			
Comparison sensory EDX median–ulnar difference					
CTS group	0.93 (1.22)	0.164	3.95	0.002	0.78
Control group	0.22 (0.265)				

CTS, carpal tunnel syndrome; EDX, electrodiagnostic testing; ES, effect size; OR, odds ratio; SD, standard deviation; SEM, standard error of the mean.

mass index (BMI), vigorous exercise, and physical activities with wrist strain were all significant factors, with ORs of 1.16, 0.99, and 1.00, respectively (nonoverlapping 95% CIs). In the psychosocial logistic regression, physical component summary (PCS) scores and job satisfaction were the only significant predictors of CTS group status (ORs of 0.92 and 0.70, respectively).

The final multiple logistic regression was composed of six independent variables, and a chi-square goodness-of-fit test revealed that the logistic model significantly improved the prediction over a no variable model ($\chi^2 = 82.083$; $df = 7$; $P < 0.01$). The model accurately classified 86% of the CTS participants and 74% of the control participants, for an overall hit rate of 80.5%. Thus, the final model superseded the predictive accuracy of the singular models, with a particularly noteworthy accuracy in predicting CTS group status. The logistic coefficients, standard errors, Wald statistics, degrees of freedom, significance values, and OR for each of the variables are presented in Table 5.

Five of the six independent variables in the final model reached statistical significance, including repetition (OR = 1.84), vigorous exercise (OR = 0.97), physical activities with wrist strain (OR = 1.002), PCS scores (OR = 0.94), and job satisfaction (OR = 0.66). These independent variables were significant factors associated with CTS group status. The BMI was the only not significant variable in the final model, although it did reach borderline significance (OR = 1.08 with overlapping 95% CIs).

DISCUSSION

This study investigated a host of occupational, personological, and psychosocial variables as factors associated with CTS. Consistent with our hypothesis, a regression model including occupational, personological, and psychosocial variables superseded singular regression models by 4% to 13%. Five variables, which are representatives of all three categories, emerged as significant factors of CTS group status (repetition, vigorous exercise, physical activity with stain on the wrist, SF-36 PCS, and job satisfaction), whereas BMI was a borderline significant factor. Thus, a biopsychosocial model seems to be useful heuristic for conceptualizing CTS risk.

A primary purpose of this study was to investigate the role of psychosocial variables in CTS. Toward this end, CTS and control participants were assessed for differences on somatization, depression, anxiety, total psychological distress, health locus of control beliefs, and job satisfaction. Of these variables, only job satisfaction retained significance in multivariate analyses. This seems to suggest that job-related psychosocial factors may be more important in CTS development than traditional psychological variables (eg, depression, anxiety, and somatization). This conclusion would be consistent with the findings of Leclerc and colleagues,[11] who found that low job satisfaction was related to CTS and no relationship between depressive/somatic symptoms and CTS.

Contrary to traditional psychological factors, physical repetition was one of the strongest factors related to CTS group status.

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TABLE 3. Significant Univariate Findings

Variables	Means (SD)/ES/Actual : (Expected) Proportions OR	SEM	*t* Value/χ^2 Value	*P*	ES/OR
Repetition					
CTS group	3.91 (1.16)	0.151	3.86	0.000	0.61
Control group	3.16 (1.31)	0.124			
Repetition and force					
CTS group	7.24 (2.08)	0.222	3.21	0.002	0.51
Control group	6.12 (2.35)	0.271			
Total OHU scores					
CTS group	15.61 (3.85)	0.413	2.25	0.025	0.30
Control group	14.17 (4.05)	0.468			
BMI					
CTS group	29.88 (6.46)	0.693	4.86	0.000	0.76
Control group	25.51 (4.66)	0.538			
Vigorous exercise					
CTS group	76.36 (141.88)	15.29	− 4.54	0.000	0.72
Control group	221.83 (254.55)	29.59			
Exercise with strain on hand/wrist					
CTS group	626.10 (562.85)	60.69	2.64	0.009	0.42
Control group	417.81 (404.89)	47.06			
Anxiety					
CTS group	3.37 (3.80)	0.407	− 1.97	0.05	0.31
Control group	2.30 (2.97)	0.343			
Depression					
CTS group	3.62 (4.93)	0.529	− 2.61	0.010	0.41
Control group	1.93 (2.84)	0.328			
Somatization					
CTS group	1.88 (2.28)	0.244	− 2.88	0.007	0.45
Control group	0.986 (1.53)	0.177			
Total psychological distress					
CTS group	8.88 (9.91)	1.06	− 2.75	0.007	0.42
Control group	5.22 (6.27)	0.724			
External-powerful others health locus of control					
CTS group	16.22 (5.89)	0.639	− 2.48	0.014	0.39
Control group	14.02 (5.22)	0.602			
Job satisfaction					
CTS group	4.86 (1.49)	0.173	3.88	0.000	0.61
Control group	5.91 (1.85)	0.199			
Physical component summary-SF-36					
CTS group	40.82 (10.19)	1.12	6.39	0.000	1.02
Control group	51.62 (10.90)	1.26			

BMI, body mass index; CTS, carpal tunnel syndrome; EDX, electrodiagnostic testing; ES, effect size; OR, odds ratio; SD, standard deviation; SEM, standard error of the mean; SF-36, Short Form–36.

Researchers have put forth several plausible explanations for the deleterious effects of repetition on median nerve functioning. Cantatore and colleagues,[31] for example, suggested that repetitive work may result in increased pressure in the carpal canal, which subsequently compresses the median nerve. Wieslander and colleagues,[32] too, found that histological changes in the carpal canal were correlated with repetitive movements of the hand/wrist. Thus, the common speculated pathway between repetition and median nerve damage is increased levels of pressure in the carpal canal. Elevated pressure levels may have several deleterious effects, all of which result in damage to median nerve functioning.

This study also found that participants with CTS engaged in less-vigorous exercise and more physical activities with wrist strain than did control participants. Interestingly, the measure of vigorous exercise used in this study comprised items both with and without wrist strain (eg, weight lifting, mountain biking, racquet sports, and jogging). Thus, vigorous exercise was associated with decreased CTS risk, irrespective of the wrist strain involved in such exercise. In contrast, however, the measure of physical activities with wrist strain comprised lighter (nonvigorous) activities, such as gardening, housework, and yard work, and was associated with increased risk for CTS. When considered together, it may be speculated

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TABLE 4. Occupational, Personological, and Psychosocial Logistic Models Predicting CTS

Variable	β	SE	Wald	df	P	R Exp (B)
Occupational logistic regression results						
Age, yr	0.047	0.014	12.137	1	0.000	1.049
Repetition	0.558	0.281	3.928	1	0.047	1.746
Repetition and force	0.120	0.202	0.353	1	0.552	1.127
OHU total	− 0.040	0.083	0.231	1	0.631	0.961
Constant	− 4.216	1.127	13.985	1	0.000	0.015
Personological logistic regression results						
Age, yr	0.014	0.014	1.00	1	0.317	1.014
BMI	0.150	0.040	13.852	1	0.000	1.162
Vigorous exercise	− 0.004	0.001	9.133	1	0.003	0.996
Exercise w/o wrist strain	0.002	0.000	11.414	1	0.001	1.002
Constant	− 4.908	1.363	12.960	1	0.000	0.007
Psychosocial logistic regression results						
Age, yr	0.016	0.014	1.148	1	0.284	1.016
PCS	− 0.082	0.020	15.925	1	0.000	0.922
Job satisfaction	− 0.356	0.124	8.313	1	0.004	0.700
Somatization	0.007	0.139	0.002	1	0.961	1.007
Depression	0.039	0.076	0.169	1	0.681	1.032
Anxiety	− 0.002	0.096	0.000	1	0.984	0.998
POHLC	0.039	0.037	1.117	1	0.291	1.040
Constant	4.463	1.614	7.650	1	0.006	86.72

BMI, body mass index; CTS, carpal tunnel syndrome; *df*, degrees of freedom; OHU, Occupational Hand Use scale; PCS, physical component summary; POHLC, Powerful Others Externality Health Locus of Control scale; SE, standard error.

TABLE 5. Final Logistic Model With Six Predictor Variables

Variable	β	SE	Wald	df	Sig	R Exp (B)
Age, yr	0.018	0.017	1.071	1	0.301	1.018
Repetition	0.610	0.189	10.426	1	0.001	1.841
Job satisfaction	− 0.410	0.143	8.236	1	0.004	0.663
BMI	0.082	0.049	2.860	1	0.091	1.086
PCS	− 0.058	0.022	6.750	1	0.009	0.944
Vigorous exercise	− 0.003	0.001	5.565	1	0.018	0.997
Exercise strain	0.002	0.001	11.466	1	0.001	1.002
Constant	− 0.818	2.517	0.106	1	0.745	0.4

BMI, body mass index; *df*, degrees of freedom; PCS, physical component summary; SE, standard error.

that vigorous exercise serves to moderate the deleterious effects of wrist-stressing activities. That is, individuals who engage in vigorous physical exercise, even when wrist strain is involved, may receive nonspecific health benefits, which outweigh the specific deleterious effects of wrist strain. In the absence of vigorous exercise, however, the expected relationship between wrist straining activities and CTS subsists.

In the final logistic model, the PCS of the SF-36 was a significant factor related to CTS group status. The PCS is an aggregate measure derived of physical health derived from SF-36 subscales. Given that the CTS group was compared with a group of individuals seeking consultations for orthopedic problems, this finding seems to suggest that CTS is associated with considerable physical health dysfunction.

The negative association with the PCS is consistent with the findings with other physical variables (vigorous exercise, BMI, and physical activities with strain on the wrist) and CTS. Considered together, the connection between CTS and low PCS scores may be

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the result of declines in overall levels of physical health. These declines could also be the result of nonspecific general health, reducing habits/behaviors/conditions.

Next, CTS participants reported significantly lower levels of job satisfaction than control participants. Over time, this may contribute to poorer occupational health and subsequently bring about increased rates of CTS.

Alternatively, individuals with low job satisfaction may be more acutely aware of painful symptoms. As such, dissatisfied workers would be more likely to notice symptoms of CTS and less resistant to the pain associated with such symptoms. It is also possible that low job satisfaction may exacerbate already-existing symptoms of CTS through enhanced perception, stress, and biomechanical load. Finally, it is plausible that individuals who receive a diagnosis may attribute blame to job-related factors and subsequently lower their perceptions of job satisfaction.

It is also worth noting that the CTS and control groups differed in terms of educational attainment, which could lead to different occupational contexts (including job control, exposures, and strain) that patients in the two groups experienced.

Limitations

This study incorporated a case–control methodology. Although case–control designs hold certain advantages (especially in the study of diseases with relatively low case rates), findings from these designs are limited by several constraints. For instance, findings from this study do not allow for speculations regarding causality or temporality. As such, it remains unclear whether the identified correlates are antecedents, concomitants, or consequences of CTS. Furthermore, working at the time of recruitment in this study was not a requirement for eligibility, and thus there may be some unknown variations in work status between case and control group members.

In addition, findings from this study are susceptible to confounds and/or spurious relationships. Hence, the positive associations found in this study may be artifacts of a yet-to-be identified factor associated with CTS. Also, the negative relationship found between job satisfaction and CTS may be confounded by sensitivity to pain and/or autonomic reactivity. Specifically, it could be that the relationship between job satisfaction and CTS disappears when sensitivity to pain is considered. Another possible confound may have resulted from the use of control participants from an orthopedic clinic. Specifically, individuals seeking an orthopedic evaluation may represent a highly active population (eg, individual seeking evaluation after sports-related or exercise-related injuries). If this were the case, the negative association with vigorous exercise and the positive association with obesity may have been artifacts of inappropriate levels of baseline exposure with which CTS participants were compared.

Relatedly, the present findings are also tempered by the possibility of recall motivation/biases. For instance, state-dependent learning suggests that an individual's particular state of mind affects memory and recall processes.[33] As such, individuals in a depressive state may be more likely to notice and process depression-related cues. If applied to participants in this study, the pain/disability associated with CTS, along with the common belief that CTS is an occupational disorder, may have resulted in negative recall bias of job-related conditions.

Finally, this study was limited in the amount of data collected on occupational factors, such as job demand or job control. More data on work factors may have led to finding further associations (or lack thereof) between occupational and psychological factors, and CTS.

CONCLUSIONS

Bearing its limitations, this study found the biopsychosocial perspective to be a useful conceptualization of risk for developing CTS in an occupational setting. These results must be considered in the context in which they were found, an occupational medicine clinic, and that this sheds light on some of the characteristics that may be found in CTS patients in this setting. We believe that this perspective is appropriate in the multifaceted context of occupational health and the workers' compensation system, and we encourage using this perspective in future research with occupational health patients.

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