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ABSTRACT

Title of Thesis: Predicting Clinical Outcomes and Lost Work in Patients With Work-Related Upper Extremity Disorders.

Julie Kay Miller, Doctor of Philosophy, 1998

Thesis directed by: Michael Feuerstein, Ph.D.
Professor
Department of Medical and Clinical Psychology
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Although past research has suggested that a wide range of demographic, occupational, physiological, biomechanical, and psychosocial factors may be important in work-disabled low back pain patients, the influence of a combination of these factors on clinical outcomes and lost work in patients with work-related upper extremity disorders has rarely been studied. The present study utilized a prospective multifactorial approach to predict clinical and work outcomes in a recently diagnosed sample of work-related upper extremity patients. The objectives were two-fold: First, to develop and validate a comprehensive assessment instrument to be utilized by health care professionals to assess and predict clinical outcomes in patients at increased risk for chronic long-term disability. Second, the study attempted to determine whether a multivariate model which considers demographics and occupational status, medical status, pain/symptoms, activity/function, work demands/work characteristics, work environment/work perceptions, support, and mental health measures determined in the early stages of a work-related upper extremity disorder is predictive of clinical and work outcomes at one month post initial diagnosis. Forty-eight subjects were assessed via questionnaire and pinch/grip strength measurements no more than six weeks after their initial diagnosis with a work-related upper extremity disorder. Outcome measures of days lost work, pain/symptoms, activity/function, and mental health were completed one month after baseline. Multivariate hierarchical regression analyses were used to determine the relationship of predictor variables to each of the four outcomes. Results indicated that number of lost workdays was predicted by attorney consultation, days missed work in the previous month, symptom severity, and high work support. Pain/Symptoms were predicted by prior healthcare treatment history, baseline symptom severity and function scores, and ergonomic stressors. Functional impairment was predicted by prior healthcare treatment history, age, baseline function, and job stress. Mental Health (distress) was predicted by baseline mental health scores and symptom severity. Results support multidimensional models of work-related upper extremity disorders and associated work disability.

PREDICTING CLINICAL OUTCOMES AND LOST WORK
IN PATIENTS WITH
WORK-RELATED UPPER EXTREMITY DISORDERS

by

Julie Kay Miller

DISSERTATION

Presented to the Faculty of the Department of Medical and Clinical Psychology
Uniformed Services University of the Health Sciences
in partial fulfillment of the requirements for the degree of
Doctor of Philosophy 1998

DEDICATION

To God and My mother.
Without God, there would have been no life and no faith;
I needed both to live and survive.
Without my mother, there would have been no nurture or hope;
I needed both to flourish and persevere.

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TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

Prevalence and Costs Related to Work-Related Upper Extremity Disorders

According to the National Safety Council, there were approximately 960,000 disabling upper extremity injuries in the United States in 1992 alone (NSC, 1993). These injuries, which include afflictions such as carpal tunnel syndrome and tendonitis, accounted for one-third of all disabling work injuries and about one-fifth of worker's compensation costs (NSC, 1993). Carpal tunnel syndrome (CTS) is one of the most commonly-occurring Work-Related Upper Extremity Disorders (WRUEDs) in the United States (US Department of Labor, 1995). Most significantly, approximately 50% of all cases of carpal tunnel syndrome are work-related (MMWR, 1989), making carpal tunnel syndrome a primary focus as the exemplar for the study of work-related upper extremity disorders. Disorders associated with repeated trauma, the broad classification used by the Bureau of Labor and Statistics, now account for approximately 65% of all occupational illnesses, or about 332,000 cases in 1994 (Bureau of Labor Statistics). One of the most common work-related upper extremity disorders causing employees to miss work is carpal tunnel syndrome. Others may include tendonitis, thoracic outlet syndrome, cubital tunnel syndrome, medial and lateral epicondylitis, nerve impingements, trigger finger, or unspecified mononeuritis of the upper limb. Work disability from carpal tunnel syndrome is common, with more than one month of lost work time reported in about half of the cases of work-related carpal tunnel syndrome reported by the Bureau of Labor Statistics (1995). The time lost from work due to carpal tunnel syndrome is significantly longer than that for low back pain (Cheadle et al., 1994). The lost job productivity may lead to direct and indirect costs in excess of $10,000 for an uncomplicated case, and greater than $30,000 for an individual with a more chronic, complicated case of work-related carpal tunnel syndrome (Rider, 1991; Palmer and Hanrahan,1995). Although there is little data available regarding the economic costs associated with work-related upper extremity disorders, the National Council on Compensation Insurance (NCCI) reported that the average cost for a cumulative injury claim in 1989 was over $24,000 (NCCI, 1991). In recent studies in which case definitions were more clearly specified as upper-extremity disorders, the mean cost per case has ranged from $8,070 (Webster and Snook, 1994) to approximately $10,000 (Brogmus and Marco, 1992). In Webster et al.'s study, it was noted that the mean cost per case of upper extremity cumulative trauma disorders (including carpal tunnel syndrome) was almost two times the amount for the average worker's compensation claim, and the median cost per case was almost five times the amount for all compensable claims (Webster and Snook, 1994, p.714). Furthermore, the total compensable costs for upper extremity cumulative trauma disorders that occurred in 1989 in the US was estimated at $563 million, with 25% of the cases accounting for almost 90% of the costs (Webster and Snook, 1994). This is significant in that it suggests that those cases with chronic, unremitting disability are the source of most of the expenditures.

Demographically, over 80% of work-related carpal tunnel syndrome cases occur in individuals between 25 and 54 years of age; the backbone of our nation's workforce. Interestingly, numerous scientific studies have shown a ratio of 4-5:1 in women versus men for carpal tunnel syndrome (Bureau of Labor and Statistics, U.S. Department of Labor, 1995; Katz et al., 1990; Stevens et al., 1988). Recent research using the Occupational Health Supplement to the National Health Interview Survey (n=30,074) indicated that hand discomfort (not yet diagnosed as carpal tunnel syndrome or upper extremity disorder) from work was reported in 12.5% of female respondents while back pain from work injury and back pain from repeated work activities was reported in only 1.7% and 3.6% (respectively) of women (Behrens, 1994). Furthermore, although Bigos, Baker, and Lee (1993) cited back injury as the most expensive industrial injury and the most frequent source of disability in adults under age 45, recent research has indicated that upper extremity disorders such as carpal tunnel syndrome are projected to surpass back injury as the most frequent cause of work-related disability (Cummings, 1993).

As a consequence of the increasing human costs and economic toll associated with such occupational musculoskeletal disorders, the National Institute for Occupational Safety and Health (NIOSH) proclaimed work-related musculoskeletal disorders one of the top ten priority work-related conditions that demand increased attention and understanding for improved prevention, treatment, and rehabilitation (MMWR, 1983). Of considerable concern is that despite the utility of current treatments for carpal tunnel syndrome (and similar Work-related upper extremity disorders), there is a subset of individuals who do not fully recover (Adams, Franklin, and Barnhart, 1994; Higgs, Edwards, Martin, and Weeks, 1995). In Adams et al.'s study of post-operative occupationally-related carpal tunnel syndrome patients, the mean duration of lost time due to disability was four months, with 8% of cases resulting in over one year of lost work time. In order to understand why some individuals develop chronic, unremitting disability, studies such as the proposed investigation are needed. A better understanding of the multiple determinants of prolonged disability (e.g., Himmelstein et al., 1995) should assist in the prevention of long-term disability and in the identification of factors associated with carpal tunnel syndrome and other work-related upper extremity disorders. In this way, early and appropriate interventions may be developed for those individuals with, or at increased risk for work-related upper extremity disorders.

BACKGROUND

Anatomy and Pathogenesis of Carpal Tunnel Syndrome and Work-Related Upper Extremity Disorders

Work-Related Upper Extremity Disorders (WRUEDs) are disorders of the muscles, tendons, peripheral nerves, or vascular system. They may be caused, precipitated, or exacerbated by intense, forceful, repeated or sustained exertion, movements, insufficient recovery intervals, vibration, or exposure to cold. (Armstrong et al., 1993; Silverstein et al., 1987). The common characteristic among individuals who develop work-related upper extremity disorders appears to be repetitive or intensive use of the hands, simply conceptualized within a dose-response relationship (Armstrong et al., 1993). Thus, the response that occurs in reaction to the dose (exposure) may decrease or augment the potential for responding to subsequent exposures. Work-related upper extremity disorder symptoms typically fall into the two categories of tendon-related and nerve-entrapment-related disorders (Putz-Anderson, 1988; Armstrong et al., 1993). Among the tendon-related upper extremity disorders, tendonitis of the shoulder, elbow, forearm, and wrist are most common. Among the nerve-entrapment-related upper extremity disorders, carpal tunnel syndrome is the most common peripheral tissue compression neuropathy (Kerwin, Williams, and Seiler, 1996). As Armstrong et al. (1993) point out, the known pathogenesis and/or risk factors involved in the development and/or exacerbation of work-related upper extremity disorders, both tendon and nerve-entrapment-related is very similar. In addition, while a precise diagnosis is most useful when examining and/or treating afflicted workers, the diagnostic overlap and "fuzziness" with regard to symptoms, site(s), and work-related upper extremity disorder diagnoses makes this very difficult in the earliest stages of such disorders. Armstrong et al. state that it is often necessary to sacrifice some specificity in order to obtain a high degree of sensitivity in identifying (and treating) workers in the early stages of work-related upper extremity disorders. So, although there are subtle differences among these disorders, they are for logistical purposes often grouped as one diagnostically related group of syndromes/disorders holding common mechanical, anatomical, and physiological exposure and response mechanisms. This group of related disorders is referred to here as work-related upper extremity disorders and carpal tunnel syndrome is a good exemplar for this group, both in terms of its' symptomatological presentation and high degree of work-relatedness, as well as its' high prevalence and societal impact discussed previously. In view of this, a discussion of the anatomical considerations at work in the pathogenesis of carpal tunnel syndrome is useful in understanding carpal tunnel syndrome and work-related upper extremity disorders in general. Related terms used in the literature for the related group of syndromes/disorders include repetitive strain injuries, cumulative trauma disorders, repetitive motion injuries, overuse syndromes, and work-related musculoskeletal disorders.

Anatomically, the carpal tunnel is an anatomic space in the palmar region of the hand which serves as a relatively rigid canal for the median nerve and flexor tendons to run from the forearm across the wrist into the palm. The median nerve lies within the tunnel, surrounded by the bones, muscles, tendons, and ligaments which form the walls of the canal, and is aligned with the third finger of the hand. Once it passes through the tunnel, it bifurcates into a sensory branch and a motor branch. The sensory branch subdivides to innervate the thumb, index, third, and part of the fourth finger. The motor branch innervates the muscles of the hand. The relative rigidity and limited free space of the carpal tunnel means that it is not able to accommodate extreme alterations in pressure within the canal very well. Thus, any process which diminishes the capacity of the tunnel or expands the volume occupied by its contents will increase interstitial carpal tunnel pressure and ultimately cause compression of the median nerve. Although Hagberg et al. (1995, p.60) describe carpal tunnel syndrome as "compression of the median nerve at the wrist," which, along with "partial thenar atrophy" is in line with the International Classification of Diseases (Ninth Revised Clinical Modification; ICD-9-CM; U.S. Department of Health and Human Services, 1980) [ICD-9] criteria, the mechanism of carpal tunnel syndrome is thought to be related to mechanical stresses and ischemia. These mechanical stresses may involve stretching or compression of the median nerve (Hagberg et al., 1995). Furthermore, as Ditmars and Houin (1986) point out, the superficial and anterior position of the median nerve under the transverse carpal ligament make it particularly susceptible to direct mechanical compression by the flexor tendons as well. Any increase in tissue pressure above critical levels may significantly impair the blood supply, hence oxygen, to the tissues. As with ischemia in any body tissue, effects may be immediate and profound depending upon the duration of the ischemic episode. This may lead to functional deficiencies of the sensory (e.g., numbness, tingling, complete paresthesias) or motor functions (e.g., weakness, total paralysis) of the nerves which are sensitive to any disruptions in the microcirculation (Lundborg and Dahlin, 1996). While interstitial pressures have been measured within the tunnel at neutral position at only 2.5mmHg; pressures at normal wrist flexion and maximum extension are about 30 and 31 mmHg respectively (Gelberman et al., 1981). Even such normal increases in carpal tunnel pressure result in decreased epineural venous blood flow (Lundborg and Dahlin, 1996). Interestingly, Gelberman et al. also found that patients with carpal tunnel syndrome exhibited an average carpal tunnel pressure of 32mmHg while normals showed average pressures of only 2.5mmHg. In addition, studies which have shown that participants with systemic hypertension require higher levels of interstitial carpal tunnel pressure to cause nerve conduction block suggest that complete conduction block will occur at interstitial carpal tunnel pressures that are about 30mmHg less than the participant's diastolic blood pressure (Gelberman et al., 1983; Szabo et al., 1983). With higher levels of pressure between 60-80 mmHg, there will be a complete cessation of intraneural blood flow (Rydevik, 1981). Furthermore, studies have shown that extreme or awkward wrist postures (prolonged and/or repetitive) increase pressure within the carpal tunnel, resulting in paresthesias (Gelberman et al., 1981; Szabo and Chidgey, 1989).

In addition to the effects of extreme pressures and/or mechanical impingements, the structural and functional integrity of the peripheral nerves, including the median nerve, are also dependent upon its tensile properties. As Kerwin et al. (1996) point out, tensile stretch is a major source of nerve (as well as tendon) damage which may result in sensory and/or motor impairment. Under normal conditions, activities and movements of the hand produce minor alterations in posture and tissue conformation without the development of neurologic signs or symptoms. Although it is well-recognized that there is a safe limit of stretch or elongation beyond which there is damage, this limit has not been empirically quantified (Kerwin et al., 1996). Furthermore, the clinical picture is complicated by the fact that perineural damage may exist without detectable alterations in gross morphology.

Acute and Chronic Forms of Carpal Tunnel Syndrome

Carpal tunnel syndrome may occur in both acute and chronic forms. Although both the acute and chronic states are similar in that they are nerve compression neuropathies, they have several distinctions in their magnitude, duration, mechanisms, and sequelae.

Acute Carpal Tunnel Syndrome

Acute carpal tunnel syndrome, as the name implies, is a state in which there is an abrupt onset of and sustained increase in the interstitial pressure within the carpal tunnel compartment. This condition may be found in a gamut of clinical situations in which there is excessive edema or fluid accumulation within the canal. These conditions may include fracture at the distal end of the radius, or acute hemorrhage due to any traumatic injuries or pathological condition.

Chronic Carpal Tunnel Syndrome

Chronic carpal tunnel syndrome exists when there is a slower, insidious elevation in the interstitial carpal tunnel pressure. The peak pressure may be less severe, and at more moderate levels than that in acute carpal tunnel syndrome, but it will not have an abrupt onset or remission. It is the eventually persistent and continuous nature of the elevated pressure that is thought to be the injurious process here. Whether chronic carpal tunnel syndrome is categorized as early (mild), intermediate, or advanced depends upon the duration, persistence, and severity of sensory and motor symptoms as well as whether or not there are irreversible or reversible pathophysiologic changes in the median nerve tissue (Gelberman et al., 1988). The extent of the damage and subsequent severity classification correspond with the duration and magnitude of median nerve compression in the carpal tunnel (Gelberman et al., 1981; Kerwin, Williams, and Seiler, 1996). According to Kerwin et al. (1996), chronic carpal tunnel syndrome in the early stages is characterized by mild, intermittent symptoms of less than one year's duration. This is clinically significant in that a "milder" symptom picture may be indicative of poorer prognosis and chronic disability (Kerwin, Williams, and Seiler, 1996).

Causes and Contributing Factors

Idiopathic or Multifactorial?

Although there are numerous factors which may contribute to the increased interstitial carpal tunnel pressure which eventuates in median nerve compression and/or carpal tunnel syndrome, the causes of carpal tunnel syndrome are still not completely understood. Although Phalen's (1972) description of "idiopathic" carpal tunnel syndrome as one type of carpal tunnel syndrome that occurs in otherwise healthy adults, the lack of probable causes of carpal tunnel syndrome in such individuals does not truly exist, hence the term "idiopathic" is probably not accurate. It may be more appropriate to conceptualize these cases as having a "mixed" etiology which may include a combination of extrinsic and intrinsic factors, which can include those related to disease states (innate or acquired), epidemiological (demographic or environmental) factors, and work-related or occupational stressors.

Extrinsic Factors

Extrinsic factors are those conditions in which the pressure within the carpal canal is increased for reasons which do not involve a change in the volume of the canal contents. Such changes may occur due to the alteration of bony or soft tissue structures forming the canal. These alterations may be due to physical or mechanical trauma (e.g., dislocations, fractures), or neuropathic or degenerative disease states (e.g., diabetes mellitus, rheumatoid arthritis, osteoporosis, hemophilia) which are genetically-linked or acquired (Kerwin et al., 1996).

Intrinsic Factors

Intrinsic factors are those which increase the volume of the contents, and subsequently the interstitial pressure, within the carpal tunnel (Kerwin, Williams, and Seiler, 1996). Such factors may include inflammatory disease states (e.g., rheumatoid arthritis, nonspecific tenosynovitis); conditions which alter (increase) fluid levels (e.g., thyroid disorders, obesity, pregnancy, kidney disease); and incursion of the lumbrical muscle into the carpal tunnel [a normal occurrence with finger flexion which may be injurious if the muscle is hypertrophied due to the nature of one's work] (Cobb et al., 1994); Kerwin, Williams, and Seiler, 1996).

Anatomy and Gender As Risk Factors

Interestingly, since variances in carpal tunnel diameter exist in the normal population, with women occupying the lower end of the carpal tunnel size distribution, this has been suggested as one possible reason for the sometimes higher prevalence of carpal tunnel syndrome in females (Slater and Bynum, 1993). Another related theory that has received some empirical support (e.g., Papaioannou et al., 1992) is that smaller carpal tunnel size (not gender per se) may be a predisposing or potential etiological factor for carpal tunnel syndrome. Papaioannou et al.'s research showed that men with carpal tunnel syndrome, when compared with normals, have smaller carpal tunnel spaces (similar to their female counterparts). Controversy remains in this regard, and the precise role that genetically-determined carpal tunnel size may have in the etiology of carpal tunnel syndrome is not yet clear.

Job Tasks As A Risk Factor

Carpal tunnel syndrome (and its related symptoms of the muscles, tendons, and nerves of the fingers, hands, wrists elbows, shoulders, and neck) has recently been shown to be associated with hand-intensive jobs that involve repetition, awkward postures, excessive force (Armstrong et al., 1993) and strong grip and vibration exposure (Szabo and Madison, 1992).

So, what Phalen (1972) referred to as "idiopathic" carpal tunnel syndrome, and what Braun (1989) referred to as "dynamic" carpal tunnel syndrome may more accurately be described as a "mixed" or "multifactorial" carpal tunnel syndrome (of which work-related carpal tunnel syndrome is one example). While the literature does not support the statement that "occupational or job-related hand or wrist overuse" as a risk factor for developing carpal tunnel syndrome is "controversial" (Kerwin, Williams, and Seiler, p.248, 1996), work does not have a simple linear cause-effect relationship with carpal tunnel syndrome. As Hagberg et al., (1995) state, "there is strong evidence supporting the contribution of work related factors to the development of carpal tunnel syndrome." (p 69). In fact, well-controlled empirical research documenting the significant role of hand and wrist overuse in work-related carpal tunnel syndrome has been going on for over 10 years (e.g., Cannon et al., 1981; Falck and Aarnio, 1983; Punnet et al., 1985; Punnet and Robins, 1985). In addition, epidemiological, case-referent, cross-sectional, and cohort studies have suggested this relationship for up to 30 years (e.g., Armstrong and Langolf, 1982; Franklin, Haug, and Heyer, 1991; Hymovich and Linholm, 1966; Masear, Hayes and Hyde, 1986; McKenzie et al., 1985; Putz-Anderson, 1988; Wisseman and Badger, 1977). Although many case-control studies have documented the increased prevalence of work-related upper extremity disorders in certain industries, occupations, and geographical regions, the precise potential etiological role of most of these factors has not been determined (Armstrong and Langolf, 1982; Franklin, Haug, and Heyer, 1991; Hymovich and Linholm, 1966; Masear, Hayes and Hyde, 1986; McKenzie et al., 1985; Putz-Anderson, 1988; Wisseman and Badger, 1977). Specific contributing biomechanical factors which have been identified include: jobs with repetitive wrist movement or use of vibrating tools (Cannon et al., 1981), high- force movements (Nathan et al., 1988; Silverstein et al., 1987), and awkward or extreme wrist postures (de Krom et al., 1990). As Hagberg et al. (1995) and Armstrong et al. (1993) point out, there appears to be an additive or multiplicative effect as well in that studies show that repetitiveness alone, although a risk factor, has a smaller association with work-related carpal tunnel syndrome than repetitiveness combined with high-force (Silverstein et al., 1987) or cold (Chiang et al., 1990).

Furthermore, although research has suggested that work factors (other than ergonomics) may play a role in the development of carpal tunnel syndrome (Armstrong et al., 1993; Theorell, 1991) the exact nature of this relationship remains controversial (Kasdan, 1994; Silverstein et al., 1996).

Evidence For Multifactorial Etiology and/or Maintenance

Although there are a very limited number of empirical studies which have examined etiology of work-related carpal tunnel syndrome from a multifactorial perspective; findings from epidemiological studies have suggested that the development of work-related upper extremity disorders, including carpal tunnel syndrome, is associated with a multitude of factors which includes not only workplace characteristics, but demographics and personal attributes as well (Bigos et al., 1991; Cheadle et al., 1994; Frymoyer and Cats-Baril, 1987; Rohrer, Santos-Eggimann, Raccáud, and Haller-Maslov, 1994). Additional factors proposed to play a role include ergonomics, existing medical disorders (e.g., diabetes mellitus, rheumatoid arthritis), obesity, and various psychosocial factors (Bongers et al., 1993; Hales et al., 1994; Kasdan et al., 1994; Rempel et al., 1992; Theorell, 1991).

In regard to exacerbation, maintenance and prognosis; the research does support the idea that physical injury or abnormal physical findings are related to pain and disability; however, physical findings alone are not predictive of long-term work disability associated with work-related musculoskeletal disorders, particularly low back pain (Bigos et al., 1991; Hasenbring, Marienfeld, Kuhlendahl, Soyka, 1995; Lancourt and Kettelhut, 1992). Furthermore, the existing literature examining factors which exacerbate and maintain work-related carpal tunnel syndrome, both in regression cohort and case-control studies, has consistently shown the role, as Armstrong et al. (1993) describe, that increased "dose" or exposure plays in the exacerbation and maintenance of work-related carpal tunnel syndrome (Cannon et al., 1981; Franklin et al., 1991; Wieslander et al., 1989; de Krom et al., 1990). Unfortunately, methodological limitations in many of the existing studies limit the implications that may be made. These limitations include lack of appropriate control groups when indicated (e.g., usual care, no treatment, placebo), insufficient statistical analyses, very small sample sizes, and variable case definition and participant inclusion criteria. In addition, the variability in the types of outcome measures used, measurement of outcomes, in combination with the small number of prospective and randomized studies, make the available body of research specific to predictors of work-related carpal tunnel syndrome outcome very limited.

Overall, cross-sectional epidemiologic studies examining variables related to work-related musculoskeletal disorders (including carpal tunnel syndrome and back pain) are mixed in study design, number and diversity of variables studied, and measurement of outcomes. Population-based cross-sectional studies rarely focus on work-related variables, and as Bongers et al. (1993) point out in their comprehensive review, many of the existing studies lack adjustment for confounding variables. Case-control studies, although useful for prevalence data and demographic data, do not usually provide data on the extent of reports of work-related upper extremity disorders in U.S. industry as a whole (Brogmus, Sorock, and Webster, 1996).

Hales et al.'s large (n=533) study (1994) of telecommunication employees utilizing video display terminals (VDTs) provided additional evidence supporting the idea that a multifactorial model of work-related upper-extremity musculoskeletal disorders may be useful as the basis for the development of innovative assessment and treatment procedures. Hales et al. found modest but comparable associations of numerous variables with the existence (n=111) of at least one upper-extremity musculoskeletal disorder. These variables were relevant to a multitude of areas including demographics (non-caucasian race); medical status (existence of a thyroid condition and use of bifocals at work); psychosocial and work environment characteristics (fear of being replaced by computers, increased work pressure, surging demands in workload, lack of decision-making opportunities in low-control mundane work tasks, high information-processing load, a high variety of changing work tasks, and lack of a production standard).

Most occupationally-focused studies which target video display terminal workers have consistently shown the effect of ergonomic (e.g., Maeda et al., 1982; Sauter et al., 1991) and psychosocial (Hales et al., 1994; Linton et al., 1989; Sauter et al., 1983; Starr et al., 1985) stressors in the evolution and/or exacerbation of musculoskeletal symptoms and/or disorders.

Treatments

Existing treatments for carpal tunnel syndrome are as varied as the factors contributing to the development of carpal tunnel syndrome (Feuerstein et al., 1996).

Non-Surgical Treatments

Non-surgical conservative treatments for carpal tunnel syndrome may include a combination of splinting, steroid injection, ergonomics, activity modification, exercise, and vitamin B-6 therapy (Sailer, 1996; Jacobson, Plancher, and Kleinman, 1996; Weiss et al., 1994). Patient education is also typically employed as part of any treatment regimen, and, when integrated and implemented within a multifactorial, multidisciplinary treatment/rehabilitation framework, outcomes may be enhanced (Feuerstein et al., 1993).

Splinting of the wrist in a neutral position to maximize carpal tunnel space diminishes pressure within the canal and is a mainstay of nonsurgical treatment which may be particularly useful if employed within the first three months after symptom onset (Monsivais and Scully, 1992). Splinting also limits motions of the wrist which may increase pressure or exacerbate inflammatory processes in edematous tissues.

Despite the frequent use of splints, some research suggests that symptomatic relief may be expected in only 55% of cases four months after treatment (Miller et al., 1994). A variety of materials and configurations of splints are available according to individual needs.

Corticosteroid injections are one commonly used method for decreasing inflammation in local tissues. Usually, the injection is followed by immobilization of the joint in a splint for several weeks. Although some discomfort is common for the first 24 to 48 hours post injection, alleviation of symptoms is usually rapidly achieved (Giannini et al., 1991; Kulick et al., 1986).

Ergonomic accommodations, particularly at the workplace, are a potentially effective part of many carpal tunnel syndrome treatment regimens. Ergonomically designed hand tools, keyboards, computer screens, chairs, and desks are some examples of attempts to allow for more neutral wrist positioning and proper postural alignment of the body to prevent carpal tunnel syndrome and related disorders tied to repetitive motions and/or improper or awkward work postures. Although avoidance of prolonged forceful gripping may be difficult in many jobs, gloves or tool handles which dampen vibrations to the hand may be feasible. Gloves may also be coated with high-friction materials to decrease the force needed to pinch, grip, or lift objects (Sailer, 1996).

Modification or limitation of participation in activities which involve repetitive, forceful, or prolonged wrist and finger motion or gripping should be accomplished if possible. For those with work-related carpal tunnel syndrome, this is often extremely difficult, particularly if the employer is not supportive of such efforts. Modification of the workload or pace of work is important if the individual is to remain working. Sailor (1996) points out that activity modification, combined with ergonomic interventions, may be quite effective in preventing disability if accomplished early. This idea is supported by studies such as Westin's (1990) study of a preventive organizational intervention for video display terminal workers at the Federal Express Corporation.

Aerobic and/or range-of-motion exercise is another potentially useful tool in the prevention and treatment of carpal tunnel syndrome symptoms (Cook et al., 1995; Sailor, 1996). Although there is very little empirical data to support or refute it, suggested potential benefits may include increased tissue perfusion, weight loss, increased flexibility, and more efficient healing of injured tissues (Sailor, 1996). In fact, Cook et al.'s findings indicated that range-of-motion exercise was more effective than splinting as measured by symptom severity, general function, and return to work. If such regimens may be accomplished during the work break, this provides an opportunity for the individual to break the "work posture" which may be aggravating carpal tunnel syndrome symptoms, and provide increased strength and perfusion to tissues affected by prolonged, awkward, or sedentary body postures (Sailor, 1996).

Vitamin B-6 (pyridoxine) therapy is another, more controversial, conservative treatment for carpal tunnel syndrome that arose out of the observation by Ellis and colleagues (1976) that vitamin B-6 deficiency commonly coexisted in patients diagnosed with carpal tunnel syndrome (Ellis et al., 1976a; Ellis et al., 1976b; Ellis et al., 1977). Although there is a plethora of studies both supporting and refuting the association vitamin B-6 deficiency and carpal tunnel syndrome, it is well-accepted that such a deficiency can cause reversible peripheral neuropathy that abates upon B-6 administration (Ball, 1994; Leklem, 1994; Linder, 1991). Furthermore, administration of proper dosages of B-6 has been shown to reduce pain (Bernstein and Dinesen, 1993; Lazo-Guzman, 1989), while overconsumption may cause neuropathy (Bernstein, 1990; Foca, 1985; Parry and Bredesen, 1985).

Cognitive-behavioral or biobehavioral interventions are often overlooked in the literature which discusses treatment modalities (e.g., Sailer, 1996). However, it has been suggested that just as such factors may have a role in the etiology and/or exacerbation of carpal tunnel syndrome, these may be useful in the treatment as well (Feuerstein, 1996). Cognitive-behavioral interventions may include treatments such as cognitive restructuring, relaxation training, pain management strategies, and communication skills training (Spence, 1989; Spence, 1991), while biobehavioral interventions may involve techniques such as biofeedback and muscle re-education (Skubick et al., 1993). A few studies such as that by Swerissen et al. (1991) have used a combination of cognitive-behavioral interventions and movement-retraining in the treatment of individuals with occupational injuries with some limited success.

Surgical Treatment—Carpal Tunnel Release

The common surgical, or non-conservative treatment for carpal tunnel syndrome is carpal tunnel release. Optimally, carpal tunnel release is performed only after attempts at more conservative treatments have failed to produce satisfactory long-term remission of carpal tunnel syndrome symptoms (Sailer, 1996). Although there are a gamut of variations in the basic procedure, the end goal is release of the transverse carpal tunnel ligament, and subsequent rehabilitation strategies are basically the same, although recovery progress may vary according to characteristics of the procedure or the patient. As Sailer (1996) astutely points out, comparison of the degree of invasiveness (openness) of the procedure on recovery outcomes is difficult at best due to the fact that handedness, work type, availability of work accomodation strategies, and compensation status are just some of the variables which affect and complicate this relationship.

An intensely structured physical therapy program for the hand, combined with splint use and progressively increasing use of the hand is employed, typically in the acute and subacute stages of carpal tunnel syndrome, with close monitoring to prevent complications. Rehabilitation is generally a 3-stage (postoperative immobilization, mobilization, progressive strengthening and work conditioning) lengthy process which may be between 3 and 8 weeks for light activity workers, or up to 3 months or more for workers with jobs that require heavy lifting or high-repetition motions (Sailer, 1996).

Predictors of Return to Work—Factors Affecting Return to Work Following Treatment

While most researchers seem to agree that the economic cost of lost work time, treatment, and worker's compensation is spiraling upward, there continues to be debate regarding the proper strategies to address these issues. Cummings (1993) states that direct industrial compensation costs alone (without lost or diverted manpower and psychosocial effects) were 70 billion dollars in 1993. However, there is little consensus regarding the most efficacious strategies to prevent injury and/or rehabilitate workers for return to the workplace. The main reason for this lack of consensus appears to be the plentiful body of contradictory findings and beliefs regarding factors which affect return-to-work (RTW).

Although studies of prolonged functional recovery in work-related carpal tunnel syndrome are lacking, a number of studies of prolonged functional recovery of low back pain are helpful in examining variables which have been shown to be associated with, and possibly predictive of, work disability. These studies, although using work-related back pain as a model rather than work-related carpal tunnel syndrome, utilize many of the same multifactorial concepts that have been proposed as models for development of work-related upper extremity disorders. The ergonomic, biomechanical, psychosocial, and work-related risk factors for work-related low back pain are well-documented (Bergenudd and Nilsson, 1988; Bigos, Spengler, and Martin, 1986a; Bigos, Spengler, and Martin, 1986b; Garg and Moore, 1992; Marras et al., 1995; Skovron et al., 1994; Svensson and Andersson, 1983). This makes the inclusion of some of the work-related low back pain literature useful in augmenting the more scarce, developing body of research which specifically focuses on work-related upper extremity disorders such carpal tunnel syndrome. Two particular broad categories of interest which are relevant to the proposed study are 1) Predictors of functional recovery; and 2) Predictors of clinical outcomes.

Predictors of Delayed Functional Recovery

Relevant variables which have been shown in to potentially account for delayed functional recovery and return to work include demographics, injury/symptom history, work history, job characteristics, perceptions of the workplace, employer practices affecting return to work, and coping abilities of the worker (Bigos et al., 1991; Cheadle et al., 1994; Deyo, 1987; Habeck et al., 1991; Hasenbring, Marienfeld, Kuhlendahl, Soyka. 1995; Lancourt and Kettelhut, 1992; Marras et al., 1995).

Two other factors which are often hypothesized as predictive of functional status and return-to-work are presence of compensation and attorney consultation or litigation. In a recent review of the literature by Gallagher, Williams, and Skelly (1995), they present evidence that supports the idea that the results from prior studies reporting that workers who receive work compensation payments or have consulted an attorney are less likely to return to work are questionable at best. So, while such factors may have some value in the few months subsequent to the injury, findings presented by Gallagher et al. and Tollison (1993) showed that significant differences in return to work among compensated and non-compensated workers were negligible six months post-injury. Gallagher et al. even argue that in a subgroup of patients seen as having elevated risk due to poor locus of control, compensation actually increased their return-to-work outcomes. Despite the controversy, a recent well-conducted large-scale (n=7,651) meta-analysis of the existing research on the relationship of chronic pain and financial compensation showed that receiving financial compensation is associated with greater levels of reported pain and reduced treatment outcomes (Rohling, Binder, and Langhinrichsen-Rohling, 1995). Theories attempting to explain this relationship include Fordyce's (1985) behavioral explanation that states that the behavior (per this model) of pain is reinforced by the receipt of compensation and Mendelson's (1982) hypothesis that compensation is in a sense "treating" the patient's experiences of depressed mood, anxiety, and increased sensitivity to pain that occur as a result of disabling injury and economic instability. According to the latter idea, patients who receive monetary compensation should eventually exhibit reduced symptoms and greater levels of recovery, a finding not supported by Rohling, Binder, and Langhinrichsen-Rohling's findings.

Unfortunately, one potential barrier to expedient return-to-work outcome lies within the current worker's compensation system; the very system which is purportedly designed to assist workers during their disability (Guest and Drummond, 1992; Bigos et al., 1993). Using industrial back pain as an illustrative model, Guest and Drummond (1992) point out that the terminology and structure used in the worker's compensation system have unwittingly fostered the development of adversarial attitudes in what they have appropriately termed an "adversarial help" system. This oxymoron is unfortunately apropos in that a system with uncontrollably burgeoning expenditures has had very little effect in achieving its purported goal of "keeping our populous productive" (Bigos et al., 1993, page 112). Such a system, which appears judgmental toward the very individuals whom it invites to seek help seems to demand that the patient "prove " that he/she is ill; a double-sided message which can promote somatization and exaggerated "pain behavior" which is then often interpreted as evidence of malingering and just cause to withhold needed treatment or benefits (Bigos et al., 1993; Holloway, 1994; Waddell, Turk, and Melzack, 1989). Furthermore, although contributors to the worker's distress may be multifactorial stressors related to pressures from work, relationship, or personal problems, society's stigma against admitting distress that is not physically-focused only enhances the pressure for the worker who "needs a break" to voice complaints with a "legitimate" or "acceptable" physical cause as it may be viewed as the only viable avenue to obtain time off from work pressures. Surprisingly, despite the fact that the detrimental impact of psychosocial stressors (e.g., role conflict, role ambiguity) on return-to-work has been established in the occupational literature (e.g., Fisher and Gitelson, 1983; Jex, Beehr, and Roberts, 1992), this has had little effect on the configuration of the existing worker's compensation systems.

Predictors of Clinical Outcomes and Return to Work

Workplace variables that have been found to be associated with the development, exacerbation, or maintenance of work-related musculoskeletal pain (one frequently-examined clinical outcome) include the type of work; exposure to repetitive movement, excessive force, and/or awkward posture; and psychosocial stressors (Bigos et al., 1991; Bureau of Labor Statistics, 1994; Frymoyer et al., 1983; Habeck et al., 1991; Marras et al., 1995). The variables which affect clinical outcomes, including pain, symptoms, mood, and function, may also affect return-to-work, a non-clinical outcome of interest which may be affected by a multitude of factors including the injured worker's perceptions of functional capabilities and characteristics of the work environment (Feuerstein et al., 1993).

Presence of a psychological disturbance is another factor which is often seen as indicative of poor clinical and return to work outcomes. One limitation of the literature supporting this idea is the use of "pain behavior" or objective behavioral signs of pain exhibited on physical exam, as indices of psychological disturbance. While in certain specific psychiatric populations this may have some value (e.g., hypochondriasis, somatization disorder), it may not be an appropriate indicator for this construct (psychological disturbance) in most instances. Furthermore, although Gatchel et al. (1994) found Axis I diagnoses in over 90%, and Axis II diagnoses in over 50% of 152 disabled chronic low back pain patients entering a rehabilitation program; they reported that neither type or degree of psychopathology was significantly predictive of patient ability return-to-work. However, it is important to note that the best outcomes from treatment and rehabilitation programs have been in programs which included psychosocial components (Gatchel et al., 1994). While Bigos et al. (1992) states that many of the existing strategies used in the past have been "dismal failures" in successfully preventing back problems or restoring function, Burke, Harms-Constas, and Aden (1994) and Gatchel et al. (1994) have observed better results in programs which are structured to address psychosocial and/or psychopathological factors, including those stemming from the workplace. Indeed, some researchers even propose that psychosocial factors are more important factors in return-to-work than physical indices (Gallagher et al., 1989; Lancourt and Kettelhut, 1992). Feuerstein et al.(1994) used a multivariate approach in analyzing predictors of vocational outcome in workers with chronic low back pain. Although Feuerstein et al. note the importance of psychological characteristics, they also listed important demographic (e.g., younger, absence of legal claim), medical (fewer surgeries, shorter duration of disorder), physical (e.g., greater trunk and lower extremity strength), and pain-related (lower pain intensity, lower impact of pain on function) predictors of return-to-work following multidisciplinary rehabilitation.

In a related vein, Bigos et al. (1991, 1992) examined a variety of work-related and non-work-related variables that were predictive of work-related low back pain symptoms and/or delayed return-to-work. Even Bigos et al.'s (1991,1992) large-scale prospective study (n=3020) of back-injured aircraft employees showed only one significantly predictive physical variable (prior history of back injury) useful for predicting acute work-related back pain. Conversely, they found the most predictive factors were psychosocially-linked (job dissatisfaction and mental health). In a related study, Fordyce et al. (1992) found that subscales on the MMPI that measure lassitude-malaise, denial of social anxiety, and need for affection to be somewhat predictive of subjective reports of back pain among similar workers. Interestingly, the subscale specifically measuring somatic complaints was not significantly predictive of subjective report of back injury.

In addition, studies of workers with more physically demanding tasks (e.g., Leavitt, 1992; Tate, 1992) show that some physical variables may be highly relevant for a subset of workers with highly physically demanding work tasks and increased injury severity. So, even though many studies support the importance of psychosocial variables as equally or more important than physical factors; there may be a subset of workers for whom physical factors are more salient.

Ultimately, these data, while valuable, still do not identify who will respond best to treatments nor what treatments are most efficacious in promoting successful return-to-work

Multifactorial Models of Work-Related Upper Extremity Disorders and Implications for Functional Recovery and Clinical Outcomes

One of the principal goals in the treatment or rehabilitation of the worker with a work-related upper extremity disorder is to assist the recovering worker in accomplishing successful return to work by reducing the discrepancy between the worker's work capabilities and the demands of the work environment. Few theoretical models have been proposed that consider how the multitude of contributing factors influence clinical outcomes, recovery, and return to work in workers with work-related upper extremity disorders. One such model, proposed by Feuerstein (1991), is the Rochester Model of work disability. This model is applicable to all work-related musculoskeletal disability, including low back pain and work-related upper extremity disorders. Feuerstein proposes that the combination of medical status, physical capabilities, and work tolerances in relation to work demands and psychological and behavioral resources (worker characteristics, psychological readiness for work, ability to manage or cope with pain) contributes to the development, exacerbation, and maintenance of work disability associated with work-related upper extremity disorders. This implies that these factors should be predictive of measures of functional improvement following work-related disability and rehabilitation.

Another model, proposed by Sauter and Swanson (1996), is the Ecological Model of musculoskeletal disorders. This model represents an integration of earlier more unidimensional psychosocial stress models (e.g., Kagan and Levi, 1971; Karasek and Theorell, 1990) and biomechanical models of musculoskeletal disorders. Here, the etiology (and possibly exacerbation and maintenance) of work-related musculoskeletal disorders may be linked to the characteristics of work technology, which includes both the nature of the tools and work systems at the workplace. Work technology, which Sauter and Swanson illustrate using a video display terminal (VDT)/computer as one example of the primary tool in office or video display terminal work, has a direct link to physical demands and work organization, with physical demands also linked to work organization in a way that illustrates the fact that the latter may be exacerbated by the former. The salient point is that the ecological model recognizes the multidimensional etiology of work-related upper extremity disorders in a framework which incorporates technology, physical demands (including ergonomics), work organization (including mechanization), individual factors, biomechanical strain, and psychological strain. In addition, this model incorporates cognitive processes as mediators, a characteristic not included in most other similar models (e.g., Bongers and de Winter, 1992; Bongers et al., 1993). The inclusion of cognitive mediators, such as attribution/labeling (of, in this case, symptoms) is vital and logical in that the worker's environment is replete with competing stimuli, and the influence of situational and experiential factors in such inferential processes has been well-accepted since Schacter and Singer's (1962) classic work.

A third model is based upon the construct of workstyle (Feuerstein, 1996) which is one psychosocial variable simply defined as "how the individual approaches work." Workstyle is viewed as an individual pattern of cognitions, behaviors, and physiological reactivity that co-occur while performing job tasks. The workstyle may be associated with alterations in physiological state that with repeated elicitation can contribute to the development, exacerbation and/or maintenance of recurrent or chronic musculoskeletal symptoms related to work. According to this model, an "adverse" or high-risk workstyle, is one which predisposes or is associated with increased occurrence of work-related upper extremity disorder symptoms. This adverse workstyle may be precipitated by any number or combination of factors (e.g., need for achievement, need for acceptance, fear of job loss, fear of loss of social support) which affect the perceived work demands. This model is based upon the premise that certain workstyles (which involve heightened behavioral, cognitive, and physiological reactivity) when paired with work climate, work demands, and workstation factors, interact; increasing exposure to ergonomic stressors, thereby enhancing the likelihood of work-related upper extremity disorder symptoms or exacerbation and maintenance of symptoms that already exist.

Although it has been shown that increased ergonomic strain is associated with increased risk of work-related upper extremity disorders (e.g., in Armstrong et al., 1993), this model suggests that certain workstyles may interact to predispose and/or potentiate such risks. In addition, workstyle factors may serve as risk factors, either alone, or in concert with biomechanical and other factors, to exacerbate or maintain work-related upper extremity disorder symptoms, contributing to chronic, long-term disability (Feuerstein, 1996).

A fourth model is that proposed by Armstrong et al. (1993). Armstrong et al.'s model emphasizes the multifactorial conceptualization of work-related neck and upper-extremity disorders viewed within a dose (exposure) response relationship. This model is an interactional one in which the complex interplay between exposure, dose, capacity, and response is used as a conceptual framework for understanding, discussing, planning, and interpreting relevant research focusing on the development of work-related musculoskeletal disorders.

Limitations of Previous Research

Although previous research with low back pain has suggested the importance of pain levels, distress, pain coping, pain behavior, somatization, and return to work expectations on the functional status of work-disabled low back pain patients; the influence of these factors on clinical outcomes related to rehabilitation of work-disabled carpal tunnel syndrome patients has not been examined until recently (Feuerstein et al., 1993). Limitations existing in the present body of empirical literature include : 1) the lack of research addressing predictors of recovery in work-related carpal tunnel syndrome (most of the research that does address predictors of recovery focuses on low back pain, not carpal tunnel syndrome); 2) most of the research that does address predictors of recovery in work-related carpal tunnel syndrome deals solely with surgical samples; 3) the existing outcome studies rarely include multivariate measures of outcome, focusing either on symptoms, function, or return-to-work but not all three; these studies routinely neglect potential ergonomic, work-related, and psychosocial predictors, and if they do include one or two of these, they exclude other important measures (e.g., demographics, occupational status, pain/symptom severity, activity level and function); 4) methodological limitations, including the lack of prospective studies, inadequate or non-existent statistical analyses, small sample sizes, unclear case definition (e.g., duration of symptoms prior to treatment, presence of concomitant diseases), inconsistencies in the types of outcomes studied and unclear operational definitions of how outcomes were measured, poor homogeneity of the sample in regard to occupational status, comparable disease severity and/or disability, lack of specific hypotheses, and a small number of prospective studies across multiple outcome categories.

While there is emerging evidence that supports the multifactorial nature of carpal tunnel syndrome and its association with work disability (Feuerstein et al., 1996), existing investigations rarely have included multidimensional measures of outcome or predictors of recovery.

Rationale for Proposed Study

Work-related upper extremity disorders, such as carpal tunnel syndrome, when persistent, may lead to decrements in physical and psychological functioning and ultimately, in a subgroup of cases with chronic, prolonged long-term work disability. The interactive role of ergonomic, psychosocial, and other stressors in the development, exacerbation, and maintenance of work-related upper extremity disorders, although showing preliminary support in the literature, has not yet been thoroughly examined, particularly from a multifactorial (outcomes as well as predictors) perspective.

The proposed study will address many of the limitations that are inherent in the existing body of literature by presenting a multifactorial approach to predicting clinical and return-to-work outcomes in work-related upper extremity disorder patients via a prospective design. Case definition and outcome measures will be clearly defined and thoroughly analyzed. The information that will be gained from the study is critical to design empirically based primary and secondary treatment and prevention efforts directed at the suspected multifactorial nature of these symptoms/disorders, and the factors that appear to influence outcome/disability. Once such information is available, better assessment tools may be developed to identify the factors demonstrated to be related and predictive of work-related upper extremity disorder development and long-term recovery or lack of same. Furthermore, organizational interventions involving work methods and work environment may be developed to reduce associated morbidity and work disability.

Finally, personnel who are at particular risk for work-related upper extremity disorder or long-term work-related upper extremity disorder-associated disability may be identified so that some targeted early prevention/intervention strategies may be employed to maintain function.

General Study Objectives:

To develop and validate a comprehensive assessment instrument to be utilized by health care professionals to assess and predict clinical outcomes in patients at increased risk for chronic long-term disability associated with work-related upper extremity disorders.

The present study is designed to determine whether a multivariate model which considers demographics, medical status, pain/symptoms, activity/function, work demands/work characteristics, work environment/work perceptions, support (social support), and mental health (mood/thoughts) measures determined in the early stages of a work-related upper extremity disorder is predictive of clinical outcomes and return to work at one month post initial diagnosis.

Specific hypotheses for the proposed study are:

1. A combination of demographics, medical status, pain/symptoms, activity/function, work demands/work characteristics, work perceptions/work environment, support (social support), and mental health (mood and thoughts) will significantly predict clinical outcomes.

2. Cases with both greater symptom severity and greater psychosocial stressors will be more likely to exhibit delayed functional recovery than those with either alone.

3. Cases with greater symptom severity (a composite of frequency and severity) will display higher levels of ergonomic and psychosocial stressors.

4. Cases with lost work time will display higher levels of ergonomic and psychosocial stressors.

5. Cases with greater functional limitations will display higher levels of ergonomic and psychosocial stressors.

METHOD

Participant Recruitment, Screening, and Inclusion Criteria

Work-related upper extremity disorder participants were recruited from the metropolitan Washington D.C., Maryland, and Northern Virginia communities via advertisements placed in various local media, clinics, and hospitals. Volunteers were accepted for the study if they:

1) met the modified NIOSH case definition for an occupational upper extremity disorder by reporting a) symptoms of pain, aching, stiffness, burning, tingling, or numbness (any one or more) within the preceding six weeks; b) no previous accident (non-occupational) or acute trauma to symptom area within the previous year; c) no previous diagnosis to the specified symptom area(s); d) symptoms began after employment at present job; e) symptoms lasted greater than 1 week, or occurred at least once per month since onset;
2) were a male or female between 20 and 65 years of age; and,
   were currently working 20 or more hours per week

Sample Description

The sample consisted of 52 participants who met the selection criteria. After a brief phone screen that posed questions which addressed basic inclusion criteria, followed by completion of a medical information form outlining necessary diagnostic criteria, all eligible participants were scheduled to participate in the study and offered monetary compensation (40 dollars). See Appendices A and B for copies of the phone screen and medical information form. Individuals with a history of seizure disorder, major endocrine disease (e.g., insulin-dependent diabetes mellitus), non-correctable sensory or physical impairment (e.g., deafness, blindness, bipolar disorder, dwarfism), current psychoactive substance abuse, or current pregnancy were excluded as potential participants. Approximately 250 people were screened over a six-month period, approximately 60 met the case inclusion criteria, and 52 followed-through with participation. Reasons for non-inclusion included: individuals who were outside the age range (e.g., an 84-year-old carpenter), had major confounding medical conditions or physical anomalies (e.g., diabetes mellitus, rheumatoid arthritis, dwarfism), had problems which were not clearly symptoms of an upper extremity disorder and/or necessarily work-related (e.g., potentially a result of a hobby, recent fall, or accident), reported long-standing symptoms and/or had been first diagnosed months or years ago versus within the past six weeks, were now unemployed, on full-time disability, or no longer working at least 20 hours per week. Other reasons individuals declined to participate included statements which indicated: insufficient monetary compensation ("it's not worth it"), feeling unable to take time to visit study site at all or within a reasonable time-frame ("I'm too busy", "I could do it in a couple of months"), changing their minds for various reasons (e.g., "I'm afraid my boss will find out somehow"), or desiring a treatment study ("Oh, I only wanted to do it if I'm going to get free treatment"). The sample was comprised of 38 women and 14 men who ranged in age from 22-63 years. See Table 1 for demographic characteristics and Table 2 for diagnostic characteristics.

General Overview of Design and Procedures

The study utilized a single group (work-related upper extremity disorder patients) prospective design. Participants were asked to complete a 30-45 minute baseline questionnaire which originally consisted of 347 total individual items divided into eight general sections that measured: occupational status and demographics, medical status, pain and symptoms, activity and general function, work demands/characteristics, work environment and workstyle, (social) support, and mental health (mood and cognitions). These eight broad categories were constructed apriori and each contains related items proposed to contribute to the prediction of outcomes.

Follow-up questionnaires consisting of 100 items in four general areas of outcomes (i.e., work status, pain and symptoms, activity and general function, and mental health) were distributed at the time of the initial assessment with instructions to complete one month after the initial work-related upper extremity disorder diagnosis. The follow-up questionnaire was expected to take approximately 15-20 minutes to complete and mail back in the accompanying pre-paid and addressed envelope. A telephone call was placed to each participant within one week prior to their anticipated completion of the follow-up questionnaire to serve as a reminder and opportunity for requesting mailing of a replacement questionnaire, if necessary. Questions were paired with a variety of response formats including: forced choice, open-ended, and 10 centimeter Visual Analogue Scale (VAS) with verbal descriptors at the two extreme poles.

Procedure

For the initial assessment, the participant was seated in a comfortable chair in a well-lit and temperature-controlled room. Each participant completed informed consent procedures (see Appendix C) and after any questions had been answered, height, weight, and pinch and grip strength were measured in an adjoining office. Pinch and grip measurements were taken in both the dominant and nondominant hand via three trials and the scores were recorded and averaged. Instructions read to each participant were standardized and are provided in Appendix D. No invasive measures were employed. Afterward, the participant was given a baseline questionnaire to complete with an assigned participant ID# so that nominal identifiers could be removed from the data collection forms and given to the principal investigator (PI) for safekeeping. This protected the confidentiality of participants so that unnecessary linking of their names and personal response data would not occur. The researcher checked on each individual's progress every 10-15 minutes and offered clarification regarding any questions on response format or question content. After completion of the multidimensional self-report measure, each participant was given a follow-up questionnaire with their subject identification number and the date to be completed filled in on each form with a pre-paid addressed envelope addressed to the investigator included. Each participant was followed over a period of one month with follow-up questionnaires completed one month after the baseline measures in order to track the course of work status, pain/symptoms, activity/function, and mental health over the weeks following initial diagnosis. Each participant was telephoned within approximately one week prior to the one month follow-up period as a reminder to complete the follow-up form. At this time, if the participant had misplaced the form, a replacement was mailed so that it could be completed on schedule.

PREDICTOR VARIABLES

Prediction of Work Status, Pain/Symptoms, Activity/Function, and Mental Health

The predictor variables used in the present study fall into eight general categories which were collected and used to predict clinical outcomes one month after administration of the baseline measures relevant to the work-related upper extremity disorder. A questionnaire originally consisting of 347 items was used to obtain baseline measures in each of eight categories: Demographics/Occupational status; Medical Status; Pain/Symptoms; Activity/Function; Work Demands/Work Characteristics; Work Environment and Workstyle; Support (Social Support); and Mental Health (mood/cognitions). These measures were used to predict the four occupational and clinical outcomes of Work Status, Pain/Symptoms, Activity/Function, and Mental Health, measured one month after the initial baseline measurement.

BASELINE QUESTIONNAIRE

Demographics/Occupational Status

The first section of the baseline questionnaire included questions on age, gender, educational level, marital status, and ethnicity as well as how long the individual had held their current job, job title, full or part-time status, and whether or not there had been breaks or periods of limited or alternate duty. This section contained items which were intended to measure various demographic and occupational status characteristics. These were included based upon findings in the literature which indicate that factors such as non-caucasian race, female gender, divorced status, type of job, union status, attorney consultation and litigation status, and return-to-work expectations may be significant factors in the exacerbation and/or maintenance of work-related upper extremity disorders (Cheadle et al., 1994; Hales et al., 1994). This category included a total of 12 individual questions.

Medical Status

This section contained items intended to measure various aspects of medical status. These were included based upon findings in the literature which suggest that factors such as thyroid condition, rheumatoid arthritis (Hales et al., 1994), use of bifocals at work (Hales et al., 1994), and prior medical condition or injury (Chaffin and Fine, 1993) may be significant factors in the exacerbation and/or maintenance of work-related upper extremity disorders. This category included a total of 55 items, including pinch and grip strength which have shown to be reliable and valid measures of hand strength and function (Levine et al., 1993; Mathiowetz, Weber, and Volland, 1984), disability and impairment (Gelberman et al., 1983), and predictive of future function (Levine et al., 1993). Furthermore, Moore and Garg (1995) suggest that since maximal strength varies within the population, with required strength remaining constant; weaker individuals generally have greater strain placed upon them, and therefore may be at greater risk for carpal tunnel syndrome, other work-related upper extremity disorders, or poorer outcomes in general. Procedures used to measure pinch and grip strength followed the recommendations outlined by the American Association of Hand Therapists (ASHT, 1992) and manufacturers of the Jamar dynamometer.

In order to determine current musculoskeletal health status and the relationship of impaired status to work outcomes, a series of more focused questions related to whether there is pain or discomfort that is believed to be work-related and whether and how such discomfort has interfered with work were posed. Questions regarding prior history of a worker's compensation injury were asked as well as specification of type and site of any previously-diagnosed upper extremity disorders as well as presence of other potentially serious medical conditions (i.e., diabetes, thyroid problems). Questions related to past treatment of pain or other problems of the hands, wrists, arms, shoulders, or neck by medical (i.e., steroids; surgery), physical (i.e., splinting), or psychological (i.e., stress or pain management) therapies were included. These were followed by questions regarding how helpful various treatments and providers have been in facilitating recovery and/or return-to-work. Finally, general data regarding alcohol, tobacco, and medication usage were included in this section as well. The total score was computed for each group of related items and each group was considered as one variable.

Pain and Symptoms

This section contained items which were intended to measure various characteristics of pain and symptoms commonly observed in work-related upper extremity disorders. These were included based upon findings in the literature which suggest that factors such as increased symptom severity and increased symptom frequency, as well as pain coping strategies may be significant factors in the exacerbation and/or maintenance of work-related upper extremity disorders (Himmelstein et al., 1995; Levine et al., 1993; Rosenstiel and Keefe, 1983). This category included a total of 17 individual items. As per the instructions of the original authors, the total score was computed for each group of related items and each group was considered as one variable.

After general information regarding presence or absence of upper extremity pain and its relationship to and effects on work status were collected, more specific questions focusing on hand and wrist pain and symptoms were asked. This section measured the qualitative (e.g., weakness, numbness, or tingling), quantitative (e.g., severity, frequency) aspects of symptoms, general effects on function (e.g., difficulty grasping objects, difficulty sleeping), pain beliefs and coping responses to pain or discomfort, as well as general measures of work-related upper extremity disorder symptoms.

The Discomfort Intolerance Survey (DIS) is a 6-item measure with statements describing participant's reactions or behavior related to various descriptions of discomfort. Each item is a statement accompanied by a visual likert-type scale from 0-6 with 3 verbal descriptors ranging from "Not at all Like Me" at 0-1 to "Extremely Like Me" at 5-6; "Moderately Like Me" being in the middle 2-4 area. This measure is currently being validated and was modified from it's original form into a 10 cm visual analogue scale (VAS) response format (Schmidt, 1995). Scott and Huskisson's (1976) extensive analysis showed that this type of VAS is very accurate, more sensitive than descriptive scales, and easy for patients to use in the graphic representation of pain or discomfort.

Activity and Function

This section of the questionnaire contained items which were intended to measure various aspects of general function and activities of daily living. These were included based upon findings in the literature which indicate that factors such as general function (Ware and Sherbourne, 1992) and functional self-efficacy (Lackner, Carosella, and Feuerstein, 1996) may significantly contribute to the exacerbation and/or maintenance of work-related upper extremity disorders or work-related musculoskeletal disorders in general.

This section contained questions that more specifically address the effects of hand and/or wrist symptoms and general physical and/or emotional health on activity and function; both in non-work-related and work-related daily tasks or activities of daily living. Questions about perceptions of general health status and feelings during the preceding four weeks were also included.

The SF-36 (Ware and Sherbourne, 1992) is a 36-item survey consisting of items which represent eight general areas: limitations in physical activities due to health problems, limitations in social activities due to physical or emotional problems, limitations in usual role activities due to physical health problems, bodily pain, general mental health (e.g., "How much of the time during the past 4 weeks:" "have you been a very nervous person?" or "have you felt so down in the dumps that nothing could cheer you up?", limitations in usual role activities because of emotional problems, vitality (energy and fatigue), and general health perceptions (e.g., "I seem to get sick a little easier than other people," "I am as healthy as anybody I know," "I expect my health to get worse," "My health is excellent"). This category included a total of 53 individual items. The total score was computed for each group of related items and each group was considered as one variable.

The inclusion of diverse measures is consistent with the view that overall quality of life includes not only biological and physical aspects of health and well-being, but psychological perceptions, perceived function, and occupational and social functioning (Greenfield and Nelson, 1992; Ware, 1991; Wilson and Cleary, 1995).

Work Demands and Work Characteristics

This section contained items which were intended to measure factors related to physical (and psychosocial) demands of the workplace and characteristics of the work environment. These were included based upon findings in the literature which indicate that factors such as: feeling rushed at work, working in a painful way to ensure high quality, fear of developing a pain problem at work, fear of being replaced by computers, lack of decision-making input, high information-processing demands, time pressure, monotonous work, and perceived exertion may be significant factors in the exacerbation and/or maintenance of work-related upper extremity disorders (Houtman et al., 1994; Feuerstein, 1996; Hales et al., 1994; Keyserling et al., 1993; Reid et al., 1991). This category included a total of 107 individual items. The total score was computed for each group of related items and each group was considered as one variable.

Questions related to characteristics and frequency of task-oriented (e.g., "How frequently do you find yourself making a 'pinching type' motion?") or ergonomic stressors potentially related to occupational tasks (e.g., "How much can the height of the work surface be adjusted?", or "How frequently do you find yourself using the computer mouse?") were included as well as characteristics of the job and its associated physical and mental demands. The section began with more general questions regarding frequency of requirements on the job to work "very fast", with time pressure, marked increases in workload, and increases in mental concentration or thought processing. More specifically-focused questions regarding hand and wrist movements followed, with questions regarding the frequency of repetitive, forceful, and rapid, jerky movements included. This was followed by additional hand and wrist movement-focused, and task-specific questions addressing the frequency of specific (e.g., pinching, squeezing, screwdriver-twisting) movements and work tasks.

Some questions regarding the perceived effort required in both a typical and highly demanding workday were included, as well as questions related to relatively-stable characteristics of the physical work environment and general attitude and interaction patterns of the workgroup as a whole. Finally, questions about individual coping strategies and attitudes used in the management of work-related pain and symptoms were included along with assessment of job-focused functional self-efficacy and return-to-work expectations.

The National Institute for Occupational Safety and Health (NIOSH) Checklist of Work-Related Psychosocial Conditions (NIOSH, 1995) is a 26-item (excluding demographics) measure designed to be completed by a NIOSH evaluator who is examining characteristics of a given workplace environment. This measure was modified slightly in verbiage to allow use as a self-report measure answered by the worker.

Some items were extrapolated from risk factor areas outlined in Stetson et al.'s (1991) worksheet for recording duration and frequency of potentially damaging ergonomic upper extremity risk factors in the workplace. The risk factors incorporated into the screen included exposure to repetitiveness, localized mechanical contact stresses, forceful mechanical exertions, awkward upper extremity posture, and hand tool use. The inclusion of these areas is supported in reviews of risk factors for work-related upper extremity disorders (Armstrong et al., 1993; Hagberg et al., 1995). A related group of items measuring workplace ergonomic stress exposure was taken from Pransky and Hill-Fotouhi's (1996) questionnaire.

Other items also related to frequency of performing biomechanically stressful work activities were adapted from information contained in the risk factors incorporated into the checklist designed by Lifshitz and Armstrong (1986) for the "control and prediction of cumulative trauma disorders in intensive manual jobs" (p.837).

(Psychosocial) Work Environment and Work Perceptions

This section contained items which were intended to measure various psychosocial aspects of the work environment and perceptions of the workplace. Specific questions about the perceptions of coworker and supervisor support and rapport and the reactions of coworkers and the supervisor to the respondent's work injury were included, as well as efforts made to accommodate or modify work schedule, work tasks, or work environment to assist the injured worker. Each respondent was also asked to appraise the degree to which he/she blames his/her employer for the injury or is angry about the employer's reaction. These were included based upon findings in the literature which suggest that factors related to perceived work environment, communication and rapport with coworkers, communication and rapport with supervisor, reactions of coworkers and/or supervisor, workplace accommodations, anger or blame directed at employer, perceived pressure in the workgroup, clarity of duties, and coping strategies used at work may be significant contributing factors to the exacerbation and/or maintenance of work-related upper extremity disorders (Bongers et al., 1993; Feuerstein, 1996; Habeck et al., 1991; Rosenstiel and Keefe, 1983; Theorell et al., 1991; Sauter et al., 1983; Hopkins, 1990; Pot, Padmos, and Brouwers, 1986; Linton, 1991). This category included a total of 65 individual items. The total score was computed for each group of related items and each group was considered as one variable.

The Coping Strategies Questionnaire (Rosenstiel and Keefe, 1983) is a 50-item questionnaire which includes questions which assess six cognitive coping strategies and two behavioral coping strategies. Each coping strategy subscale has six items and there are two questions which ask the respondent to rate the perceived efficacy of their usual coping strategy(ies) . The Catastrophizing Subscale (CS) is a six-item cognitive coping strategy subscale that assesses how often an individual contemplates a negatively-focused cognition or cognitive coping strategy (Himmelstein et al., 1995). While initially applied to low back pain patients in Rosenstiel and Keefe's study, Himmelstein et al. more recently used this subscale as part of a larger study examining the clinical and psychosocial characteristics of individuals with work-related upper extremity disorders. Himmelstein et al. found that work-disabled subjects scored significantly higher on the catastrophizing measure than individuals who continued working. So, although this questionnaire was designed to categorize different coping techniques that patients with low back pain use to manage pain, it is proposed that the use of such coping strategies may be predictive of clinical outcomes in work-related upper extremity disorder cases. This scale has consistently exhibited good psychometric properties, with an internal reliability (Cronbach's alpha) of .78 (Rosenstiel and Keefe, 1983).

Selected items related to workplace practices were obtained from Habeck et al.'s (1991) self-report questionnaire of disability management strategies in the workplace. This instrument is a 73-item questionnaire designed for investigating organizational factors and practices that were empirically related to differences in rates of worker's compensation claims in similar industrial settings (e.g., transportation, manufacturing). The items selected were those significant discriminators of high and low worker's compensation groups.

Items related to workplace accommodation (e.g., adjustability of the work surface) were based upon suggestions and results of work by Hales et al., (1994). Several items regarding ergonomic stressor exposure and satisfaction with employer responses to injury (including workplace accommodations and efforts to communicate with the employee) were taken from Pransky and Hill-Fotouhi's (1996) questionnaire. Other questions related to generic sources of job stress were also added from Moos and Moos (1994).

Support

This section is a brief measure of social support. It included questions which measured the extent to which the participant is satisfied with the reactions of family and friends to his/her problems and the extent to which he/she feels that his/her friends and relatives are willing and able to share personal problems with each other.

This section contained items which were intended to measure various aspects of the individual's social support, specifically related to family and friends. These were included based upon findings in the literature which suggest that factors such as lack of social support from spouse, friends and/or relatives may be significant in the exacerbation and/or maintenance of work-related upper extremity disorders (Hales et al., 1994). This category included a total of six individual items. The total score was computed for each group of related items and each group was considered as one variable.

Mental Health

The final section included items that assessed mood (particularly anxiety, and, to a lesser degree, depression), general stress coping, and cognitions related to mood (e.g., anxiety), problem-solving, and cognitive aspects of workstyle.

This section contained items which were intended to measure various aspects of mood (particularly anxiety). These variables, including anxiety and depression may be significant contributors to the exacerbation and/or maintenance of work-related disability and/or associated symptoms (Feuerstein, 1996; Gallagher et al., 1989; Gatchel et al., 1994; Lancourt and Kettelhut, 1992; Spence, 1990; Ursin, Endresen and Ursin, 1988; Theorell et al., 1991). This category included a total of 34 individual items. The total score was computed for each group of related items and each group was considered as one variable.

The State-Trait Anxiety Inventory, Form X-2 (Trait Anxiety) is a measure of anxiety (Spielberger, Gorsuch, and Lushene, 1970). The Trait version of the STAI-X asks individuals to indicate how they usually feel in common everyday situations. This section refers to the more stable, general feelings of anxiety. Total scores ranged from 20 to 80, with higher scores indicative of increased anxiety and/or pathology.

The psychometric properties of the scale are very good (Spielberger, Gorsuch, and Lushene, 1970).

OUTCOME VARIABLES

Outcomes were measured one month after the diagnosis of a work-related upper extremity disorder. Occupational Status, Pain/Symptoms, Activity/Function, and Mental Health (mood/cognitions) outcomes were examined after calculation of a total score for each variable within the category.

Occupational Status

This section, when finalized, contained one item, the number of workdays missed in the past month due to the work-related upper extremity disorder, intended to reflect current occupational status. This was utilized based upon findings in the literature which provide indirect evidence indicating that factors such as number of hours worked may be significant contributing factors in the exacerbation and/or maintenance of work-related upper extremity disorders (Cheadle et al., 1994; Habeck et al., 1991; Hales et al., 1994) and those such as Bigos et al. (1986) who state that time lost from work may be the most useful outcome measure for those with work-related disability. This category included a total of one individual item.

Items which were not included in the final analyses included a few questions on current work characteristics were adapted from Pransky and Hill-Fotouhi's (1996) survey. These questions ask about one's current job description and clarify the current work situation and whether any changes in work status are related to the work injury. These data were potentially important in determining whether or not a participant met the operational definition for successful work outcome and permitted examination of any mediator and/or moderator variables (e.g., change in job type, hours, or accommodations). The questions also allowed for the possibility that the worker may have changed jobs for reasons unrelated to his/her work-related upper extremity disorder (one individual was dropped from the final predictive analyses due to inability to provide useful follow-up data due to loss of job unrelated to the upper extremity disorder problem).

Pain/Symptoms

This section, when finalized, contained 11 items which were intended to measure various pain and symptom characteristics which were analyzed in the outcome data as dependent variables. These were included based upon findings in the literature which suggest that factors such as increased symptom severity and increased symptom number may be significant factors in the exacerbation and/or maintenance of work-related upper extremity disorders (Himmelstein et al., 1995; Levine et al., 1993; Rosenstiel and Keefe, 1983). Research using low back pain as a model has consistently shown that lower symptom severity is a better prognostic indicator which is linked to improved outcomes (e.g., decreased work disability, improvement in symptoms, and return-to-work (Deyo and Diehl, 1988; Frymoyer and Cats-Baril, 1987; Hazard et al., 1996; Lancourt and Kettelhut, 1992; Singer et al., 1987).

The Symptom Severity Scale (Levine et al., 1993) is an 11-item self-administered questionnaire for the assessment of the severity of symptoms in patients who have carpal tunnel syndrome. The scale exhibited high test-retest reliability with Pearson correlation coefficient of r=0.91. and internal consistency (Cronbach's alpha = 0.89. As per the original author's instructions, the total score was computed considered as one variable. This category included a total of 11 individual items.

Activity/Function

This section, when finalized, contained 8 items which were intended to measure various aspects of general function and activities of daily living. These were included based upon findings in the literature which suggest that factors such as functional status (Levine et al., 1993) represent important outcomes in patients with work-related which may be significant factors in the exacerbation and/or maintenance of work-related upper extremity disorders (Pransky and Himmelstein, 1996). Initial levels of perceived function and performance of activities of daily living should be predictive of future levels of function based upon studies which show that general function (McHorney, Kosinski, and Ware, 1994) and functional status, like symptoms, are responsive to clinical change (Levine et al., 1993) and useful in measuring a gamut of clinical and patient-centered (e.g., work status, sense of well-being) outcomes (Brazier et al., 1992; Maklan, Green, and Cummings, 1994; McHorney et al., 1992; McHorney, Ware, and Raczek, 1993; McHorney, Kosinski, and Ware, 1994; Stewart, Hays, and Ware, 1988).

The Functional Status Scale (Levine et al., 1993) is an eight-item self-administered questionnaire for the assessment of functional status in patients with carpal tunnel syndrome. The scale exhibited high test-retest reliability with a Pearson correlation coefficient of r=0.93 and internal consistency with Cronbach's alpha=0.91. As per the original author's instructions, the total score was computed and considered as one variable. This category included a total of eight items.

Mental Health

This section, when finalized, contained items which were intended to measure various aspects of mood (particularly anxiety). This set of items were included based upon findings that suggest that conditions such as increased anxiety and depression may be significant factors in the exacerbation and/or maintenance of work-related disability and/or associated symptoms (Feuerstein, 1996; Gallagher et al., 1989; Gatchel et al., 1994; Lancourt and Kettelhut, 1992; Spence, 1990; Ursin, Endresen and Ursin, 1988; Theorell et al., 1991).

The Mental Health Index (MHI-5) is a five-item measure of mental health that is a subscale contained within the 36-item standard-form health survey (SF-36) from the Medical Outcomes Study (Ware and Sherbourne, 1992). It exhibits a test-retest Pearson correlation coefficient of r = .95 with the 38-item "long form" measure of mental health, the Mental Health Index (Davies et al., 1988; Veit and Ware, 1983). As per the original author's instructions, the total score was computed and considered as one variable.

Selection of Predictor Variables

Data reduction to identify variables to be included in the various regression analyses was accomplished by examining the interrelations among variables using correlation matrices. Composite scores of multi-item measures within the apriori categories (i.e., demographics, pain/symptoms, medical status, work characteristics/work demands, work environment/work perceptions, social support, activity/function, and mental health) were examined for cross-correlations, and measures which indicated correlations of .28 or above ($p < .05$) were reviewed.

As mentioned, the questionnaire categories were chosen apriori, and although they were chosen to reflect different broad areas of interest, it was expected that there would be some overlap in item areas and constructs. Although some overlap may have been unavoidable in the sense that the reflected constructs are not completely discrete and therefore would not demonstrate complete discriminant validity, an attempt to rectify any such category overlap involved empirically creating sets of items which each reflected an area hypothesized to be predictive of outcomes. Given the fact that the baseline questionnaire had a large number of items (347), the first set of analyses was targeted at reducing the number of items to the smallest number based upon empirical, conceptual and clinical considerations. In order to accomplish this, the questionnaire items were subjected to correlation analyses and those items that demonstrated Pearson correlation coefficients of at least .28 ($p < .05$) or greater were subjected to data reduction procedures. It was assumed that the analyses would generate groups of items that approximated the eight broad categories used to construct the screening questionnaire: Demographics/Occupational Status; Medical

Status; Pain/Symptoms; Activity/Function; Work Demands/Work Characteristics; Work Environment and Workstyle; Support; and Mental Health.

The original baseline screening questionnaire included items that comprised pre-existing scales (i.e., symptom severity scale, functional status scale, Borg measures of physical exertion (typical workday and highly demanding workday), SF-36 (including the MHI-5 subscale), Stait-Trait Anxiety Inventory (trait version), Discomfort Intolerance Survey (adapted), Upper Extremity Function Scale, work resources and work stressors subscales, NIOSH Checklist or Work-Related Psychosocial Conditions (adapted), Pransky Ergonomic Index, and the catastrophizing subscale of the Coping Strategies Questionnaire) as well as items that were included to measure conditions that were assumed to predict outcomes of interest (e.g., workplace accommodations). In an effort to reduce the number of variables used in the regression analyses the following approach was used:

1. Composite scores were computed for each group of related items within each of the broad categories of predictors: demographics, medical status, pain/symptoms, work demands/work characteristics, work environment/work perceptions, social support, activity/function, mental health.
2. Correlation matrices were computed for each of the broad categories of predictor variables. Refer to Tables 3-12 for the specific correlation matrices as well as a correlation matrix containing all predictor and dependent variables.
3. Variables were eliminated if they correlated at $r=.28$ ($p < .05$) with another measure believed to assess a similar construct.

Other considerations for eliminating a variable included: a) missing data, b) indication by respondent(s) that a question (s) was difficult to understand or answer because of wording or format and therefore was subject to varied interpretation which would preclude efficacy as a valid and reliable baseline measure of the specific outcome of interest, or c) did not have demonstrated or hypothesized utility for upper extremity specifically (i.e., may have been associated with low back pain outcomes and not work-related upper extremity disorders.

This screening procedure resulted in the identification of eleven potential predictor variables of interest. These variables were: body mass index and dominant-hand grip strength (medical status), symptom severity score (pain/symptoms), functional status score (activity/function), (work environment/work perceptions), ergonomic stressor exposure, quantity of workload and physical exertion, typical workday (work demands/work characteristics), workplace social support (social support), catastrophizing and the mental health index (mental health). Seven demographic and medical history items were entered as covariate controls (age, attorney consultation, education, prior worker's compensation claim, gender, healthcare treatment history, and number of symptomatic upper extremity disorder sites by history. The baseline equivalent measure for each outcome was also entered into the analysis.

Selection of Outcome Measures

The follow-up outcome measures recorded at one month fell into four broad categories: occupational status, pain/symptoms, activity/function and mental health. A single score was computed for each of these areas and these scores were used as dependent variables in the analyses conducted to predict outcomes.

Data Analyses

Test-retest reliability of the Questionnaire

Test-retest reliability of the various subscales of the screen was also computed. All participants who completed the baseline screen were invited (for an initial incentive of twenty dollars) to complete the screen again within ten days after the first administration. This was to allow determination of test-retest reliability of the instrument.

Prediction of outcomes

A separate hierarchical multiple regression was computed to predict follow-up scores indicative of patterns of poorer outcomes for each of the four outcome categories: occupational status, pain/symptoms, activity/function, and mental health. In this way, the utility of the baseline screen in predicting clinical and work outcomes was determined. Hierarchical regression analyses were performed to examine the relationship between potential predictor (independent) variables and the (dependent) outcomes of interest.

The specific predictor measures entered into the regression analyses were: the baseline measure of the outcome of interest (workdays missed in the past month, pain/symptoms, activity/function, or mental health), body mass index, dominant-hand grip strength, symptom severity scale score , functional status scale score, work stressors-Moos, NIOSH quantity of workload subscale, physical exertion-typical workday (Borg scale), ergonomic stressor exposure at work-Pransky, the catastrophizing subscale of the coping strategies questionnaire, the mini mental health index (MHI-5), and work resources-Moos. These were entered, and while controlling for age (in years), attorney consultation, educational level (in years), prior worker's compensation injury, gender, healthcare treatment history, and number of sites of upper extremity disorder by history, four separate hierarchical regression analyses (each reflecting a different outcome) were computed.

Finally, in an effort to examine a potential means of a simplified and clinically meaningful scoring methodology to assist in determining risk status, a composite index of risk was computed utilizing a unit weighting procedure described by Dawes, Faust, and Meehl (1989) and Cohen and Cohen (1983). This index of risk sum was calculated for each participant summarizing the predictive utility of the baseline scores for each of the 11 (attorney consultation, days missed work, symptom severity score, work resources, healthcare treatment history, functional status score, ergonomic stressors, age, work stressors, mental health index) statistically significant predictors for each of the four outcomes (work, pain/symptoms, perceived functional impairment, mental health). Using +1 (positively predictive), -1 (negatively predictive), and O (not predictive) at discretionary cutoff points for each predictor score, a composite index of predictive risk was calculated using the sum of the assigned unit weight values. This sum was examined as a potentially easy and readily interpretable face-valid method of scoring (e.g., higher score = higher risk). Pearson correlation coefficients were computed to examine the relationship between the composite index of risk for each participant and each of the four outcomes (work, pain/symptoms, activity/function, mental health).

Lastly, an outcome-specific index of risk was computed utilizing the same unit weighting procedure. This outcome-specific index of risk summarized the predictiveness of the baseline scores of the statistically-significant predictors for each outcome. The index of risk for work outcome included symptom severity score, attorney consultation, days missed work-past month, and work resources-moos as predictors summarized in the index. The index of risk for pain/symptom outcome included ergonomic stressors, symptom severity score, healthcare history, and functional status score as predictors summarized in the index. The index of risk for activity/function outcome included functional status score, healthcare history, work stressors-moos, and age as predictors summarized in the index. The index of risk for mental health outcome included the MHI-5 and symptom severity score as predictors summarized in the index.

Results

Demographic characteristics

Demographic variables are presented in Table 1. Demographic characteristics of the sample (n=52) were examined and revealed an age range of 26-63 years (mean=41.1, SD=9.66). Gender distribution included 38 (73.1%) females and 14 (26.9) males. 40 (76.9%) of the participants identified themselves as white or caucasian, 7 (13.5%) as black or african-american, 4 (7.7%) as latino or hispanic, and 1 (1.9%) as asian or pacific islander. 16 (30.8%) described having attended "some college" without a 2-year degree, 9 (17.3%) "some graduate school" without a Master's degree, 8 (11.5%) had earned a Master's degree, 6 (11.5%) had earned a graduate degree beyond a Master's, 5 (9.6%) had earned a Bachelor's degree, and 4 (7.7%) had earned 2-year degrees and a high school diploma or equivalent. 3 (5.8%) responded affirmatively to a question asking if they had consulted an attorney regarding a worker's compensation claim and 1 (1.9%) was currently in litigation regarding a worker's compensation claim. 19 (36.5%) were single, 2 (3.8%) were single but cohabiting in a romantic relationship, 7 (13.5%) were divorced, 1 (1.9%) were separated and widowed, and 22 (42.3%) were married. 14 (26.9%) stated they had had a prior worker's compensation injury and 7 (13.5%) were members of a union.

Clinical characteristics

Diagnostic clinical characteristics and diagnoses are presented in Table 2. Most of the participants had a primary diagnosis of work-related carpal tunnel syndrome. Most participants had more than one related diagnosis or syndrome(s), therefore, the total number of listed diagnoses exceeds the number of participants. No participants were included who did not have a diagnostic profile which included symptoms characteristic of at least one ICD-9 category 353, 354, 726, or 727 work-related upper extremity disorder (see Table 2).

Test-retest reliability and psychometric properties of predictors

A subset of approximately 25% (n=12) of the sample completed a second baseline questionnaire within 10 days of the initial screen and test-retest reliability of was computed using Pearson correlation coefficients (Anastasi, 1988). The scales/variables used in the present study showed test-retest Pearson correlation values ranging from 0.4 to 0.9. The lowest test-retest reliability was demonstrated on the NIOSH quantity of workload subscale ($r = 0.41$). All other scales demonstrated at least a $r = 0.7$ level of test-retest reliability. The highest test-retest reliability (excluding demographic and missed work items) was shown on the activity/function measure ($r = .94$), the Functional Status Scale. Table 17 reveals the test-retest results for each of the scales/variables used in the prediction of outcomes. In addition, all of the predictive measures (with the exception of "workdays missed" and a measure of self-reported ergonomic stressors (Pransky and Hill-Fotouhi, 1996) have been used in previous research and have demonstrated good test-retest reliability and internal consistency (see pages 43-46).

Predicting Multidimensional Outcomes

Multivariate hierarchical regression analyses were used to determine the relationship of predictor variables on each of the four outcomes (days lost work, pain/symptoms, activity/function, mental health at one month follow-up. Data from a total of four participants (including one who lost her job unrelated to her upper extremity problem) were eliminated from the final predictive analyses due to incomplete or tardy completion of the follow-up questionnaire, leaving a final n of 48). As hypothesized, the combination of significant predictors varied for each of the four outcomes.

Predictors of Work/Occupational Status

Regression analyses indicated that two demographic/occupational variables were predictive of work/occupational status at 1 month follow-up (see Table 13). Consultation with an attorney ($p < .01$) and number of days of missed work ($p < .01$) in the past month (the baseline equivalent of the outcome measure) were predictive of a higher number of work days missed in the month between baseline and 1 month follow-up. With regard to pain/symptom predictors, Symptom Severity Score (SSS) was predictive of the work outcome. In addition, a workplace-focused measure of support, the work resources subscale was statistically predictive of work outcome ($p < .05$). Lastly, the Borg scale subjective measure of physical exertion (typical workday) was modestly predictive of work outcome ($p < .07$). Controlling for nonmodifiable demographic variables, the four statistically significant predictors of work outcome were able to account for 65 percent of the variance in work outcome at one month follow-up.

Predictors of Pain/Symptoms

Regression analyses showed one medically-related variable to be predictive of pain/symptom outcome one month later (see Table 14). Health care history, a measure of treatment history, was predictive (p < .02) of pain/symptom outcome. As expected, Symptom Severity Score (the baseline equivalent of the pain/symptom outcome) was predictive (p < .01) of pain/symptom outcome. With regard to activity/function, Functional Status Score (FSS) was predictive of pain/symptom outcome at one month follow-up. Lastly, an ergonomic measure (Pransky) was predictive (p < .001) of pain/symptom outcome one month later. Controlling for nonmodifiable demographic variables, the four statistically significant predictors of pain/symptom outcome were able to account for 74 percent of the variance in pain/symptom outcome in the UED participants at one month follow-up.

Predictors of Activity/Function Outcome

Regression analyses showed one nonmodifiable demographic variable, age, to be predictive (p < .05) of activity/function outcome one month later (see Table 15). With regard to medical status, one medically-related variable, healthcare history, was found predictive (p < .01) of activity/function outcome at one month follow-up. As expected, Functional Status Scale (the baseline equivalent of the activity/function outcome) predicted (p < .01) activity/function outcome at one month. Finally, lower levels of workplace support were predictive (p < .05) of activity/function outcome 1 month later. Overall, the three potentially modifiable (excluding age) and statistically significant predictors of activity/functional outcome accounted for 64 percent of the variance in activity/function outcome in the upper extremity disorder participants at one month follow-up.

Predictors of Mental Health

Regression analyses showed two variables to be predictive of mental health outcome at one month follow-up (see Table 16). Symptom Severity Score was predictive ($p < .01$) of mental health one month later. As expected, the Mental Health Index, the mental health subscale of the SF-36 (and the baseline equivalent of the mental health outcome measure) was also predictive ($p < .01$) of mental health at one month follow-up. Overall, the two statistically significant variables were able to account for 55 percent of the variance in mental health outcome in the work-related upper extremity disorder participants at one month follow-up.

A Composite Index of Risk

Utilizing a unit weighting procedure, a composite index of risk score was computed for each participant summarizing the predictiveness of the baseline scores on each of the 11 (attorney consultation, days missed work, symptom severity score, work resources, healthcare treatment history, functional status score, ergonomic stressors, age, work stressors, mental health index) statistically significant predictors of outcome. The composite index of combined predictors was correlated with work outcome ($r = .44$, $p < .05$), pain/symptom outcome ($r = .65$, $p < .01$), activity/function outcome ($r = .62$, $p < .01$), and mental health outcome ($r = -.45$, $p < .05$).

These findings indicate that the composite index of risk is significantly correlated with each of the four outcome measures investigated.

Lastly, an outcome-specific index of risk was computed utilizing the same unit weighting procedure. This outcome-specific index of risk summarized the predictiveness of the baseline scores of the statistically-significant predictors for each outcome. The index of risk for work outcome (using symptom severity score, attorney consultation, days missed work-past month, and work resources-Moos as predictors summarized in the index) showed a correlation of r=.50 ($p < .01$) for work outcome. The index of risk for pain/symptom outcome (using ergonomic stressors, symptom severity score, healthcare history, and functional status score as predictors summarized in the index) demonstrated a correlation of r=.71 ($p < .01$) for pain/symptom outcome. The index of risk for activity/function outcome (using functional status score, healthcare history, work stressors-Moos, and age as predictors summarized in the index) showed a correlation of r=.68 ($p < .01$) for activity/function outcome. The index of risk for mental health outcome (using the MHI-5 and symptom severity score as predictors summarized in the index) demonstrated no significant correlation.

Clusters and patterns of predictors

Participant response patterns

In an effort to determine whether patterns of predictors exist among individuals with UEDs, a cluster analysis was completed on the predictor variables using a k-means format (SPSS, version 7.5, 1996). Results indicated the presence of three distinct clusters of response patterns. Cluster 1 (n=9; 5 females, 4 males) appears to be a relatively young group of individuals who exhibit higher pain/symptom scores, low grip strength, low BMI, low reported physical exertion and workload quantity in the workplace, greater reported impairment of activity/function, and higher ergonomic stress exposure. This group also shows the greatest tendency for missing work, low catastrophizing, and low levels of reported mental health despite their higher reported workplace support. Cluster 2 (n =16; 10 females, 6 males) is similar in age to those in Cluster 1, yet these individuals exhibit a tendency for few missed workdays, low levels of activity/function impairment, moderate levels of pain/symptoms and ergonomic stress exposure, low-to-moderate grip strength, moderate BMI, low levels of catastrophizing, and high levels of mental health. Cluster 3 (n=12; 11 females, 1 male) is a group of older workers who report rare workdays missed, low-to-moderate pain/symptom levels, moderate activity/function impairment, moderate-to-high levels of mental health, and high grip strength.

Discussion

The present study prospectively examined the potential predictive efficacy of a multidimensional model of work-related upper extremity disorders (WRUEDs) on multiple clinical and work outcomes in a sample of patients recently presenting with a work-related upper extremity disorder. This study differed from most previous investigations in several respects. First, unlike previous studies (e.g., Adams, Franklin, and Barnhart, 1994; Cook et al., 1995, Kulick et al., 1986) this study was not limited to surgical patients. Second, attempts were made to limit the sample to a recently-diagnosed, less chronically-ill sample that could be prospectively examined. Most studies which have included examination of recently-diagnosed individuals have been cross-sectional or retrospective in design (e.g., Hales et al., 1994; Himmelstein et al., 1995). Third, examination of multiple potential predictors (assumed to play a role in work-related upper extremity disorders) and the assessment of multiple indices of outcome was accomplished. Finally, a number of potentially important demographic and occupational covariates were controlled for in the analyses. Based upon existing models of work-related musculoskeletal disorders and related disability (Feuerstein, 1991; Armstrong et al., 1993; Sauter and Swanson, 1996; Feuerstein, 1996), it was anticipated that a combination of demographic, medical status, pain/symptom, activity/function, work demands/work characteristics, work perceptions/work environment, social support, and mental health factors would significantly predict clinical outcomes. Overall, this hypothesis was supported. Clinical (and work-related) outcomes were each best predicted by some combination of factors from the various categories. Even more interesting is the observation that a combination of predictive factors differed substantially for each of the four (1 work, 3 clinical) outcomes (workdays missed, pain/symptoms, activity/function, mental health) and a maximum of four predictors were able to account for a relatively large percentage of the variance in any one outcome.

With regard to the work outcome, a combination of attorney consultation, higher levels of reported pain/symptoms, more days missed work, and higher social support in the workplace was predictive of poorer work outcome, as measured by number of days missed work related to the work-related upper extremity disorder problem. The combination of these four predictors was collectively able to account for more of the variance in work outcome than any one factor alone.

These findings support research that suggests that unidimensional measures such as pain or symptom level, are not by themselves effectively predictive of long-term work disability in surgical or nonsurgical patients with work-related upper extremity disorders [including low back pain] (Cheadle et al., 1994; Hazard et al., 1996; Lackner, Carosella, and Feuerstein, 1996; Palmer, 1993; Higgs, 1995). This also suggests that multidimensional models of risk are most appropriate for examining not only etiological factors, but for exacerbation and maintenance of work-related upper extremity disorders as well. Furthermore, the identification of multidimensional areas of risk supports the need for multidimensional, collaborative treatment approaches. Clearly the utility of a singularly-focused evaluation and/or treatment or prevention effort is limited. Indeed, attempts to prevent and/or intervene on a single factor (e.g., missed work, or pain or social support) are not likely to achieve the desired work outcome. Furthermore, the combination of attorney involvement, high symptoms, and high workplace support as predictive of greater lost work time is consistent with the findings of Tait, Chibnall, and Richardson (1990), who observed that litigation was associated with lower levels of mental distress in low back pain work-disability patients; and Himmelstein et al. (1994), who found higher levels of workplace support reported by work-disabled patients. Himmelstein et al., with regard to Tait et al.'s findings, hypothesized that attorney involvement may serve as a coping strategy for distressed workers who are struggling with their pain and the bureaucracy of the worker's compensation system. If so, it may be that if alternative coping strategies and support are available to such individuals early in their pain/symptom experience, the likelihood of attorney involvement may be attenuated. These findings are not necessarily inconsistent with results by Bonger's et al. (1993) who found that lack of coworker social support was associated with greater levels of musculoskeletal symptoms and musculoskeletal disease. Indeed, low workplace support may exacerbate symptoms and discourage treatment and missed work, while high workplace social support may serve as a coping mechanism and support system which validates the worker's concerns and "gives the worker permission" to miss work in order to seek treatment or obtain rest. In this instance, the association between high workplace social support and greater missed workdays may not be an adverse finding. It may be that workers who are "allowed" to miss work may have better long-term outcomes than those who continue to drive themselves at work despite pain/symptoms. In fact, Himmelstein et al. found lower levels of employer-directed anger in workers who reported a more positive work environment; such workers may have less motivation to seek litigation if they feel they are being supported by their employer.

With regard to the pain/symptom outcome, a combination of higher levels of reported pain/symptoms, a greater number of individual treatments by history, higher reported exposure to ergonomic stressors at work, and higher levels of perceived functional impairment were predictive of poorer pain/symptom outcome, as measured by higher scores on the Symptom Severity Scale (SSS).

These findings support studies which have reported that medical history, high work demands (Hales et al., 1994), and ergonomic stressors are associated with the development and/or exacerbation of musculoskeletal symptoms and/or disorders (Maeda et al., 1982; Sauter et al., 1991). This suggests that all those interested (e.g., worker, employer, doctor, insurance provider) in preventing and/or alleviating pain/symptom sequelae of work-related upper extremity disorders should note the suggestion that early identification, intervention, and multifaceted but organized, targeted treatment may be the most efficacious strategy since, in this study, a greater number of various treatment attempts by history was actually predictive of higher levels of pain/symptoms (as well as more missed workdays). Clearly, the idea of a "shotgun" approach to treatment, or the mere compilation of a broad number of varied treatment modalities may, in fact, predict poorer outcome. This idea is supported by research by Reid, Ewan, and Lowy (1991) whose findings suggest that individuals with work-related upper extremity disorders may become "treatment-seeking" in their efforts to obtain a more clear-cut diagnosis, treatment, prognosis, and the associated benefits (pain/symptom relief, worker's compensation, and validation from others who may seem to doubt the severity of the problem). This haphazard approach to treatment may result in a greater number of attempted treatments which are not necessarily effective. On the other hand, early, targeted, consistent interventions aimed at alleviating or reducing pain/symptoms, alleviating ergonomic stressors at work, and improving activity/function may directly (e.g., alleviate pain/symptoms) facilitate desired outcomes. In fact, well-intentioned but narrow attempts at intervention (e.g., ergonomic accommodation only), when targeted in isolation, may have minimal effectiveness on pain/symptoms if functional impact and integrated medical management is not undertaken as well.

With regard to the activity/function outcome, a combination of a more extensive treatment history, older age, higher level of self-reported impairment of activity/function, and increased psychosocial stress in the workplace (work stressors) was predictive of higher levels of perceived functional impairment as measured by higher scores on the Functional Status Scale (FSS).

These findings support studies which have suggested that age (Himmelstein et al., 1995), work environment characteristics (e.g., fear of being replaced by computers, lack of decision-making opportunities, increased work pressure) (Hales et al., 1994), and increased psychosocial stressors (Bongers et al., 1993, Linton et al., 1989; Sauter et al., 1983; Starr et al., 1985) may play a role in the evolution and/or exacerbation of musculoskeletal symptoms and/or disorders. Furthermore, these factors may be particularly relevant when examining activity/functional outcomes (as opposed to pain/symptom outcomes). Thus, early interventions which include multidimensional foci (e.g., alleviation of pain/symptoms, activity/functional enhancement, and improved workplace support and stress reduction), with particular efforts directed at older employees, may be the most fruitful in producing improved levels of activity/function. Although very few intervention studies have attempted to test this hypothesis in a group of individuals with work-related upper extremity disorders (with the exception of low back pain), these findings are consistent with those such as Feuerstein et al., 1993, who compared multidisciplinary occupational rehabilitation versus usual (medical) care in a group of workers who were on worker's compensation disability associated with work-related upper extremity disorders. Usual care consisted of medical management by the primary physician and included various treatments such as physical therapy, therapeutic exercise, hand therapy, chiropractic treatment and rehabilitation counseling. The multidisciplinary program included physical conditioning, work conditioning, work-related pain and stress management, ergonomic consultation at the workplace, and vocational counseling/placement for those who were unable to return to their former job. Feuerstein et al. found that the group who received the multidisciplinary occupational rehabilitation had an almost 2-to-1 ratio of return-to-work and return to full-time work compared to the usual care group. Whether the reason(s) that increased age is a predictor of poorer activity/function outcome may be physiological, psychological, or behavioral, it is clear that special efforts should be made to identify and treat older workers who may have work-related upper extremity disorder symptoms. Although there may be some nonmodifiable factors related to decreased physiological resiliency, it is also possible that some of the reason(s) for this increased risk are amenable to change. For example, it may be that older workers have a more entrenched "conscientious" or "hard-driving" workstyle, or a tendency for self-reliance and a "can-do" attitude. Such workers may be reluctant to complain or admit symptoms which may be incompatible with their self-image, or which they believe may threaten job security in an ageist society. Research on worker participation in worksite-based stress management and/or wellness programs has indicated that whatever the reason, older workers are more likely to be non-participators (Alexy, 1991; Wilson et al., 1994).

Lastly, with regard to mental health outcome, a combination of lower reported mental health (the absence of "unhealthy" moods/thoughts such as depression and anxiety) and higher pain/symptoms is predictive of poorer mental health outcome as measured by lower scores on the MHI-5. These findings support the general idea that there is a relationship between work-related upper extremity disorder pain/symptoms and individual psychological states (e.g., moods). However, it more specifically supports the idea that pain/symptoms may influence an individual's current psychological state, but an individual's current psychological state may not necessarily affect levels of pain/symptoms. This suggests that declining mental health indices may be sequelae which occur in response to increased pain/symptoms in some individuals with work-related upper extremity disorders. Thus, if some individuals are shown to exhibit lower indices of mental health and may be seen as "distressed," findings suggest that such distress may be in response to increased levels of pain/symptoms and the associated difficulties.

These findings are supported research by Reid, Ewan, and Lowy (1991) and Feuerstein's (1996) concept of workstyle. Reid et al., in a retrospective study of female workers with repetitive strain injuries, found that these individuals reported a tendency to "drive" themselves despite their symptoms, and most described themselves as "hard-driving" or "pushing" themselves in their preoccupation with work even before they were injured. Many of these women, particularly those with less clear-cut diagnoses, also reported that they felt that their problem was not taken seriously, and in their search for credibility and "proof" of their illness (before being able to obtain worker's compensation benefits and medical treatment), they reported increased distress and increased treatment-seeking behavior. The implication that higher emotional distress is a response to higher levels of pain/symptoms is also supported by the lack of other psychosocially-related predictors of mental health outcome (e.g., social support, catastrophizing) in that lower social support or a tendency for negativistic thinking (i.e., catastrophizing) is not associated with, or responsible for, poorer mental health outcomes. That is, neither low social support nor a tendency for negativistic thinking was associated with poorer mental health. Thus, at least in terms of the 1 month follow-up there is no support for the idea that decreased levels of mental health precede heightened pain/symptoms in this sample. This contradicts the findings of studies which suggest psychological stress as a causative factor in the development of symptoms of musculoskeletal disease (Leino, 1989; Dimberg et al., 1989). This suggests that early interventions which include treatments to alleviate pain/symptoms may enhance overall mental health outcomes as well.

With regard to the first of the minor hypotheses, it was also expected that individuals with both greater symptom severity and greater psychosocial stressors would be more likely to exhibit delayed functional recovery (poorer activity/function outcomes, more work days missed) than those with either (high symptom severity or high psychosocial stressors) alone. Overall, this hypothesis was supported. With regards to days missed work at one month follow-up, greater days of work missed was best predicted by a combination of factors, including higher symptom severity score and higher support in the workplace. Although the most efficacious model with regard to predicting work outcome included other factors as well (i.e., attorney consultation, days missed work at baseline), the basic hypothesis was supported with regard to work outcome. With regard to activity/function outcome, high levels of workplace stress added to the predictive utility of the model. That is, participants with both high levels of psychosocial stress in the workplace and high reported activity/function impairment were at greater risk for poorer activity/functional outcomes at one month than participants with either (i.e., high activity/function impairment or high workplace stress) alone. Although the more subjectively-focused (i.e., pain/discomfort sensation/perception) measure of pain/symptoms (the Symptom Severity Scale) did not predict activity/function outcome despite its' high correlation with the more objectively-focused (i.e., functional task ability) self-report of functional limitation (the Functional Status Scale), this hypothesis was supported overall. As with the main study hypothesis, the predictive utility of the model was enhanced further by the inclusion of two other factors (i.e., attorney consultation, number of workdays missed) predictive of work or (healthcare history, increased age) activity/function outcome.

Third, it was expected that cases with greater symptom severity (at baseline) would also display higher levels of ergonomic and psychosocial stressors. This hypothesis was supported. Cases with greater levels of symptom severity did exhibit higher levels of reported ergonomic stressors as measured by Pransky and Hill-Fotouhi's (1996) ergonomic index, and the Borg scale measure of physical exertion (typical workday). In addition, cases with greater Symptom Severity Scale scores also tended to display higher catastrophizing scores. Higher symptom scores also showed some relationship to lower mental health scores and lower support in the workplace.

Fourth, it was hypothesized that cases with lost work time would display higher levels of ergonomic and psychosocial stressors. This hypothesis was also supported. Cases with greater workdays missed tended to exhibit higher ergonomic stressor scores (Pransky et al.'s Ergonomic Index, Borg physical exertion-typical workday) as well as higher scores on the catastrophizing measure.

Predictively, although cases with a greater number of workdays missed did report higher levels of workplace-related psychosocial stress, scores on the ergonomic stressor measure did not significantly contribute to poorer work outcome at one month, as measured by a greater number of workdays missed. So, although higher ergonomic stress did contribute to poorer pain/symptom outcome (higher levels), and higher levels of pain/symptoms were related to poorer work (more days missed) outcome, higher ergonomic stress was not directly related to poorer work outcome; while low workplace support was. In view of this, strictly ergonomic interventions might not directly influence or improve work outcome, however, they could alleviate pain/symptoms, which indirectly might enhance work outcome. Most optimally, a combined ergonomic, work support, and pain/symptom intervention should enhance both work and non-work-related outcomes.

Lastly, it was hypothesized that cases with greater perceived functional impairment (as measured by higher Functional Status Scale score) would display higher levels of ergonomic and psychosocial stressors. Overall, this hypothesis was supported. Participants reporting greater levels of functional limitation (which was inversely correlated [e.g., low grip strength] with the objective measure of dominant-hand grip strength) tended to report higher levels of ergonomic stressors at work (Borg scale, physical exertion-typical workday, Pransky et al.'s Ergonomic Index). The Borg measure (which asks the respondent to rate the degree of physical exertion associated with a typical workday) proved to be much more highly correlated with impairment in activity/function, while Pransky et al.'s Ergonomic Index showed a higher relationship with lost work time (both were highly correlated with pain/symptom scores). In addition, participants who reported high levels of activity/function impairment also tended to exhibit high levels of catastrophizing and low mental health index (MHI-5) scores. This is particularly interesting because these two psychosocially-focused measures are not correlated with one another nor did they tend to simultaneously exhibit high correlations with other independent variable's as they did here. Both of these measures demonstrated independent (unique) relationships with activity/function.

As anticipated, the patterns of predictors that were identified were unique, depending upon the outcome category. Ergonomic stress scores were predictive of pain/symptoms, and pain/symptoms scores were predictive of mental health, but neither perceived functional impairment nor ergonomic stress scores were directly predictive of mental health outcome. Similarly, although ergonomic stress scores were predictive of pain/symptom outcome, and the latter was predictive of work outcome, ergonomic stress scores were not directly predictive of work or activity/function outcomes.

At least three possibilities for this finding exist. One, it is possible that ergonomic stress does not affect work (as measured by workdays missed) or activity/function outcomes. This appears unlikely given the high correlation between pain/symptoms and activity/function, and the fact that ergonomic stress scores were predictive of pain/symptom outcome. Since the activity/function measure was not work-focused, it may be that non-work-related activity/function was not greatly affected by work-related ergonomic stressors. Second, it is possible that the component of ergonomic stress that does influence work and activity/function outcomes was not assessed by the measure used. Third, it is possible that ergonomic stress only affects work and activity/function outcomes indirectly via pain/symptoms. In this view, it is theoretically possible that ergonomic stressors alone have no impact on any of the four outcomes, and it is individual differences in responding (both to ergonomic stress and to pain/symptoms) that mediate impact on outcome(s). These individual differences may be cognitive (e.g., tendency for negative thoughts, catastrophizing, etc.) , behavioral (e.g., tendency to seek treatment, self-initiate adaptive strategies, etc.), physiological (body type), or some combination of these. An interesting test of this hypothesis would be examining a sample of workers exposed to an equivalent level and type of ergonomic stressors to identify what factors distinguish those who develop high levels of pain/symptoms and/or work disability. The exact nature of the relationship among these factors appears intriguing and warrants further investigation.

Several potential limitations of the present study should be noted. These include: a relatively small (n = 48) sample size, limited objective measures (e.g., BMI, key pinch and grip strength measurements), limited follow-up measures (one month), lack of uniform on-site physician diagnostic screening, and inability to accurately control for length of symptom duration prior to seeking diagnosis and/or treatment. Despite broadening of the study to include all work-related upper extremity disorder cases (versus carpal tunnel syndrome only), it was much more difficult to recruit individuals who fit our study criteria than anticipated, despite the payment for participation and known prevalence of such disorders. Individuals who had been diagnosed months, even years earlier, responded at a rate of three or four-to-one for every individual who met criteria for inclusion. Further broadening of inclusion criteria would have defeated the purpose of the study. Logistics of the study dictated that objective clinical evaluation be relatively brief, therefore, we limited such measures to key suspected predictors such as measurements of body weight and height (for body mass index computation), grip strength, and key pinch strength measurements. Grip and key pinch strength measurements were highly correlated, allowing us to eliminate the latter in our data analyses. We did not conduct electrodiagnostic studies nor did we collect such data from some patients who had received such evaluations. Similar to Katz et al. (1997) we concluded that aside from practical obstacles (as well as the questionable utility of such measures in isolation), we were more interested in measures of symptoms, functional limitations, and perceptions of ergonomic and psychosocial workplace stressors as they relate to one another and to work-focused outcomes. In addition, Lancourt and Kettlehut (1992) found that in low back pain patients, several "nonorganic" factors were better predictors of return to work than findings from "organic" medical measures (e.g., electrodiagnostic studies, physical examination). While the etiological, medical, and clinical correlates of work-related upper extremity disorders are similar but not equivalent, it may be that many of the factors that predict return-to-work and other outcomes of interest are. The limited follow-up (one month) was related to the difficulty recruiting. Although follow-up measures are still being collected as part of an ongoing line of programmatic research, the returned follow-ups for the final n (48) mentioned was complete for only the first follow-up period. An attempt to compensate for the absence of an on-site physician diagnostic screen included the implementation of diagnostically stringent criteria for inclusion in the study. It was not feasible to control for differences in technique or ability among physicians who diagnosed the individuals included in the study. Due to the small n, the exclusion of a small number of patients (4) who met all diagnostic criteria but who were not officially diagnosed by a physician due to limitations in healthcare coverage or refusal to visit a physician affiliated with their workplace (due to fear of negative effects on employment and/or promotional status) was not practical. This is not viewed as a major limitation given data from studies such as Barron et al.'s (1996) which indicated that there is a strong association between self-report of pain/symptoms and physician's diagnostic findings. Finally, although accepted cases were limited to individuals first diagnosed and/or treated within six weeks prior to baseline screening, the variations that exist among individuals in elapsed time between initial symptom onset and seeking of treatment and/or diagnosis could not be controlled. It is possible that all individuals with work-related upper extremity disorders are in a sense, recurrently ill, or "chronic" and that despite attempts to limit the sample to a recently-diagnosed acute cohort, the episodic nature of work-related upper extremity disorders may inhibit this. There is no standardized route of presentation for afflicted individuals among workplace-based or medically-based treatment facilities. The time frames and order of presentation vary as greatly as the individuals themselves. Presentation to occupational medicine, physical medicine and rehabilitation, hand surgeons, chiropractors, physical therapists, occupational therapists, general practitioners, pain treatment specialists, neurologists, psychologists, and worksite-based providers is very inconsistent and unpredictable. The screen that is being developed is designed in part to assist with this problem.

The initial baseline screen has been reduced from one which required 30-45+ minutes for the participants to complete. This research represents an initial approach forward in the development of a brief (15-minute) screen which may be administered (and scored) by any healthcare provider, rendering a predictive multidimensional risk profile which appears to explain a high percentage of the variance in clinical and work outcomes one month later. The predictive utility of the questionnaire in identifying those at greatest risk for poorer short-term (and potentially longer-term) outcomes has been demonstrated, and the practicality of the brief 15-minute version of the questionnaire is impressive. The predictive ability of the questionnaire has been retained in a brief measure which allows for its' use across a variety of clinical and occupational settings without excessive utilization of time, money, or manpower.

Findings from the additional examination of potential composite indices of risk demonstrated the robustness of the multidimensional questionnaire. The outcome-specific indices of risk examined via the unit weighting analysis demonstrated again the predictive utility of the baseline scores for three (work, pain/symptom, activity/function) of the four outcomes. The lack of significant findings for the predictiveness of mental health predictors for mental health outcome here indicates the need for additional study of the role of psychological factors in the development and/or maintenance of work-related upper extremity disorders. It may be that these factors play less of a role than previously suggested, or it is possible that the measures used in this study as predictors of mental health outcome are not discretely tapping the construct of interest.

Identification of individual risk profiles, as well as "type" of profile as identified with cluster (1,2, or 3) membership should enable those involved in prevention and treatment efforts to tailor multidimensional treatment strategies (individual and group-based) targeted at each individual's areas of risk and outcome(s) of interest. For example, an individual who exhibits high pain/symptom score, high ergonomic stressor exposure, high perceived activity/function impairment, low grip strength and BMI, and low reported physical exertion and quantity of workload in the workplace would "belong" to cluster 1 and would require a different intervention strategy than an individual in cluster 3. First, although low reported physical exertion and quantity of workload in the workplace may seem inconsistent with the rest of the profile, it may be that individuals exhibiting this profile are self-accommodating, decreasing their workload and physical exertion in attempts to alleviate pain/symptoms. This groups' greater tendency to miss work may be an additional attempt to cope with pain/symptoms which may be encouraged by the higher reported workplace support. Individual and group-based interventions for workers with this risk profile may include a combination of 1) workplace accommodations designed to decrease exposure to ergonomic stressors; 2) modification of workplace duties to increase workload with appropriate non-ergonomically stressful tasks which would increase activity/function; 3) physical exercise program to increase strength and flexibility which should be assets in this younger group; and psychosocial interventions to improve sense of well-being and mental health (such as stress management or relaxation training, perhaps in combination with #3). Since members of this group tend to exhibit poor outcomes in all four areas (missed work, pain/symptoms, activity/function, mental health), interventions aimed at improving all of these areas would be included.

Alternatively, while workers demonstrating a risk profile characteristic of cluster 3 might have a very different treatment program despite the shared work-related upper extremity disorder problem. Individuals in this group tend to be older, report few or no workdays missed, low-to-moderate pain/symptom levels, moderate activity/function impairment, moderate-to-high levels of mental health, and high grip strength and BMI. This supports findings from studies such as Franklin et al.'s (1991) which found associations between high grip strength, improved surgical outcomes, and fewer workdays missed. The findings from this study suggest that the association between high grip strength and fewer workdays missed exists independent of surgical intervention. Although these individuals may appear to have a more desirable profile in that they appear to have lower levels of risk and improved outcomes, such individuals may be at higher risk over the long-term if they are minimizing their pain/symptoms and feel unable to allow themselves to miss work or diminish their workload. Although the tendency to continue to drive themselves at work and function despite pain/symptoms may be admirable in the short-term, it may be that these older individuals may work diligently until they are so disabled from the severity of their work-related upper extremity disorder that they are unable to ever fully recover. So, although these individuals may appear to be less in need of treatment, they may in fact be those most in need of intervention. Treatment strategies for these individuals may include: 1) Relaxation training and stress management aimed at allowing breaks from an overly work-focused hard-driving workstyle; 2) A social skills and discussion group aimed at encouraging interaction with others, group support, acceptance of limits versus Type A (hard driving) mentality; 3) workplace analysis and education of the employee regarding ergonomic stressor exposure and suggested workplace accommodations; and 4) employer involvement in ensuring earned vacation periods are taken on a regular basis by the employee.

Finally, individuals with a risk profile characteristic of cluster 2 tend to be a little older than those in cluster 1, yet still relatively young compared to those in cluster 3. However, these individuals differ from cluster 1 in that they have few missed workdays, low levels of activity/function impairment, moderate levels of pain/symptoms and ergonomic stress exposure, low-to-moderate grip strength, moderate BMI, low levels of catastrophizing, and high levels of mental health. So, this group of individuals is similar to cluster 1 except that they tend to have higher levels of grip strength, and lower levels of pain/symptoms and functional impairment; the profile is "middle of the road" on most measures, including BMI. It is possible that individuals in this group, with their high levels of mental health and lack of extremes, may have the best prospects for long-term recovery.

In conclusion, these data support multidimensional models of predictors and outcomes in the prevention, evaluation, and treatment of work-related upper extremity disorders. Additional research should attempt to address the aforementioned limitations, extending our strategy to a larger sample, and include longer follow-up intervals after completion of baseline measurements. Additional efforts to identify potential cognitive, behavioral, or physiological mediators involved in clinical and work-related outcomes should be enthusiastically supported. Oversimplified unidimensional views in the examination and/or treatment of work-related upper extremity disorders should be considered limited in that they do not adequately capture the complex nature of these disorders.

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Table 1 Demographic characteristics of the sample

Characteristic	n	%	Mean	SD
Age, in years			41.1	9.66
Gender				
Female	38	73.1		
Male	14	26.9		
Ethnicity				
Asian or pacific islander	1	1.9		
Black or african-american	7	13.5		
Latino or hispanic	4	7.7		
White or caucasian (non-hispanic)	40	76.9		
Other	0	0.0		
Education (years)	15.6	2.62		
High School diploma or GED	4	7.7		
Some college	16	30.8		
2 year degree	4	7.7		
Bachelor's degree	5	9.6		
Some graduate school	9	17.3		
Master's degree	8	15.4		
Graduate degree	6	11.5		
Marital Status				
Single	19	36.5		
Single, but cohabiting	2	3.8		
Divorced	7	13.5		
Separated	1	1.9		
Widowed	1	1.9		
Married	22	42.3		
Attorney Consultation				
No	49	94.2		
Yes	3	5.8		
Current Litigation				
No	51	98.1		
Yes	1	1.9		
Prior Worker's Comp Injury				
No	38	73.1		
Yes	14	26.9		
Union Membership				
No	45	86.5		
Yes	7	13.5		

Table 2 Diagnostic characteristics of the sample

Diagnostic category	n*
Mononeuritis of the upper limb(354)	
Carpal tunnel syndrome (354.0)	24
Cubital Tunnel Syndrome(354.2)	1
Unspecified mononeuritis of the upper limb(354.9)	6 (+4)**
Tendon, synovium, and bursa disorders(727)	
Trigger finger (acquired) (727.03)	1
Radial styloid tenosynovitis (deQuervain's) (727.03)	1
Other Tenosynovitis of the hand and wrist (727.05)	2
Specific bursitis often of occupational origin (727.2)	2
Unspecified disorder of the synovium, tendon, and bursa(727.9)	1
Peripheral enthesiopathies(726)	
Medial (726.31) and/or Lateral epicondylitis(726.32) (tendonitis; tennis elbow)	11
Unspecified enthesiopathy(726.9)	2
Nerve root and plexus disorders (353)	
Thoracic Outlet Syndrome (353.0)	1
Unspecified nerve root and plexus disorder (353.9)	2
Disorders of the muscle, ligament, and fascia(728)	
Muscle spasm(728.85)	1
Unspecified disorder of the muscle, ligament, or fascia(728.9)	1
Disorders of the cervical region(723)	
Cervicalgia(pain in neck) (723.1)	2

*note. total n is greater than sample size because many subjects had multiple diagnoses. No subjects were included that had a diagnosis of 728 or 723 exclusively.

** note. 4 undiagnosed subjects who exhibited symptoms consistent with carpal tunnel syndrome are included here.

Table 3 Correlations Among Demographic Measures

	Attorney Consultation	Bifocals	Education	Ethnicity	Handedness	HXUED	Litigation	Gender	Prior WC Injury	Union membership	Marital Status
Age	-.28*	.41**	-.05	.08	-.24	.09	-.19	-.04	-.04	.04	.49***
Attorney Consultation		-.12	.01	-.01	-.14	-.05	.57***	-.15	.22	.14	-.24
Bifocals			-.12	.14	-.07	.15	-.07	-.08	.25	.09	.05
Education				.20	.05	-.18	-.14	.09	-.11	-.19	.23
Ethnicity					-.00	-.24	-.16	-.11	-.00	-.03	-.20
Handedness						.05	-.08	.20	.11	.13	-.30*
HXUED[a]							.08	-.07	.03	-.03	.03
Litigation								-.09	-.09	.36**	-.10
Gender									.12	.14	.12
Prior WC Injury										.02	-.13
Union membership											-.02

p < .05 ** p < .01 *** p ≤ .001

[a] HXUED = History of Upper Extremity Disorder

Table 4 Correlations Among Measures of Medical Status

	Body Mass Index	Dominant Grip	Dominant Pinch	HCHX	DZHX	HXSURG	MEDPHYSX	REC SURG	TX LAG
Body Mass Index		-.12	-.12	.14	.24	.08	.06	.30*	.05
Dominant Grip			.85***	-.33*	-.12	.01	.11	-.02	.15
Dominant Pinch				-.24	-.15	.06	.11	-.08	.05
HCHX					-.04	-.12	.35*	.14	-.02
DZHX						.17	.15	.23	.00
HXSURG							-.06	.48**	.31*
MEDPHYSX								-.09	.12
RECSURG									.05
TXLAG									

$p < .05$ ** $p < .01$ *** $p \leq .001$

note. HCHX = Health Care Treatment History, DZHX = Other Disease History, HXSURG = History of Surgery for an Upper Extremity Disorder, MEDPHYSX = History of Other Medical and Physical Symptoms Prior to Current Problem, RECSURG = History of Physician Recommendation of Surgery for Current Upper Extremity Problem, TXLAG = Duration of Pain/Symptoms before seeking medical evaluation and treatment.

Table 5 Correlations Among Work Demand Measures

	Borg Physical Exertion, typical workday	NIOSH work qu., physical and mental exhaustion	NIOSH work qu., quantity of workload	NIOSH work qu., workload variance
Borg Physical Exertion, typical workday		.35*	.31*	.20
NIOSH work qu., physical and mental exhaustion			.49***	.56***
NIOSH work qu., quantity of workload				.52***

* $p < .05$ ** $p < .01$ *** $p \leq .001$

Table 6 <u>Correlations Among Pain/Symptom Measures</u>

	Pain Severity, past week (VAS)
Symptom Severity Score	.42**

* $p < .05$ ** $p < .01$ *** $p \leq .001$

Table 7 Correlations Among Measures of Workplace Support

	Satisfaction with Employer Response	Supervisor/ Employer Reaction (positive)	Support, Work Resources- Moos
NIOSH work qu., social support	.28	.07	-.05
Satisfaction with Employer Response		.74***	.45**
Supervisor/ Employer Reaction (positive)			.30*

* $p < .05$ ** $p < .01$ *** $p \leq .001$

Table 8 Correlations Among Job Stress Measures (Physical/Psychosocial)

	Job Stress: Anger/Blame	NIOSH work qu., Job Future Ambiguity	Job Stress: Job Support	NIOSH work qu., physical and mental exhaustion	Job Stress: NIOSH work qu., work pressure	Job Stress: Workstyle, cognitive (Total)	Job Stress: Work Stressors-Moos
Job Stress: Anger/Blame a		-.35*	.39**	.21	.35*	.35*	-.44**
NIOSH work qu., Job Future Ambiguity			-.26	-.14	-.13	-.21	-.03
Job Stress: Job Support				.16	.25	.19	-.61***
NIOSH work qu., physical and mental exhaustion					.40**	.33*	.03
Job Stress: NIOSH work qu., work pressure						.35*	-.17
Job Stress: Negative Workstyle, cognitive (Total)							-.11

* $p < .05$ ** $p < .01$ *** $p \leq .001$
a reverse-scored item, the higher the score, the lower the employer-directed anger/blame.

Table 9

Correlations Among Measures of Ergonomic Stressors and Workplace Accommodations

	Ergo Accomm 1 (Habeck)	Ergo Accomm 2 (New)	Ergo Workstyle (cognitive)
Ergonomic Stressors Total	-.44*	-.13	.34*
Ergo Accomm 1 (Habeck)		.23	-.23
Ergo Accomm 2 (New)			-.14

* $p < .05$ ** $p < .01$ *** $p \leq .001$

Table 10 Correlations Among Measures of Activity/Function

	Functional Status Scale [a]	SF-36 [b]	UEFS [c]
Functional Status Scale		-.60***	.93***
SF-36			-.67***

* p < .05 ** p < .01 *** p ≤ .001

a Higher score = higher perceived functional impairment

b SF-36 = the SF-36 Health Survey; Higher score = Higher perceived health

c UEFS = the Upper Extremity Function Scale; Higher score = higher perceived functional impairment

Table 11 Correlations Among Measures of General Distress/Mental Health

	STAI [a]	MHI-5 [b]	Premorbid Life Stressors Q343
STAI		-.43**	.22
MHI-5			-.23

* $p < .05$ ** $p < .01$ *** $p \leq .001$

[a] STAI = Stait-Trait Anxiety Inventory, (trait version); Higher score = Higher Trait Anxiety.
[b] MHI-5 = the Mini Mental Health Index, a five-item subscale of the SF-36 Health Survey: Higher score = Higher Mental Health.

Table 12 Correlations Among All Independent and Predictor Variables

	age	atty	educ	gend	pwc	hctxhx	ued sites	bmi	grip	sss	fss	wsm	wd qwl	wrm	borg	ergo	catast	mhi-b	dmw-b	wk fua9	sssfua	fssfua
age																						
atty	-.31*																					
educ	-.15	-.04																				
gend	-.03	-.24	.16																			
pwc	.09	-.26	-.05	.18																		
hctxhx	-.10	.53**	.10	-.11	.01																	
ued sites	-.04	.33*	-.22	-.18	-.14	.35*																
bmi	.02	.07	-.17	-.06	.21	.33*	.17															
grip	-.19	-.29*	.17	.66**	.24	-.47**	-.33*	-.06														
sss	-.11	.14	.28*	-.18	.01	.29*	-.07	.33*	-.25													
fss	.06	.29*	.34*	-.17	.15	.55**	.03	.40**	-.44**	.64**												
wsm	-.15	-.34*	.02	.21	-.14	-.49**	-.16	-.30*	.32*	-.20	-.49**											
wdqwl	-.35*	-.01	.27	-.02	-.11	-.15	-.16	-.07	-.03	-.10	-.11	.14										
wrm	-.17	.26	.22	-.23	-.05	.01	-.22	-.25	-.09	.16	.26	-.42**	.44**									
borg	.13	-.06	-.14	.02	.16	.07	.15	.38**	-.25	.50**	.38**	-.18	.13	.38**								
ergo	-.30*	.35*	.05	-.06	.02	.02	.07	.24	-.03	.46**	.29*	-.04	.53**	.00	.01							
catast	.13	.06	.07	-.15	.04	.15	.07	.38**	-.17	.65**	.50**	-.16	.28*	.14	44**	.50**						
mhi-b	-.24	-.01	-.03	.12	-.05	-.40**	-.37*	-.33*	-.25	-.33*	-.57**	.20	.20	-.31*	-.31*	.01	-.31*					
dmw-b	-.17	.46**	-.10	-.03	.24	.14	.25	.41**	-.03	.38**	.24	-.19	.31*	.35*	.30*	.62**	.37*	-.43**				
wkfua9	-.16	.56**	.08	-.24	.20	.13	.46**	-.01	-.25	.40**	.26	-.02	.06	.06	.17	.38**	.22	-.09	.62**			
sssfua	.01	.34*	.13	.08	.07	.45**	.22	.20	-.17	.61**	.71**	-.36*	.06	.18	.54**	.60**	.71**	-.41**	.36*	.31*		
fssfua	.30*	.26	.20	-.15	.13	.50**	.16	.22	-.40**	.47**	.80**	-.51**	-.10	.10	.47**	.15	.49**	-.53**	.18	.21	.75**	
mhifua	-.33*	-.03	.07	.18	-.01	-.26	-.31	-.50**	.36*	-.50**	-.55**	.22	-.20	-.11	-.59**	-.21	-.51**	.78**	-.47**	-.31*	-.58**	-.72**

* $p < .05$ ** $p < .01$

note. atty = attorney consultation; educ = education, in years; gend = gender; pwc = prior worker's compensation injury; hctxhx = healthcare treatment history-number of treatments ever attempted for any symptoms of an upper extremity disorder; uedsites = number of sites of any upper extremity disorder by history; bmi = body mass index; grip = dominant-hand grip strength; sss = symptom severity scale; fss = functional status scale; wsm = work stressors subscale-Moos; wdqwl = work demands, NIOSH quantity of workload subscale; wrm = work resources subscale-Moos; borg = borg scale, degree of exertion associated with a typical workday; ergo = ergonomic stressor exposure-Pransky et al.; catast = the catastrophizing subscale of the Coping Strategies Questionnaire; mhi-b = the baseline questionnaire measure of the mini mental health index, a five-item subscale of the SF-36 Health Survey; dmw-b = the baseline measure of days missed work, past month; wkfua9 = the outcome measure of days missed work, past month; sssfua = the outcome measure of the symptom severity scale; fssfua = the outcome measure of the functional status scale; mhifua = the outcome measure of the mini mental health index.

Table 13 <u>Predictors of Lost Work at One Month</u>

Model	R	R Square	Adjusted R Square	Standard Error of the Estimate	R Square Change	F Change	p value	Beta
Age								
Attorney Consultation	.560	.314	.287	2.37	.314	11.89	.002	.250
Education								
Prior WC Injury								
Gender								
Healthcare Treatment History								
UEDSites a	.629	.396	.348	2.26	.082	3.40	.08	.270
Days Missed Work	.735	.541	.483	2.02	.145	7.56	.01	.550
Body Mass Index	.775	.601	.532	1.91	.061	3.50	.07	-.536
Grip Strength								
Symptom Severity Score	.868	.753	.696	1.54	.151	13.45	.001	.453
Functional Status Score								
Work Stressors, Moos								
Work Demands, Quantity of Workload								
Borg scale, Physical Exertion, typical workday								
Ergo Stressors								
Catastrophizing								
MHI-5								
Support-work resources, Moos b	.894	.799	.741	1.43	.046	4.79	.04	

note: Predictors are listed in the order in which they were entered into the regression.
Data for the statistically significant predictors retained in the model are listed.
a UEDSites = Number of Sites of Diagnosed Upper Extremity Disorder, by history
b Lower score = more negative work environment

Table 14 <u>Predictors of Pain/Symptoms at One Month</u>

Model	R	R Square	Adjusted R Square	Standard Error of the Estimate	R Square Change	F Change	p value	Beta
Age								
Attorney Consultation								
Education								
Prior WC Injury								
Gender								
HCTXHX [a]	.451	.203	.170	.687	.203	6.12	.02	.146
UEDSites								
Symptom Severity Score	.672	.452	.404	.582	.249	10.43	.004	.100
Grip Strength								
Body Mass Index								
Functional Status Score	.749	.562	.502	.532	.110	5.51	.03	.420
Work Demands, Quantity of Workload								
Work Stressors, Moos								
Borg Physical Exertion, typical workday	.882	.778	.722	.398	.038	3.46	.08	.217
Ergonomic Stressors, Pransky	.860	.740	.690	.420	.178	14.35	.001	.396
Catastrophizing								
MHI-5								
Work Resources, Moos								

<u>note</u>: Predictors are listed in the order in which they were entered into the regression. Data for the statistically significant predictors retained in the model are listed.

[a] HCTXHX = Healthcare Treatment History-the number of attempted treatments ever tried for any upper extremity disorder symptoms.

Table 15 Predictors of Functional Impairment at One Month

Model	R	R Square	Adjusted R Square	Standard Error of the Estimate	R Square Change	F Change	p value	Beta
Age, in years	.614	.377	.325	.847	.126	4.84	.04	.199
Attorney Consultation								
Education								
Prior WC Injury								
Gender								
HCTXHX a	.501	.251	.221	.910	.251	8.39	.008	.044
UEDSites								
Functional Status Score	.839	.705	.666	.596	.328	25.53	.00	.671
Grip Strength								
Body Mass Index								
Symptom Severity Score								
Work Stressors, Moos b	.872	.761	.717	.548	.056	5.14	.03	-.274
Work Demands, Quantity of Workload								
Borg Scale, Physical Exertion, typical workday								
Ergo Stressors								
Catastrophizing								
MHI-5								
Work Resources, Moos								

note: Predictors are listed in the order in which they were entered into the regression.
Data for the statistically significant predictors retained in the model are listed.
a HCTXHX = Healthcare Treatment History; the number of treatments ever attempted for symptoms of an upper extremity disorder.
B Higher score = more negative work environment

Table 16 Predictors of Mental Health at One Month

Model	R	R Square	Adjusted R Square	Standard Error of the Estimate	R Square Change	F Change	p value	Beta
Age, in years	.332	.110	.079	4.154	.110	3.47	.07	.109
Attorney Consultation								
Education								
Prior WC Injury								
Gender								
HCTXHX								
UEDSites a	.458	.210	.151	3.986	.099	3.40	.08	.192
MHI-5 b	.785	.617	.573	2.829	.407	27.61	.000	.000
Grip Strength								
Body Mass Index								
Symptom Severity Score	.846	.715	.669	2.488	.098	8.62	.007	.007
Functional Status Score								
Work Stressors, Moos								
Work Demands, Quantity of Workload								
Borg Scale, Physical Exertion, typical workday								
Ergo Stressors								
Catastrophizing								
Work Resources, Moos								

note: Predictor are listed in the order in which they were entered into the regression.
Data for the statistically significant predictors retained in the model are listed.
a UEDSites = Number of Sites of Upper Extremity Disorder, by history
b Higher score = Higher Mental Health

Table 17 Test Re-Test Reliability of the Predictor Variables

Item/Measure	r	alpha
Workdays Missed in the Past Month	.95	.97
Medical Status-Number of UED sites by history	.83	.83
Medical Status-Healthcare Treatment(s) History	.87	.94
Work Demands-Ergonomic Stressors	.65	.65
Pain/Symptoms-(SSS)	.80	.81
Activity/Function-(FSS)	.94	.89
Work Stressors (Moos)	.66	.73
Work Demands, Quantity of Workload	.41	.80
Physical Exertion, Typical Workday (Borg)	.60	.62
Ergonomic Stress Exposure (Pransky et al.)	.65	.60
Mental Health-(MHI-5)	.65	.44
General Distress-Catastrophizing	.56	.64
Work Resources (Moos)	.83	.91

IMAGE EVALUATION TEST TARGET (QA-3)

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