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Occupational Epidemiology of Carpal Tunnel Syndrome

August 22, 1994

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Sponsors
National Institute for Occupational Safety and Health
UCLA Center for Occupational and Environmental Health
UCLA Injury Prevention Research Center

Grant Number
SOH (AHR-S1) 5 R03 OH02765-02

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List of Abbreviations

CTD	Cumulative Trauma Disorder
CTS	Carpal Tunnel Syndrome
95% CI	Ninety Five Percent Confidence Interval
EGRET	Epidemiologic Graphics, Estimation, and Testing Package
EMG	Electromyography
POR	Prevalence Odds Ratio
SAS	Statistical Analysis System
SEIU	Services Employees International Union
UCLA	University of California, Los Angeles

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Significant Findings

Cross-Sectional Survey

- The prevalence of self-reported hand/wrist symptoms was high among all three occupational groups examined in this study. 12% of court reporters, 16% of data entry staff, and 17% of clerks/technical staff reported hand/wrist symptoms consistent with CTS (pain, tingling and numbness occurring at least once a week). Sprinkler fitters and carpenters had symptoms prevalences of 17% and 12%.

- Hours of computer or stenographic keyboard use were associated with self-reported hand/wrist symptoms. This association persisted after controlling for age, duration of employment and personal/medical factors. This effect was higher among court reporters and data entry staff than among clerks and other technical staff.

- Among carpenters and sprinkler fitters, hand/wrist symptoms were associated with self-reported repetitive motion activities. However, information collected on power and hand tool use and the number of hours worked per week could not explain the association between reported repetitive motion activity and hand/wrist symptoms.

- The prevalence of hand/wrist symptoms increased with age among office worker occupations (reaching a peak among 50-59 year olds), however, among trade workers occupations, the prevalence was highest in the 30-39 year old group and decreased among older workers.

- The likely explanations for the age trends are an increasing susceptibility among older female office workers and healthy worker selection among trade workers. Sprinkler fitters and carpenters who experience symptoms are likely to move into other occupations and therefore our sample would not have included older workers likely to report symptoms.

- Inverse associations between age and hand/wrist symptoms and between job duration and hand wrist symptoms suggest that health worker selection is an important phenomenon among sprinkler fitters and carpenters. This potential bias limits our ability to assess the impact of workplace exposures and hand/wrist symptoms. Our attempts to assess healthy worker selection by examining symptoms occurrence among retired workers were not successful because nearly all of the retired workers participating in this survey had retired many years ago and workplace exposures were no longer relevant to current symptoms status.

- Several personal and medical factors were associated with hand/wrist symptoms, however, they did not act as confounders in the associations between workplace exposures and hand/wrist symptoms consistent with CTS. Arthritis, a history of wrist sprain, a history of hysterectomy or oophorectomy, and obesity were factors modestly associated with hand/wrist symptoms.

- Psychosocial work factors were divided into four domains: decision latitude, job demand, social support and job satisfaction. A stressful psychosocial work environment was associated with increased prevalence of musculoskeletal symptoms. Job demand and job satisfaction were consistently associated with hand/wrist symptoms, neck/shoulder pain, and low back pain.

- The effect of job demand appeared to be stronger in females than in males. High job demand also produced greater effects among workers with low decision latitude than with high decision latitude.

Case Control Study

- The reporting of CTS-like symptoms varied substantially between the two surveys in this study. Among respondents who participated in both the cross-sectional survey and the case control study, 46% of respondents who reported symptoms of pain, tingling, and numbness in the hand/wrist area in our cross-sectional survey did not have all of these symptoms a year later in our follow-up case-control study. 10% of the respondents who reported no symptoms during the first survey reported CTS-like symptoms in the case-control study.

- We observed little association with electrodiagnostic findings and standard clinical tests for CTS (Tinel's and Phalen's). Based on a clinical evaluation of electrodiagnostic results, 13% of the clinically determined CTS cases were positive on Tinel's test and 31% were positive on Phalen's test. The false positive rates on these tests were 14% for Tinel's test and 34% for Phalen's test.

- The presence of self-reported hand/wrist symptoms (pain, tingling, and numbness) was not associated with a positive finding on electrodiagnostic studies. 48% (23 participants) of those reporting symptoms (n=44) were classified as normal by electrodiagnostic criteria. Of those not reporting symptoms (n=92), 45% were classified as positive by electrodiagnostic criteria.

- Agreement between two physicians in classifying CTS based on EMG findings was moderate. The weighted kappa coefficient for the two physician raters was 0.61. This suggests that even with more objective criteria, the classification of CTS is difficult in epidemiologic studies and in clinical practice.

Abstract

Carpal tunnel syndrome (CTS) is one of the most commonly reported and widespread of the cumulative trauma disorders. This study was designed to examine the magnitude of symptoms suggestive of CTS among trade occupations and office workers. Work-related factors, medical conditions, and CTS diagnostic indicators were also evaluated. Data entry operators, court reporters, clerical staff, carpenters, and sprinkler fitters were selected to represent a range of ergonomic exposures. The study design involved a cross-sectional survey (Phase I) followed by a nested case-control study (Phase II). The data collected in the Phase I questionnaire and Phase II personal interview included detailed work history and job task information, demographic data, hand/wrist and other musculoskeletal symptoms, medical conditions, reproductive factors, psychosocial factors, and recreational activities. In the case-control study, clinical tests (Tinel's and Phalen's tests) and electrodiagnostic exams were given in addition to the personal interviews. We examined the prevalence of symptoms consistent with carpal tunnel syndrome (CTS) in a cross-sectional survey among 529 county office workers and 667 active trade workers and 136 retired trade workers from two unions representing carpenters and sprinkler fitters. Because the overall response rate in Phase I was only 35%, these results must be interpreted cautiously. Although we conducted a phone survey of non-respondents, these results have not yet been fully analyzed to assess the amount of non-response bias.

We estimated the effects of the hours per day using computer keyboards and amount of time involved in repetitive motion activities of the hand and wrist on symptoms consistent with CTS. Work task information was collected for the hours per day using power and hand tools, hours per day working above shoulder level, and hours per day involved in repetitive motion activities. Clerks and technical staff had the highest symptom prevalence. The prevalence of hand/wrist symptoms suggestive of CTS was 12% and 17% for carpenters and sprinkler fitters. Among office workers, the odds ratios for hours of keyboard use were higher among court reporters and data entry staff than among clerks and technical staff. The prevalence of CTS symptoms increased for up to ten years of work experience, but decreased after that period, suggesting healthy-worker selection bias. Controlling for age, duration of employment and personal/medical factors, the prevalence odds ratios (POR) and 95% confidence intervals (95% CI) for keyboard use and repetitive motion exposures among all county workers were elevated [POR=1.9 95% CI(1.1, 3.3) and POR=2.2, 95% CI (1.0, 4.9)]. For keyboard use, the odds ratios for court reporters and data entry staff were higher than for clerks and technical staff [POR=5.1, 95% CI (1.3, 19.2), POR=2.2 (0.6, 8.4), and POR=1.4, 95% CI(0.6, 3.4)] respectively. Among trade workers, the prevalence odds ratios (PORs) and 95% confidence intervals (CI) for the worker's assessment of repetitive motion activities were 3.2 and (1.6, 6.3)].

This association was not explained by specific work exposures. The number of hours worked per week was inversely associated with CTS symptoms. Power tool and hand tool use were modestly associated with CTS symptoms, however exposure response

trends were not consistent. CTS symptoms decreased with increasing age, and decreased with increasing length of employment. These patterns were consistent for both carpenters and sprinkler fitters. Our results suggest that musculoskeletal symptoms are higher among these occupations than indicated by studies of workers compensation data and that healthy worker selection limits our ability to estimate the effects of workplace exposures on CTS symptoms.

Many occupational studies of carpal tunnel syndrome (CTS) have not addressed the potential confounding effects of personal and medical factors, yet these factors could distort the relationship between workplace repetitive motion and physical demands exposures and CTS. In this study, we evaluated the effects of medical conditions, previous injury, reproductive factors, and other personal factors on the occurrence of CTS symptoms and as confounders for occupational exposures. Several medical conditions and previous injuries were associated with CTS symptoms including rheumatoid arthritis, ganglionic cysts, nerve damage, tendinitis, wrist sprains, and injuries to the hand/wrist. Obesity, measured by the body mass index, was slightly associated with CTS symptoms. For women's reproductive factors, a history of hysterectomy or oophorectomy were modestly associated with CTS symptoms, whereas there was no association with a history of other gynecological surgeries and birth control pill use. Hours of keyboard use and time involved in repetitive tasks were important risk factors in these worker populations. However, previous injuries, medical conditions and other personal factors, although associated with CTS symptoms, were not confounders for the effects of these exposures on CTS symptoms. Although the effects of job-related risk factors were not strongly influenced by medical conditions or previous injury in this population, future occupational studies need to address both occupational and personal/medical factors to properly estimate the effects of occupational exposures on CTS on different worker populations.

Indicators of psychosocial work factors were developed from questions on decision latitude, job demand, social support, and job satisfaction. Job demand and job satisfaction were consistently associated with hand/wrist symptoms, neck/shoulder pain, and low back pain. The effects of job demand were modified by sex and decision latitude; the effect of job demand was higher in females than males and higher among workers with low decision latitude than with high decision latitude.

The diagnosis and classification of CTS is complex even when symptom information, clinical tests, and electrodiagnostic exams are available. We observed little association between Phalen's and Tinel's tests and electrodiagnostic findings. Symptom reporting was also not well correlated with the clinical and electrodiagnostic tests, nor was symptom reporting consistent from one year to the next. Nearly half of the study participants who reported CTS-like symptoms in the Phase I survey did not report the exact same symptoms a year later in the Phase II case-control study. The difficulties in determining CTS is one of the most challenging aspects of future occupational studies of CTS.

Background

Carpal tunnel syndrome (CTS) is one of the most commonly reported upper extremity disorders. CTS is a peripheral neuropathy that results from the compression or irritation of the median nerve as it passes through the carpal canal of the wrist. The symptoms of CTS include numbness and tingling in the fingers and thumb, pain in the hand and in more severe untreated cases, loss of hand function and strength (Dawson et al., 1983).

Worker compensation claims for upper extremity musculoskeletal problems increased dramatically in the latter half of the 1980s (Rempel et al., 1992). There is an ongoing debate whether these musculoskeletal injuries are the result of increased workplace exposures, reporting changes, or other factors (Gerr et al., 1992; Nathan and Keniston, 1992; Hadler 1990, 1992; Hagberg, 1992). According to some researchers, these reporting changes could have been largely influenced by the media and the use of the term "cumulative trauma disorder" by the Occupational Safety and Health Administration [OSHA] (Hadler 1990). Undoubtedly, increased awareness has led to increased reporting of CTS.

The introduction of the computer into the modern office has substantially changed office worker exposures. We see increased specialization, such as the development of exclusive data entry and text processing occupations, and an increase in editing and rewriting of documents, and the constant pressure to improve worker productivity. We have also seen increasing computer keyboard demands among telecommunication workers and other customer service representatives in a variety of service industries.

Numerous studies have related various occupational exposures with increased risks of CTS and upper extremity musculoskeletal disorders. These studies found associations between CTS and upper extremity musculoskeletal disorders and exposures involving repetitive motion, high forces, vibration, and constrained posture (Arndt, 1987; Calif Occup Health, 1990; Cannon et al., 1981; Chaing et al., 1990; Falck et al., 1983; Feldman et al., 1987; Finkel et al., 1985; Franklin et al., 1991; Morgenstern et al., 1991; Ohlsson et al., 1989; Osorio et al., 1989;, Punnet et al., 1985; Silverstein et al., 1987; 1987a; Sokas et al., 1989; Vihma, 1982; Wieslander et al., 1989; Wilkes et al., 1981). Other researchers using nerve conduction studies as the basis for defining CTS have not observed elevated associations between occupational exposures and CTS (Nathan 1988; Schottland et al. 1991). However, reduced nerve conduction velocities have been associated with grocery checker work (Osorio et al., 1989).

Several occupational groups, whose work involves high repetition and/or high force exposures, such as butchers, poultry workers, assembly workers, and grocery checkers, have been studied extensively (cf. Gerr et al., 1991; Stock, 1991). Generally these occupations' work involves a limited number of distinct tasks and fairly constant task

duration. On the other hand, trade workers job tasks are more often heterogenous and the task durations can be quite variable. The cumulative repetitiveness, forces, and vibrations resulting from the range of tasks among trade workers could produce CTS at levels similar to what has been observed in other industrial workers. However, these occupations have not been well studied to test this hypothesis (Hagberg et al., 19902. In the analysis of occupational compensation claims among worker classifications in Washington state, carpentry had the fifth highest CTS rates. The four types of workers that had higher rates of CTS than carpentry were involved with fish or poultry processing and packing (Franklin et al., 1991). Underreporting of CTS and other musculoskeletal disorders among construction workers and carpenters is likely to be a more serious problem than among other occupations because of the instability of the industry and the many small independent and self-employed contractors involved in these trades. With such underreporting, traditional surveillance systems, such as occupational claims compensation databases, may not accurately reflect the extent of CTS among carpentry and construction workers.

Although computer keyboard keys require less force than typewriters and other machines, considering the thousands of keystrokes workers perform, the cumulative forces involved with keyboard use will be high. These trends suggest that worker exposures have increased and have the potential for adverse health impacts and are not simply an artifact of reporting.

Studies conducted among computer operators or video display terminal (VDT) users and other key machine users such as postal workers and accountants, have observed increased risks of CTS and upper extremity musculoskeletal disorders associated with repetitiveness, posture, and work stress factors (Bernard et al., 1992; Calif OHP, 1990; Duncan and Ferguson, 1974; Heyer et al., 1990; Knave et al., 1985; Maeda et al., 1980; National Institute of Occupational Safety and Health (NIOSH), 1993; NIOSH, 1990; Rempel et al., 1991; Rossignol et al., 1987). In these studies elevated odds ratios for CTS or upper extremity cumulative trauma disorders were observed for hours spent on the keyboard, typing speed, data entry versus interactive keyboard use, occupation, department, and work organization factors. Early studies among office workers usually obtained only limited pain symptom information for the upper extremities. Recent NIOSH studies have expanded and refined the questions for recording pain symptoms to more clearly define the type of upper extremity musculoskeletal disorder. The office workforces that NIOSH has studied have been newspaper reporters and newspaper editorial staff, which may or may not be representative of office environments in private industry or public agencies. Additional epidemiologic studies are needed among "general" office workers.

The studies among newspaper staff and postal workers and studies among other worker groups, assembly line workers, grocery checkers butchers, poultry workers, food production workers, and garment workers are supportive of a biomechanical etiology of CTS (Chaing et al., 1990; Falck et al., 1983; Feldman et al., 1987; Finkel et al.,

1985; Franklin et al., 1991; Morgenstern et al., 1991; Ohlsson et al., 1989; Osorio et al., 1989; Punnet et al., 1985; Silverstein et al., 1987; Sokas et al., 1989; Vihma 1982; Wilkes et al., 1981; Wieslander et al., 1989). However, several studies that used nerve conduction studies as the basis for defining CTS, did not find an association between occupational exposures and CTS (Nathan 1988; Schottland et al., 1991). Also, in the analyses of state occupational compensation claims, investigators have not detected excess risks for CTS among office worker occupations (Franklin et al., 1991; Frazer et al., 1992).

Some researchers have claimed that there is little empirical evidence for an occupational biomechanical etiology for CTS (Hadler 1990, 1992). They have emphasized the negative findings of occupational studies using nerve conduction measurements, and that positive studies rely on a CTS definition with neurodiagnostic confirmation. However, despite limitations in case ascertainment most research indicates that repetitive motion, high force, or constrained posture exposures are risk factors for upper extremity disorders and CTS (Ardnt 1987; Duncan and Ferguson, 1974; Feldman et al., 1983; Gerr et al., 1991; de Krom et al., 1990; Stock 1991; Hagberg et al., 1992; NIOSH, 1993; NIOSH, 1990). The formulation of public policy, such as a general workplace ergonomic standard, will require a better understanding of the biomechanical, psychological, and other workplace organizational factors that influence CTS and upper extremity musculoskeletal disorders. This understanding is needed to develop regulations and policy that will emphasize improvements that have the most beneficial and cost-effective impacts on CTS.

Despite substantial publicity on the issue of cumulative trauma injuries and VDT use, there are still only a small number of published epidemiologic studies among these workers.

The argument of those who discount the occupational etiologies of CTS is that other health conditions are responsible for the majority of CTS occurrence (Nathan, 1992; Nathan and Keniston, 1992; Hadler 1990; 1992). In the National Institute of Occupational Safety and Health (NIOSH) Sentinel Event Notification System for Occupational Risks (SENSOR) CTS is labeled as "work-related" if the worker is involved in an occupation with repetitive motions, high forces, awkward positions or vibration exposures (Baker et al., 1990). It has been recommended that to establish the work-relatedness of CTS, any CTS case associated with other medical conditions should be excluded (Rempel et al., 1992). The intention of such study designs and surveillance recommendations is to assure that the associations between occupational factors and CTS are not confounded by underlying medical conditions (Silverstein et al., 1987, Stock, 1992, Rempel et al., 1992). Yet, a large portion of CTS cases (potentially related to occupational exposures) could be excluded when using these guidelines, and the subsequent publicity of occupational factors may minimize the importance of other non-occupational factors (Nathan, 1992). CTS, like many other diseases and injuries, has a multifactorial etiology (Table 1 and Figure 1). From a clinical perspective CTS may be attributable to a particular cause or associated condition (Dawson et al., 1983),

however it is not possible to affirm whether a particular case of CTS was due to one specific component cause. CTS could result from occupational factors, medical conditions, previous injuries and combinations of these factors (Figure 1 and Table 1).

In the analysis of occupational risk factors for CTS, the exclusion of workers with CTS who also have medical conditions, previous injuries or other factors believed to be associated with CTS may bias the true estimates of occupational risk. For example, without controlling for potential confounders, the effects of occupational exposures may not be accurate. A better analytical strategy is to include CTS cases and use stratification or modelling procedures to estimate the effects of occupational exposures, while controlling for other personal and/or medical factors.

Underlying Mechanisms

The carpal canal is a narrow space that contains numerous tendon fibers and the median nerve (Dawson et al., 1983). The effects of most risk factors probably occurs through a process that leads to increased pressure in the carpal canal area. In figure 1 we present a potential framework to illustrate how these factors may interact with each other and how potential risk factors are related to underlying mechanisms and could lead to the expression of CTS symptoms or decreased nerve conduction velocity. The increased pressure can result from a variety of processes including fluid retention, space occupying mechanisms, inflammation, and biomechanical mechanisms (Figure 6 and Table 13). Other pathways may involve increased nerve sensitivity or biochemical actions and may not act to directly increase carpal canal pressure. Other factors such as neurotoxic exposures may act directly on nerve conduction velocity without producing CTS symptoms.

Among women, pregnancy and hormonal changes probably act to influence CTS via fluid retention mechanisms. Tendon sheath inflammation (tenosynovitis), inflammation due to arthritis, scar tissue from previous injuries, and space-occupying lesions such as cysts or cancer, all act to diminish the available space in the carpal canal. Occupational biomechanical factors such as awkward positions or repetitive movements can increase carpal canal pressure (Armstrong et al., 1979; Rempel et al., 1992). Hand dominance is a surrogate measure for hand use and biomechanical stresses (Kucera and Robbins, 1989; Nathan et al., 1992 Reinstein et al., 1981). The dominant hand, because it is exposed to more stress and higher use in work and leisure activities would, in theory, have higher CTS symptoms. Potential risk factors or conditions we have labeled as susceptibility factors include carpal canal size, diabetes, nerve degeneration and obesity. Other potential mechanisms involve increased nerve sensitivity or biochemical factors (Dieck and Kelsy, 1985; Dawson et al., 1983; Folkers et al., 1978).

Few studies have simultaneously examined occupational exposures and personal factors and medical conditions. In studies that have, there have been mixed results. In a

studies among five occupational groups (administrative/clerical, data entry, assembly, plant workers and grinders), the authors concluded that the only consistent associations were between personal factors (age, gender, and obesity) and CTS (Nathan et al., 1988, 1992 and 1992a). Other studies have identified both personal and occupational factors associated with CTS (Cannon et al., 1981, de Krom et al., 1990). In the Cannon and de Krom studies, the occupational factors associated with CTS were: use of vibration tools, performance of repetitive tasks, and wrist posture. Personal factors associated with CTS in these two studies included height and weight, and factors associated with women only, a history of gynecological surgery, and recent menopause (Cannon et al., 1981, de Krom et al., 1990).

Clinical studies among CTS patient populations have suggested that many health conditions are associated with CTS (Dawson et al., 1983; Stevens et al., 1992. Also see Table 1). Several of these conditions, such as women's reproductive factors, pregnancy, diabetes, obesity, gender and other factors have been associated with CTS in epidemiologic studies (Cannon et al., 1981; Dieck and Kelsey 1985; Nathan et al 1992b; Vessey et al., 1990; Ekman-Orberg et al ., 1987; Pascual et al., 1991). However, there have been few population-based epidemiologic studies that had sufficient sample sizes to evaluate occupational, medical and personal factors associated with CTS.

Our study population, which included more than 1100 active trade and office workers, provided an excellent opportunity to evaluate the relationships between occupational and other medical or person factors and CTS symptoms.

Research Objectives

Cumulative trauma disorders (CTDs) have emerged as important occupational health problems in today's environment of increasing occupational specialization and productivity demands. The overall goal of this research is to provide further epidemiologic information and insight on CTS and its potential occupational risk factors. This information will be valuable in assessing the needs and priorities for future prevention and intervention programs, and highlighting areas that need further research.

Our purpose was to provide epidemiologic information about the occurrence of hand/wrist symptoms suggestive of CTS in county office workers and the trade worker occupations: sprinkler fitters and carpenters. By examining office workers who report a range of keyboard use, we could test the hypothesis that increased use of computer keyboards results in increased symptoms suggestive of CTS. Our goal was to examine the associations between CTS symptoms and keyboard use while controlling for other important confounding factors that have not been addressed in earlier studies.

For trade workers, our purpose was to assess the magnitude of musculoskeletal symptoms among carpenters and sprinkler fitters. We wanted not only to examine CTS symptoms by occupational group, but also to study specific exposures and job tasks that could explain the occurrence of CTS symptoms.

The first objective was to provide epidemiologic information regarding the frequency of symptoms suggestive of CTS in occupational groups which have not received substantial epidemiologic research, but are of concern based on case reports and ergonomic studies. The occupational groups of interest were: office worker occupations (data entry operators and court clerks) and skilled trade occupations (carpenters and sprinkler fitters). These occupational groups would be expected to experience relatively higher risk of CTS based on ergonomic considerations of the work demands. The prevalence rates of CTS will be estimated and compared among these selected occupational groups, chosen to represent a range of occupational repetitive motion and postural demands on the upper extremities.

The second research objective was to examine the effects of job task factors on the occurrence of hand/wrist symptoms.

The third research objective was to estimate the effects of other factors on CTS occurrence such as past medical history, personal lifestyle, and hormonal factors, examining these other risk factors as confounders and/or modifiers of the effects of occupational risk factors.

The examination of clinical and diagnostic issues relating to carpal tunnel syndrome is the fourth research objective. This will be achieved through comparison of results

derived from self-reporting of symptoms, clinical tests, and electrodiagnostic testing of median nerve sensory and motor conduction.

The fifth research objective was to address the issue of "the health worker effects" with respect to these clerical and trade occupations, and in the context of CTS research utilizing a cross-sectional survey design. Most previous research has only been able to address the "health worker effect" or "healthy worker selection/survival" bias in a qualitative sense. Our original goal was to identify a group of inactive employees and estimate their hand/wrist symptom prevalence rates and prevalence odds ratios. BY comparing inactive to active workers, we could indirectly estimate the magnitude of the healthy worker selection bias. We were not able to realize this objective because the sample of retired workers included very few people who retired recently for whom the proposed analysis would have been valid. Instead most of the retired workers who responded to our survey retired many years ago.

Our sixth research objective was to evaluate the relationships between psychosocial factors and musculoskeletal symptom reporting.

Abbreviated electrodiagnostic testing will be used to examine clinical and diagnostic issues of CTS through comparisons of results derived from self-reporting of symptoms, clinical tests and the median nerve sensory and motor nerve conduction tests.

This epidemiologic information will help to establish future intervention and prevention programs and to identify further research needs.

Methods

To achieve the study goals and objectives a two stage study design was utilized. The first stage was a cross-sectional survey involving a mailed questionnaire to 4000 union members selected from four different unions representing five occupational groups. The second phase is a nested case-control study that involves in-depth interviews, neurodiagnostic testing and clinical examinations. In the case-control study we interviewed 69 cases and 68 controls. Each study phase is described below.

Cross-Sectional Survey

This study is part of an ongoing research project designed to assess the magnitude of symptoms suggestive of CTS and other musculoskeletal symptoms among trade workers (carpenters and sprinkler fitters) and office workers (court reporters and office staff). In the first phase of this project, we conducted a cross-sectional survey among union workers.

Study Population

The study population was selected from the membership of three Los Angeles area unions. Two of the unions represent carpenters and sprinkler fitters (Local 409 and Local 709). The third union, Service Employees International Union (SEIU, Local 660), represents Los Angeles County workers.

The study population was selected from the membership of three Los Angeles area unions. Two of the unions represent trade workers (carpenters and sprinkler fitters, Local 409 and Local 709), and the third union, Service Employees International Union (SEIU, Local 660) represents Los Angeles County office workers.

From union rosters, we selected all sprinkler fitters, a random sample of construction carpenters, and a stratified random sample of county office workers, in which we defined the strata by job titles. Based on union record job titles, we selected all court reporters, a random sample of workers with computer operator/data entry job titles, and a random sample of workers with technical/administrative job titles. We selected a total of 4400 names from the three union rosters: 1129 sprinkler fitters, 1189 carpenters, and 2082 from the county workers' union, Local 660, which represents office workers.

A self-administered questionnaire was mailed to all selected union members. Union members who did not respond to the first mailing were mailed questionnaires up to two more times if necessary. For the first two mailings, post card reminders were also mailed one week after the questionnaire.

About 90% of sprinkler fitters in Southern California are union workers. A much smaller proportion of carpenters are union workers. In this geographic area, union carpenters tend to work more on large-scale public construction projects, such as roads and transportation systems. Local 660 staff estimate that approximately 90% of county workers in non-management office positions are represented by the union. The response rates varied by occupation and union group. For court reporters (part of the Los Angeles County workers), the response rate was 51%, for sprinkler fitters 45%, for office staff (Los Angeles county workers) 32%, and for carpenters 22.3%. The overall response rate was 35%.

Union rosters contained addresses for active and retired workers. We selected all members of the sprinkler fitters union (Local 709), and a random sample of 900 active construction carpenters and 300 retired carpenters. We were interested not only in CTS symptoms occurrence among active trade workers, but also in comparing CTS symptom prevalence between recently retired workers and active workers.

This study was based on union records for administrative and practical considerations. Trade workers can work at multiple job sites often for different contractors. Any attempts to identify a sufficiently large occupational cohort scattered across numerous job sites would have been impractical. On the other hand, the unions had information centralized in their records. In the greater Los Angeles area approximately 90% of the sprinkler fitters are union members and an unknown percentage of carpenters are represented by the carpenters union.

A self-administered questionnaire was mailed to all selected union members. The questionnaire was modeled after questionnaires used in previous research on musculoskeletal disorders (Kourinka et al. 1987). Union members who did not respond to the first mailing were mailed questionnaires up to two more times if necessary. For the first two mailings, post card reminders were also mailed one week after the questionnaire. The response rates after three mailings were 45% for sprinkler fitters and 22% for carpenters.

We used union records because of the administrative and cost efficiency advantages. County workers report to many different administrative agencies, and attempts to obtain approval for the study from each separate agency to identify a sufficiently large occupational cohort would have been impractical. The county workers union had information centralized in their membership records. Local 660 represents over 90% of the Los Angeles county non-management office workers.

Three worker groups were selected for sampling from the SEIU roster: 1) court reporters, 2) office staff whose job titles indicated primarily data entry tasks (data entry staff) and 3) office staff whose job titles indicated a variety of responsibilities, (clerks and technical staff). We used union job titles for sampling purposes only. Self-reported job title information was used in the data analysis. Based on union record job titles, we

selected all court reporters, a random sample of data entry/typist occupations, and a random sample of clerks and technical staff. We selected a total of 4400 names from the three union rosters of which 2082 were county office workers. Our intent with this sampling process was to obtain a group of office workers with a range of repetitive motion demands and computer keyboard use.

A self-administered questionnaire was mailed to all selected union members. Union members who did not respond to the first mailing were mailed questionnaires up to two more times if necessary. For the first two mailings, post card reminders were also mailed one week after the questionnaire. From the questionnaire we obtained information on occupational history and job tasks, hand/wrist and arm symptoms, other musculoskeletal symptoms, housework and leisure activities, sociodemographic factors, medical history, job-related psychosocial factors, and injury history to the upper extremities.

The response rates were 51% for court reporters, 30% for other office staff (data entry, clerks, and administrative/technical staff). The overall response rate for the cross sectional survey was 35%, and among the county workers the overall response rate was 32%.

Variables

The general categories of study variables included occupational history/job task information, hand and arm symptoms, other musculoskeletal symptoms, housework and leisure activities, demographics, medical history, and other personal factors.

Housework and leisure activities included gardening, housework, knitting and sewing machine use, racquet sports, playing a musical instrument, and home carpentry and power tool use. Medical factors included previous injuries to the wrist, hands, and forearm; reproductive history (pregnancy, gynecological surgery, and use of birth control pills); and medical conditions (hypertension, diabetes, rheumatoid arthritis, lupus, and nerve damage). We also included questions on handedness, height, weight, and smoking history. The demographic factors were age, sex, race/ethnicity, educational level, and number of children.

Classification of Hand/Wrist Symptoms

The survey questionnaire included questions about pain, tingling, and numbness symptoms in the hands, wrists, and fingers. We also asked about the frequency and duration of these symptoms. In addition, the questionnaire included questions on the presence and frequency of night symptoms of numbness, pain and tingling. Respon-

dents were asked to indicate on hand diagrams where their symptoms were occurring. We also asked if they had ever received a medical diagnosis of CTS.

We developed and evaluated four sets of symptoms criteria to serve as indicators for potential CTS. These criteria were: 1) "general hand/wrist" symptoms occurring at least once a month, 2) "general hand/wrist" symptoms occurring at least once a week, 3) "nocturnal hand/wrist" symptoms, and 4) "post-job hand/wrist" symptoms. For all but the second general hand/wrist criteria, the symptoms had to occur at least once a month. All definitions required that symptoms affected the median nerve distribution area of the hand. Hand/wrist symptoms were defined as the presence of pain, tingling, and numbness in the hands, fingers, or wrist (excluding ulnar-only symptoms). Nocturnal symptoms includes all of the general hand/wrist symptoms plus the restriction that these symptoms wake them up at night. The post-job hand/wrist symptoms includes all the criteria for the nocturnal symptoms definition, plus the restriction that symptoms must first occur after the start of the current job. We developed the four symptom criteria as potential indicators of CTS to see if using more stringent symptom criteria produced different results. We did observe some minor differences, but for the most part, the analyses by different definitions gave similar results. We selected the general hand/wrist definition where the symptoms occurred at least once a week as our indicator of hand/wrist symptoms suggestive of CTS. This symptoms definition parallels definitions used in previous occupational research (Silverstein et al., 1987; Punnett et al., 1985). For convenience in labeling, throughout this paper we refer to our general hand/wrist symptoms criteria (symptoms occurring at least once a week) as "CTS symptoms."

We recognize that a substantial proportion of workers with these symptoms will not have "definitive" CTS (Katz et al., 1990). Several studies have excluded cases when it appeared that symptoms occurred before the start of their current job (Silverstein et al., 1987; NIOSH 1993; NIOSH 1990). Our post-job start classification parallels this definition. We include cases where the symptoms may have occurred before the start of the current job for several reasons. First, our information on job classification is cross-sectional; we only asked about the current job title and duration of employment. It is likely that their previous job involved similar type work. Second, because CTS symptoms may begin gradually and possibly one symptom at a time, it is difficult to pinpoint exactly when a person has CTS. Third, the current occupational exposure may also exacerbate symptoms, and it is important to evaluate these potential impacts.

Exposure assessment

Workers were asked to estimate the number of hours per day (on average) they spend using a computer keyboard. We also asked the general question of how frequently the worker was involved in repetitive tasks of the hand and fingers (Putz-Anderson 1989). For this question, the respondents could choose four possible responses: 1) very little or

not at all, 2) up to one fourth of the time, 3) one fourth to one half of the time and 4) greater than one half of the time.

The questionnaire also included open-ended questions for job titles and job tasks and responsibilities. In job title analyses, the self-reported title was used. We initially categorized office worker job titles into four general categories (court reporters, data entry, clerks, and technical staff) and job tasks and responsibilities into 21 categories. After a review of the job tasks and CTS symptom prevalence, we combined clerks and technical staff into one category for subsequent analyses.

Workers were asked to estimate the number of hours per day they use power and hand tools and the number of hours they work with their hands elevated above shoulder height. We also asked how frequently the worker was involved in repetitive tasks of the hand and fingers (Putz-Anderson 1989). For these questions, the respondents could choose four possible responses: 1) very little or not at all; 2) up to one fourth of the time; 3) one fourth to one half of the time; and 4) greater than one half of the time.

The questionnaire also included open-ended questions about job titles, job tasks or responsibilities, and the duration of employment in their current or most recent job title. We initially categorized trade worker job titles into 4 general categories: sprinkler fitters; carpenters; foreman and other trades; and administrative positions. In most analyses we collapsed the foreman and other trades and the administrative group into one category because of the small numbers of workers in those groups.

Telephone Survey

To address the potential bias due to low response, we conducted a telephone survey among a random sample of nonrespondents. We asked union members about their current employment status, job tasks, average hours worked per week, hand and wrist symptoms, and age. Our objectives were to assess how questionnaire participants differed from the telephone survey respondents with respect to hand/wrist symptoms and selected exposure factors. With this information, we could then estimate the influence that nonresponse may have had on our effect estimates. A key assumption that underlies all these analyses is that the participants in the telephone survey are representative of the nonrespondent union members with respect to the work exposures and hand/wrist symptoms.

Medical and Personal Factors

Respondents were asked if they ever had a medical diagnosis for a variety of medical conditions (previously listed) and the month and year for this diagnosis. We also included questions on the history of previous strain, fractures to the wrist and forearm and for any hand injuries. We developed a handedness score based on hand use for six

common activities (writing, throwing, toothbrush use, opening cans or bottles, table knife use, and tool use). We had a five point scale for each activity, with one indicating complete left-handedness and 5 indicating complete right-handedness. The total possible score for a pure left hander was 6 and for a pure right hander was 30. A score of 6-19 was classified as left, 20-29 as mixed and 30 as right. Right handlers were used as the reference group in the analysis of handedness and CTS. In our classification of hand dominance, a score of 6 or 30 was considered "strongly dominant," a score of 7-11 and 25-29 was labeled "dominant," and 12-24 was classified as not dominant and used as the reference group.

For leisure activities, participants were asked to record their weekly leisure time activities in categories of rarely or never, < 1 hour, 1-4 hours, 5-9 hours, and 10 or more hours. The categories of rarely or never and less than 1 hour were used as the reference categories in these analyses. We selected each these specific leisure activities under the assumptions that the biomechanical stresses involved with these activities could affect CTS symptoms. We created a summary score for all leisure activities by using the midpoint of each interval range and 10 hours for the highest category. Then we divided the workers into three groups (lest than six hours, six to eleven hours, and twelve or more hours of combined leisure and housework activities) to evaluate potential exposure-response trends.

Psychosocial Factors

The psychosocial factors of the work environment refer to those work-related stressors that the individual regularly encounters. They are collateral to physical work activities and are mainly perceived by the individual. Questions about psychosocial work environment were derived from relevant questions that have been used in previous studies for occupational stress (House, 1980, Theorell, 1990). Four areas of the psychosocial work environment were addressed in the questionnaire: decision latitude, job demands, social support, and job satisfaction.

Decision latitude was assessed by three items asking about a subjective evaluation of worker's capacities and organizational conditions:

a. You have a good deal of influence over things that affect your job
b. You are give a lot of freedom to decide how to do you work, and
c. You have the opportunity to develop your own special skill and abilities.

Participants checked one out of three alternative levels of response for each item, rarely or never (coded as 1), sometimes or occasionally (coded as 2), and frequently (coded as 3). Summing up individual values for these items generated a total score indicating the perceived level of decision latitude for that worker.

We used three items to evaluate the level of job demands:

a. You are required to work very fast,
b. You think that the amount of work you have to do may interfere with how well it gets done, and
c. You are required to work very hard (physically and/or mentally).

The scaling for job demands was similar to the scaling for decision latitude, although inverted, i.e. rarely or never was coded as 3, sometimes or occasionally was coded as 2, and frequently was coded as 1. The total scores were general and interpreted the same as for decision latitude.

Information about the sources and degrees of social support was collected by asking about the help or support available inside and outside of the work place. The questions asked were:

How much can each of these people be relied on for help or support when things get tough at work?
a. Your immediate supervisor (boss)
b. Other people at work
c. Your husband, wife or mate
d. Your friends and/or relatives.

The response given for each item was classified into four levels: "not at all", "a little", "somewhat", and "very much". A score was assigned to the corresponding level, 1 for "not at all" up to 4 for "very much". A total score was generated by summing up the four individual scores, which would then reflect the overall level of social support.

We used two items to assess job satisfaction:
a. You enjoy your work
b. You have thought seriously about leaving your job.

The are three alternative levels of response for each item: rarely or never, sometimes or occasionally, and frequently, and in reverse order for item b. The overall score for job satisfaction was the sum of the two items.

Analysis Methods

We used Mantel-Haenszel methods and logistic regression models to estimate prevalence odds ratios and 95% confidence intervals after controlling for age, sex, job duration and other factors (Kleinbaum et al., 1982; Rothman 1986). Both methods produced similar results, so for consistency we have presented our findings from the logistic regression analyses. SAS and EGRET software were used to perform the necessary computations (SAS Institute 1989; SERC 1990).

We separated these analyses by occupational groups (trade workers and county office workers) because the type of exposures and gender profiles for these groups was significantly different. The trade workers group included the categories of sprinkler

fitters, carpenters, and foreman. Ninety three percent of the trade workers were male. The county office workers group included computer data entry operators, clerks, court reporters, and technical staff. Eighty eight percent of the office workers are female.

We examined the effects of occupational and specific job tasks on CTS symptoms as follows. First, we calculated the prevalence of CTS symptoms by occupational group using our four symptoms criteria. For all subsequent analyses, we focused on the general hand/wrist criteria where symptoms occurred at least once a week. We refer to this outcome as CTS symptoms. Next we performed a job title analyses to examine the effects of occupation on CTS symptoms. We used clerks/ technical staff as the reference group to estimate the odds ratios for working as a court reporter or data entry staff. Using logistic regression models, we estimated odds ratios for court reporters and data entry staff controlling for occupational (job duration and hours worked per week), demographic, and personal/medical factors. Next we examined the effects of keyboard use and general repetitive motion demands on CTS symptoms. We developed logistic models to estimate odds ratios for these job task exposures controlling for demographic, occupation and personal/medical factors. We also analyzed keyboard use and general repetitive motion exposures within occupational groups to asses how these factors may explain the difference in CTS symptom prevalence either acting as confounders or modifying the effects of job tasks.

Odds ratios were estimated as the antilog of the regression coefficients and 95% confidence intervals were calculated as the antilog of the standard error coefficients multiplied by ±1.96 (Hosmer and Lemeshow, 1989). In the multivariate logistic models, job duration and age were forced into the model. Our purpose was to estimate the effects of occupational group or keyboard use/repetitive task exposure while controlling for age and job duration.

To control for demographic, occupational and other personal/medical factors, we used a modified backwards elimination strategy. We identified the initial full model using information from our analysis of non-occupational factors and CTS symptoms what is known about CTS risk factors (based on the scientific literature), and occupational factors of interest. We removed terms from the model that had P values greater than 0.15. We then examined the impact on the odds ratio estimate, and if there was minimal change (less than 15%), the term was excluded; if there was change to the odds ratio, the term was retained in the model (Greenland, 1989). We repeated this process until all potential personal/medical covariates had been evaluated.

We examined the effects of medical conditions, reproductive factors, previous injuries and personal factors in a three-step process. First, we examined the crude effects and the effects controlling for age and sex, or age only when the analysis focused on one gender (e.g., female reproductive factors). Subjects without the specific medical condition, previous injury or reproductive factor were used as the reference group. Second, we examined the effects of medical conditions, previous injuries, and personal

factors controlling for age, sex, and job duration. In the third step we examined the effects of each non-occupational factor on the odds ratio estimate of the job task exposures (repetitive motion or keyboard use), while controlling for age and job duration in the logistic model. We assess the impact of each factor by calculating a bias measure. This measure reflects the relative proportional change between the odds ratio from the model without the non-occupational factor versus the odds ratio from the model that includes the factor (i.e. unadjusted POR minus adjusted POR divided by the adjusted POR). Odds ratios were estimated as the natural antilog of the regression coefficients and 95% confidence intervals were calculated as the natural antilog of the standard error coefficients multiplied by ± 1.96 (Homsmer and Lemeshow, 1989).

Nested Case-Control Study

Case Control Selection

Cases and controls were selected from the initial cross-sectional study population based on their symptoms reporting. Subjects had to indicate on the survey questionnaire that they would be willing to participate in a follow-up study. The necessary symptoms criteria for categorizing a subjects as a case included: 1) pain, numbness and tingling in the hand/wrist area, and 2) frequency of symptoms: at least once per month. Controls were sampled from the pool of survey respondents who did not report any hand/wrist symptoms.

Controls were matched on age, sex and union. All eligible controls meeting the matching criteria were initially selected and assigned a random number. We contacted potential controls starting with the control with the smallest random number. If the first eligible control could not be contacted or refused to participate, we attempted to contact the next eligible control. The process was continued until a control was interviewed for every participating case (1:1 matching).

Contacted subjects either agreed to the interview or declined further participation. We made at least six attempts to contact individuals.

Case-Control Interview

Most interviews, clinical examinations and electrodiagnostic testing were performed on Saturday mornings due to difficulties in scheduling during the work week. The interview consisted of a detailed questionnaire with five sections: physical signs, work history, job tasks, symptoms and reproductive history. After the interview and clinical tests, subjects were given electrodiagnostic tests. Before commencing case-control interviews and tests, an informed consent was read to and signed by the volunteer participants. Participants were paid $15 to cover parking and travel expenses.

The questionnaire was tested on a small sample of workers, and modified based on the results of survey testing. The specific data items that were included in the survey questionnaire interview are presented in the appendix. On average the questionnaire required 20-25 minutes to administer, and the electrodiagnostic tests required an additional 30 minutes. Interviews, clinical tests, and electrodiagnostic tests were given at the UCLA EMG clinic. Specially trained research assistants conducted the personal interviews and performed the Tinel's and Phalen's test. EMG clinic neurologists administered the electrodiagnostic tests.

Physical signs included width and depth measurements for each wrist and the application of two diagnostic tests: Phalen's and Tinel's test. Results and measurements were

recorded on the interview form. During the clinical tests, the interviewers noted whether the subjects hands were warm enough for the nerve conduction exams. If a subjects hands were cool, the neurologist was notified and efforts were made to warm the subjects hands to an appropriate temperature for the nerve conduction tests.

The case-control interview included questions about work history, job tasks, hand/ wrist symptoms and reproductive information (females only). A portion of the interview focussed on specific work tasks for given occupational groups. This section of the questionnaire varied depending upon occupational group. The interviewer listed potential work tasks and had the respondents indicate the frequency and amount of time dedicated to each task in a "typical" work week. For the sprinkler fitters union (709), job task sheets included questions about their job type and location, daily tasks, and the amount of time spent using power tools. Questions for the carpenters' union (409) were similar. The job task sheet for office workers (660) included questions regarding their daily job responsibilities and the amount they spend on various office equipment such as the computer keyboard, typewriter, or stenography machine. Additionally, office workers were asked detailed question about their workstations' characteristics (e.g. whether the workstation possessed an adjustable chair or a wrist rest). At least two years of job task information was obtained for all subjects.

Electrodiagnostic Tests

The electrodiagnostic tests included sensory and motor latencies of the median and ulnar nerves, as well as orthodromic studies of the median and ulnar nerves. The median nerve latency measurements were made from the wrist to the second and fourth digits at 14 cm distance. Ulnar sensory latency studies were measured from the wrist to the fourth and fifth digits. For the median motor studies, the measures were made from the wrist to the abductor pollicus brevis (APB) and from the wrist to the second lumbrical. Ulnar motor studies were made from the wrist to the adductor digit minimi (ADM). All motor studies were for a distance of 8cm. For the orthodromic studies we measured the latencies (palm to wrist distance of 8cm) for the ulnar and median nerves and calculated a median-ulnar difference. The normal limits of these tests are listed on the electrodiagnostic data sheet included in the appendix of this report.

Analytical Methods

The main emphasis of the case-control analyses was to evaluate the relationship between clinical signs, electrodiagnostic tests, and symptoms reporting. Subjects were classified based on a variety of symptoms reporting and test results including:

- Mail survey symptoms reporting
- Case-control interview symptoms reporting

- Electrodiagnostic (EMG) criteria
- Phalen's test
- Tinel's test

CTS status, determined by electrodiagnostic criteria, combined results from the median and ulnar measurements described above. Clinical neurologists at the UCLA EMG clinic independently evaluated the EMG results and assigned subjects as CTS positive, CTS negative and equivocal based on their expert clinical judgement. Each physician was blinded to the others' coding. Differences in coding were resolved through discussion and mutual decisions between the two physicians. We calculated un-weighted and weighted Kappa coefficients to measure the agreement in assigning CTS status (Fleiss, 1981).

We compared the EMG results to symptoms reporting and clinical tests, calculating sensitivity and specificity measures.

Results

Six hundred twenty eight office workers responded to our survey. Of these respondents, 504 were included in the analysis (Table 1). Records were excluded from analysis if they were missing data for occupation, age, gender, or if they were retired or inactive workers at the time of our survey. A small number of respondents (n=29) were excluded because they were not active workers. County workers who reported non office worker occupations such as maintenance workers, janitors and others were also excluded from the analysis.

The occupational categories and demographic profile for the office worker union members are presented in Table 2. Eighty eight percent of the office workers were female. We had 78 cases of CTS symptoms among these 504 workers. The odds ratio for CTS, comparing active workers (reference group) to retired or inactive workers was 1.7, 95% confidence interval (CI) [0.5, 5.2]. No further analysis were carried out among inactive officeworkers.

We calculated the prevalence odds ratios for non-active workers (retired, laid off or not working for other reasons, n=136) compared to active workers for CTS symptoms [POR=0.8, 95% CI (0.4, 1.6)]. The age-adjusted effects for this comparison were 1.0 95% CI (0.5, 1.8). In all subsequent analyses of job tasks and occupational factors, we excluded non-active workers. Fifty five records were excluded because they lacked information on occupation and thirty three were excluded because the lacked information on age or sex (Table 3). The occupational categories and demographic profile for the trade worker study population are presented in Table 4. There were very few women in the trade occupations (among active workers n=37). Seventy percent of the female trade workers were sprinkler fitters (Table 4).

Job Tasks and Responsibilities

Clerks, technical, and administrative staff reported a variety of tasks compared to court reporters and data entry staff. Sixty five percent of the data entry staff reported typing or data entry as their primary task. Court reporters almost exclusively work on entering court testimony with the stenography machine or data editing using a VDT. Ninety five percent reported this as their primary task. Court testimony usually lasts for 4-5 hours per day. Additional editing of the court testimonies absorbs the rest of their day. Court reporters are often required to work under tight deadlines to complete courtroom documents. Clerks performed a variety of job task and responsibilities, although slightly over one third report data entry as their primary work task. Other commonly reported tasks included supervision and general office work.

Sprinkler fitters' work primarily involves fitting and threading pipe for the installation of fire protection systems. Nearly all of the fire protection systems use threaded pipe, so sprinkler fitters are frequently applying a twisting motion, often with substantial force, to connect the pipes. Much of this work is performed above shoulder height. For most of this work, the main tools are various sized pipe wrenches. Sprinkler fitters also frequently use a rivet gun to insert hanging bolts into cement ceilings. This gun applies a strong rapid burst of force to the hands and wrists of the user.

Carpenters reported a wider variety of tasks. Their two most common tasks were framing and constructing concrete forms. In Southern California, union carpenters generally work more on public works and transportation projects than other (non-union) carpenters who are more likely involved with housing projects or other general carpentry. Carpenters' most common hand tool is the hammer. We observed three types of hammers based in use, based on the handle style (wooden, fiberglass or steel handles) and a range of weights (usually 16-20 ounces). Hand-held power saws and drills are the most common power tools. Both sprinkler fitting and carpentry involves substantial lifting and moving of construction materials.

CTS Symptoms by Job Title Occupation and Age

Clerks and technical occupations had the highest prevalence of CTS symptoms (Figure 1). We sampled clerks/technical staff with the intention of using them as a reference group for comparison with court reporters and data entry staff. Despite the initial crude findings that showed higher prevalence for clerks and technical staff, we performed a job title analysis using logistic regression models to control for age, job duration, and relevant personal and medical factors to determine if these potential confounders biased the initial impressions from the crude prevalence comparisons. After controlling for age, job duration and personal/medical factors, the odds ratios for working as a court reporter or data entry staff are both close to 1.0 (Table 5).

Among all active county office workers, the highest prevalence for hand/wrist symptoms was in the 50-59 age group (Figure 2). For specific occupational groups, the highest prevalence was in either the 40-49 or 50-59 year old group. The prevalence for 60-69 year olds was always lower than 40-49 or 50-59 year groups, and the 20-29 year olds always had the lowest prevalence of symptoms. There was only one case of CTS symptoms in this group.

Among trade workers, a comparison of females to males, we restricted the analysis to the younger age groups because there were no female workers older than 40 years. The adjusted odds ratio, comparing females to males within this subset of the study population was 5.6 [95% CI (2.4, 12.8)].

CTS symptoms prevalence by trade worker occupational groups are presented in Figure 3. Sprinkler fitters and carpenters had higher CTS symptoms prevalence than foreman or administrative classifications. Carpenters had a higher prevalence of general hand/wrist symptoms, whereas sprinkler fitters had higher prevalence of more restrictive CTS symptoms criteria (Figure 3). The adjusted odds ratios of general CTS symptoms were higher for sprinkler fitters than for carpenters (Table 6).

There were no cases observed among the 22 active 60-69 year old workers. Excluding the 60-69 year old age group, the prevalence of CTS symptoms among all trade workers was lowest for the 20-29 year old group and highest among 30-39 year olds (Figure 1). After ages 30-39, the prevalence decreased among older workers.

Hours Worked and Job Duration

In general, court reporters were the only group with a substantial portion working more than 40 hours per week. As a group they averaged 46 hours per week. Data entry and clerks/technical staff averaged 38 hours per week. The mode was 40 hour (71% of the office workers). Forty-six percent of the court reporters, reported working more than 50 hours per week. We stratified hours worked in two ways, as greater than or equal to 45 and less than 45 (as the reference group) and for court reporters only as three levels (<= 40 hours, 41-50 hours, and 51+ hours. For all county workers, after adjusting for job duration, age and personal medical factors, there no association for hours worked and CTS symptoms, POR=1.1, 95% CI (0.5, 2.1). For court reporters the odds ratios was 3.0 [95% CI (1.0, 8.6) adjusting for age and job duration. The odds ratios for working 41 to 50 hours and greater than 50 hours were 3.7 and 3.8. [95% CIs (1.1, 12.1) and (1.0, 13.8)].

The number of hours worked was categorized into two groups: less than 45 hours (reference group) and 45 or more hours. Most workers (82%) worked 40 hours per week. Approximately 10% of the active trade workers reported working 45 or more hours per week. The prevalence odds ratio, controlling for occupational group, job duration and age for those working 45 hours or more was 0.6 (95% CI 0.2, 1.6). Hours per week was retained in logistic regression analysis of work factors.

Job duration was stratified into five categories: 0-1.9 years, 2-4.9 years, 5-9.9 years, 10-14.9 years, and 15 or more years. The CTS symptoms prevalence was highest in the 5-9.9 year group (Table 4). Odds ratio estimates, using the 0-1.9 year group as the reference category produced an inverted U shape relationship between job duration and CTS symptoms (Table 4). Among trade workers, CTS symptom prevalence was generally higher in the first two categories. Using the 0-1.9 year group as the reference category, the odds ratios for CTS symptoms began to decrease after 10 years of job experience (Table 8).

Keyboard Use

We defined exposed workers as those reporting greater than three hours of keyboard use per day. The reference group was those working three hours or less. We also examined keyboard use classified into three categories; 0-2.9 hours per day, 3-5.9 hours per day, and 6+ hours per day. The odds ratios increased as we controlled for age, job duration and personal/medical factors. Within specific occupational categories, court reporters have higher odds ratios (4.0 and 5.3) than all county office workers, while clerks and technical staff had lower odds ratios than all county workers (Table 9). To determine whether these differences in odds ratios were the result of confounding or effect modification, we included two indicator variables for occupational group in the logistic model (one for court reporters and one for data entry staff). The odds ratio estimates did not differ from the estimates without including the occupational group term. This indicates that occupation is not acting as a confounder between specific keyboard and repetitive task exposures, but does modify the effects of specific job task exposures to CTS symptoms.

Respondents were asked to list their job tasks and responsibilities. When we compared office staff (excluding court reporters) who reported data entry or typing as their primary or secondary job task to office staff who did not report these tasks, the odds ratios were near 2.0 [95% CI (1.0, 4.0)]. for CTS symptoms.

Power and Hand Tools and Working Above Shoulder Height

Tool use, either power or hand tools had little impact on CTS symptoms (Table 10). We grouped tool use into three categories: 0-2.9 (reference), 3-5.9, and 6+ hours per day. Controlling for occupational factors (hours worked, job duration), and a history or presence of wrist sprains, the prevalence odds ratios were 1.7 and 1.2 for power tool use and 1.3 and 1.4 for hand tool use for the 3-5.9 and 6+ hours categories respectively. There were no apparent exposure-response trends for power tool use or hand tool use (Table 10).

Work above shoulder height occurred mostly among sprinkler fitters. The odds ratios for this exposure were 1.65 [95% CI (0.8, 3.2)] for 3-5.9 hours per day and 1.83 [95% CI (1.0, 3.5)] for 6+ hours per day (Table 10).

Worker Assessment of Repetitive Motion Exposures

Workers were asked to provide a general assessment of the amount of time they work in repetitive tasks involving the hands and fingers. We calculated odds ratios by comparing workers whose jobs involved repetitive motion for more than half of their

work day with those who were involved with repetitive tasks for half of the day or less (reference group). All but three court reporters reported the highest category of repetitive motion demands so we could not estimate their occupation-specific odds ratios.

Crude and adjusted odds ratios for repetitive motion exposures ranged from 1.7 to 3.9 after controlling for age, job duration, and personal/medical factors (Table 11). Clerks and technical staff had higher odds ratios for repetitive motions exposures than did data entry staff and all county workers combined (Table 11). The effect of repetitive exposures on CTS symptoms was modified by occupational group. However the pattern of effect modification is opposite the trend with keyboard use. With repetitive motions exposures, clerks and technical/administrative staff had the hither odds ratios.

Among trade workers, the worker's overall assessment of repetitive motion demands had the highest odds ratios of all the work task exposure measures. Controlling for age, hours worked per week, job duration, and a history or presence of wrist sprain, the POR was 3.2 [95% CI (1.6, 6.3)]. The reference group in these analyses were workers who reported working half of their time or less, in repetitive activities (Table 10). The exposed group included those involved with repetitive activities more than 1/2 of the time. Although we had four categories for repetitive motion demands (see Methods), most trade workers reported the two higher categories (1/4 to 1/2 and greater than 1/2 of their time). This forced us to categorize this variable into two groups. The association between repetitive motion and CTS symptoms was not confounded by occupational classification, but the effect of repetitive tasks was modified by occupation.

Impacts on Work and Leisure Activities

Approximately 10% of the CTS cases reported a major impact on their work assignments and productivity as a result of their symptoms. Additionally, nearly 20% of the cases have changed the way they do their work or had their leisure activities affected by their symptoms (Figure 5).

Telephone Survey of Nonrespondents

We compared the results of the telephone survey to the results of the questionnaire respondents for age, hand/wrist symptoms, job task information and employment status (Table 12). We have included all questionnaire respondents (active and inactive) in this table. We have also stratified these results by union because of the two-fold difference in response rates. For both unions the prevalence of CTS (hand/wrist definition) between telephone and questionnaire respondents were approximately equal, as were the prevalence for the specific symptoms of numbness and tingling. However, the prevalence of exposure was higher among the questionnaire participants.

The higher proportion of retired and inactive workers in the telephone survey only partially explains the exposure difference. In the comparison of active workers only, the questionnaire participants exposure levels were still higher than active workers in the nonrespondent telephone survey. The average ages were the same for the two groups (Table 12).

Medical Conditions and CTS Symptoms

Several medical factors were associated with CTS symptoms. The odds ratios for CTS symptoms were elevated for nerve damage, tendinitis, cysts, arthritis, and diabetes (Table 14). We observed only minor changes in the odds ratio when controlling for age and sex than when we controlled for age, sex and job duration. Lupus was rare so the odds ratios and confidence intervals for this factor were imprecise. Among the medical conditions we measured, nerve damage and ganglion cysts had odds ratios of 6.0 and 3.0, while rheumatoid arthritis, lupus, and tendinitis had odds ratios of 2.1, 2.1 and 2.3 respectively (Table 14).

A history of a sprain injury to the wrist was the most commonly reported injury of the hand/wrist and forearm area among these workers (Table 14). After controlling for age, sex and job duration, sprains, crushing injuries and wrist fractures had odds ratios ranging from 1.5 to 2.4. In these analyses, we included only the injuries where the date of onset was before the onset of CTS symptoms and occurred in the same hand as the CTS symptoms.

Reproductive Factors

Of the active female workers, 16.8% reported previous hysterectomies, 10.1% reported oophorectomies, and 23.3% reported tubal ligation surgery. The odds ratios for CTS symptoms were near or below one for tubal ligations and bilateral oophorectomies after controlling for age and job duration. A history of a hysterectomy and unilateral oophorectomy were both modestly associated with CTS symptoms using the crude or adjusted odds ratio estimates (Table 14).

We examined current and historical birth control pill use as potential risk factors for CTS symptoms. The prevalence of current use of birth control pills was relatively low (7.6%), although 35% reported a history of birth control pill use. Current users are predominantly younger women less than 40 years old. The adjusted odds ratios were all near 1.0 for a history of birth control pill use and for current pill use. Imprecision in these estimates, reflected by the wide confidence intervals limit the interpretation of these data (Table 14).

Personal Factors

Gender was associated with CTS in these worker populations. Our ability to accurately estimate gender differences across the entire study population is confounded by occupation. We only have partial ability to control for occupation since there are very few female trade workers and a small percentage of male office workers. Within the occupational categories of sprinkler fitters and county office workers, we can make gender comparisons, but the estimates are imprecise. For county office workers the age-adjusted odds ratio comparing females to males was 1.7, 95% CI (0.9, 3.3), and for sprinkler fitters the odds ratio was 5.3, 95% CI (2.5, 11.2). There were 35 active female sprinkler fitters, all but one under age 40. There were 58 active male office workers.

The odds ratios for age group varied by gender. For males, the highest odds ratios were in the 40-49 year group, whereas for females the highest odds ratios were in the 50-59 year old group (Table 15). The odds ratios for males appear higher than for females. This is due mainly to the baseline rates in the reference groups. For males we used the 20-29 year old group and for females we used the 30-39 year old group, who had a higher prevalence. There were very few 20-29 year old females in this worker population, so we choose the 30-39 years olds as the reference group.

Obesity, measured by the body mass index, BMI (km/m^2) was associated with CTS symptoms. We noted increasing odds ratios with increasing BMI categories. The Chi-squared test for trend was low in the logistic regression model adjusting for age, sex and job duration (Table 16). We did not observe excess CTS symptoms among those classified as dominant or strongly dominant using not dominant as the reference group (Table 16). We also did not observe any differences in CTS prevalence based on handedness (Table 16).

Current smoking was modestly associated with CTS symptoms, however a history of smoking was not (Table 16). The adjusted odds ratio, adjusted for age and job duration, for current smokers versus non-smokers was 1.4 [95% CI (0.9, 2.0)]. There were no dose response trends when examining CTS symptoms by the amount of smoking (average number of cigarettes per day) among current smokers, treated as a continuous variable or grouped into categories (data not shown).

Leisure Activities and Housework

In general this worker population did not spend many hours doing the outside-of-work activities (leisure, hobbies, and housework). There were very few women and no men who spent more than one hour per week doing knitting and sewing activities. The few hours of time spent in these activities did not produce elevated odds ratios. We observed slightly elevated odds ratios (1.3-1.6) in the groups that spent ten or more

hours doing housework, gardening, carpentry, and using power tools (data not shown). For housework men had higher odds rations than women (data). The reference group in these analysis were those who never or rarely engaged in these activities. There were no apparent exposure-response trends based on increasing numbers of hour in leisure and hobby activities. We combined the hours of all leisure activities into a summary score measure. The results from the leisure score analysis indicate that overall time spent in leisure activities was not associated with CTS symptoms (Table 16), despite suggestion of trends for selected activities such as gardening and tool use.

Race/Ethnicity

Workers were asked to identify themselves as either African American/Black, American Indian, Asian Pacific Islander, Latino/Hispanic, White/Caucasian, or Other. Many of those who initially reported "Other" reported European nationalities and were reclassified as white. Our study population was 54% White, 17% Black, 14% Latino, 1.3% American Indian, 4.7% Asian/Pacific Islander, and 2.4% Other. Eighty-eight participants (5.8%) did not report their race/ethnic status. Crude and adjusted odds ratios, using whites as the reference group, were all near the null value (Table 17).

Confounding by Personal/Medical Factors

The personal/medical factors we analyzed as confounders on the effects of occupational exposures were rheumatoid arthritis, ganglionic cysts, nerve damage, tendinitis, obesity (BMI), previous wrist sprain or hand injury, current smoking status, and a history of hysterectomy. For the occupational exposures of keyboard use and repetitive motions there were only a few factors that changed the odds ratios more than 10% (Table 18). The bias ranged from one to twenty percent relative to the adjusted odds ratio. For office workers, hysterectomies and nerve damage influenced the odds ratios for the repetitive exposure measure, by more than 15%. There were no factors that influenced the odds ratios more than 10% for hours working on a computer keyboard. Among trade workers, a history or presence of ganglionic cysts was the only factor that changed the odds ratio for repetitive exposures more than 10%. The direction of the change in odds ratios was not always consistent. For example, for repetitive motion exposures wrist sprains and arthritis slightly increased the odds ratios for county office workers but decreased the odds ratios for trade workers.

Psychosocial Factors

The prevalence of neck/shoulder and low back pain by demographic factors is presented in Table 19. The prevalences were high, ranging from 45-62 percent. Smokers

had slightly higher prevalences than non-smokers. Data entry personnel and court reporters had slightly higher neck/shoulder pain than other occupations (Table 20). For low back pain, active carpenters and sprinkle fitters had higher prevalences. Foreman and administrators had higher prevalences, but these are based on relatively smaller numbers (Table 20).

The crude and unadjusted odds ratios for psychosocial factors for hand/wrist symptoms, neck/shoulder pain, and low back pain are presented in Tables 21-23. For hand/wrist symptoms, adjustment by work factors and other psychosocial factors generally reduced the observed effects. The highest effects were for job demand factors. Low job satisfaction was also associated with hand/wrist symptoms after adjustment for potential confounding factors. Job demand was the strongest factor for both neck/shoulder pain and low back pain (Tables 22-23). Low job satisfaction was also associated with these pain symptoms although not as strong as hand/wrist symptoms.

Evaluation of Clinical and Electrodiagnosis of CTS

Two neurologists independently reviewed electrodiagnostic results and categorized subjects into three categories CTS positive, CTS negative and equivocal. The kappa coefficients for the agreement between physicians range from 0.5 (unweighted) to 0.6 (quadratic weighting), which suggests fair agreement between raters (Table 26). After review of the discrepancies in CTS classification, the overall prevalence of CTS by electrodiagnostic criteria was 47.4%, with 8.8% equivocal and 43.8% definitely negative.

The comparisons of symptom reporting and clinical tests to EMG diagnostic results are presented in Table 28. For a person to be classified as having symptoms suggestive of CTS, they had to report pain, tingling and numbness of the hand/wrist area. These symptoms had to occur at least once a month. Symptoms reported in the mail survey (1 to 2 years prior to the EMG testing) had the highest sensitivity of the symptoms and clinical test measures to EMG diagnostic criteria. Tinel's test had the highest specificity and the lowest sensitivity of the four measures. Surprisingly, current symptom reporting (the case control interview) had lower sensitivity than earlier symptoms reporting. Phalen's test had a much higher sensitivity than Tinel's, although the specificity for Phalen's tests was only 0.62.

The associations between historical and current symptoms reporting was low. 45.6% of those who reported symptoms in the mail survey did not report the same symptoms in the case control interview (Table 29). This low agreement is mainly the result of subjects reporting all three symptoms (pain, tingling and numbness) in the mail survey and not reporting all symptoms in the case-control study (24 of the 31 labeled as positive in the mail survey, but negative in the case-control interview, reported at least one hand/wrist symptom). In the relationships between clinical tests and symptom reporting, Phalen's test had a higher association with self-reported symptoms than did Tinel's

test (Table 29).

In the follow-up case-control study, we had difficulties recruiting subjects for in-depth interviews, clinical tests, and electrodiagnostic testing. We relied on telephone numbers that were self-reported in the phase I survey. Many of survey respondents could not be contacted for participation in the follow-up study (Table 24). Among those contacted, the refusal rates for participation in the case-control study were high. However, the refusal rates were high for all groups (i.e., by case control status and by union), suggesting no selective refusal. However, selection bias is still a potential limiting factor of this study.

Discussion

Office Workers

Our findings underscore the limitations of relying on job title alone in the assessment of CTS symptoms among office workers. The crude prevalence by job title was highest among clerks, technical and administrative staff and lowest among court reporters (Figure 1). This was not the trend we anticipated. We expected that occupations with higher keyboard demands would have higher prevalence of CTS symptoms. However, once we controlled for confounding factors, the odds ratios were near 1.0, indicating that there were no differences between occupations (Table 5). This was still contrary to our hypothesis that court reporters and data entry would have higher prevalence than clerks and technical staff. When we examined the effects of keyboard use, we observed that the effects were modified by occupation. Occupations that required more intensive keyboard use experienced more CTS symptoms as a result of their exposures. Court reporters had the highest, data entry staff had the next highest, while clerks and technical staff had the lowest odds ratios for hours of keyboard use (Table 9). In general, court reporters and data entry staff are required to work faster, work more time under deadlines, and key in more information. In addition to occupation-specific trends, we observed increasing odds ratios for increased hours of keyboard use (Table 9).

The effects of self-reported general repetitive motion requirements were also modified by occupation. However, this modification is the opposite the trends for hours of keyboard use. Clerks and technical staff had the highest odds ratios for CTS symptoms due to self-reported repetitive motion demands compared to data entry staff and all county office workers (Table 11). These findings could partially explain why clerks and technical staff had a higher or equal prevalence of CTS symptoms, yet lower odds ratios for hours of keyboard use. This interpretation implies that there are other repetitive job demands or postural factors in addition to computer keyboard use that contribute to CTS symptoms. Filing documents, phone work, and filling out forms may be some of these type activities.

Another likely explanation for the higher prevalence among clerks and technical staff is response bias. For response bias to impact our prevalence estimates (Figure 1), more clerks and technical staff with CTS symptoms participated in our survey than those without symptoms. Response bias could affect the odds ratios for general repetitive or keyboard exposures (Tables 9 and 11) if those who participated had higher CTS symptoms and were more likely to report general repetitive exposures than those who did not participate. We were able to contact 28 non-respondents in a follow-up telephone survey. Among this group, there was a lower prevalence of symptoms and a lower proportion of exposed cases (hours of keyboard use) than among questionnaire respondents. It is difficult to quantify the potential response bias based on the small number of nonrespondents, but the survey does indicate that our effect estimates may

be positively biased relative to the source population. Despite low response, our results are consistent with previous research (NIOSH, 1993; NIOSH 1990; Heyer et al., 1990). In several work-site visits, we noted a wide range of VDT work station designs and conditions. In one case, approximately twenty clerks were working with their computers placed on table tops with no available options to adjust their equipment. Newly instituted administrative control measures allow these clerks to work for only four hours on data entry work, and there are other ongoing efforts to improve these situations. However, these policy changes are relatively recent. It may be that these types of conditions, and not simply hours on the keyboard are factors that are associated with CTS symptoms among clerks and technical staff.

Stenography Machine Use and Computer Keyboard Use

The design of the stenography machine has several potential ergonomic advantages over the computer keyboard; its height is easily adjustable, it has fewer keys than computer keyboards, and keying involves less ulnar deviation. Some court reporters subcontract their testimony editing work to outside workers (commonly referred to as "scopers"). Other reporters do all of their testimony editing work themselves. Court reporters who work more than 50 hours per week are probably doing more testimony editing work, which involves working on a computer keyboard, not the stenography machine. Our results, which show increased CTS symptoms with increased hours worked per week, imply that VDT keyboard use is more likely associated with CTS symptoms than stenography machine use.

The reporting of keyboard use by court reporters may not have been consistent. Our survey question asked about computer keyboard use. Some court reporters only reported computer keyboard usage, while others may have combined the hours for computer keyboards and stenographic machines in their reporting. The result of this reporting pattern is an over-reporting of computer keyboard use and would bias our results towards the null value, assuming that the overreporting is nondifferential between CTS cases and non-cases.

The inverted U shaped relationship between job duration and CTS symptoms suggests that a form of healthy worker selection bias could have occurred after ten years of employment. Workers affected with musculoskeletal symptoms would tend to self-select out of these occupations. Healthy survival effect among office workers could occur if those workers with symptoms have left the workforce and were not available for our study. This bias would reduce the observable effects between workplace exposures and CTS symptoms. This trend would be more convincing, though, if it began to occur for shorter job duration intervals. A more immediate healthy-worker effect has been observed among trade workers (Kelsh et al., in preparation).

Trade Workers

We attempted to quantify two specific aspects of trade workers' tasks: hand and power tool use. We also asked workers to provide a general assessment of their workplace repetitive demands. Our strongest association of work task exposure and CTS symptoms was for the repetitive motion measure (Table 5). This finding could be due to reporting "bias" or the fact that this general summary is a better reflection of total relevant exposure than was the specific task information. The hours working with tools may not quantify the intensity of work, or may not be the only factors important for CTS symptoms occurrence. Further exposure assessment methods need to be developed that can more accurately measure work tasks, the intensity of work tasks, and the postural and repetitive aspects of these tasks. Unfortunately given the variety of trade worker tasks, this is difficult to accomplish on a scale useful for epidemiologic studies (Punnett et al., 1987).

Healthy Worker Effects and Symptom Reporting

Several trends indicate that healthy-worker selection bias is affecting our results in this worker population. After ages 30-39, CTS symptoms decreased with increasing age and after 10 years, job duration was inversely associated with CTS symptoms. It is likely that as new and younger workers enter these occupations and experience musculoskeletal symptoms, they make the decision early in their careers to leave trade worker jobs and work in other occupations. Healthy-worker selection tends to bias odds ratio estimates toward the null value and will change the shape of exposure-response relationships.

Trade workers maybe less likely to report musculoskeletal symptoms than other worker groups because their threshold for reporting pain may be higher than other workers. One suggestion is that workers involved in physically demanding work may be less sensitive or less aware of pain (Westgaard et al., 1993). These occupations demand physically fit workers, which may make them less susceptible to CTS symptoms and less likely to report than other workers.

Healthy worker selection and underreporting of symptoms would tend to lower prevalence estimates especially among older or more experienced workers. If underreporting is non-differential with respect to exposure or outcome status, it will bias POR estimates towards the null value.

Gender Differences

The prevalence of CTS symptoms was higher among female trade workers than male trade workers. Since the total number of female workers was small, we could not pursue further analyses to determine if females had important exposure differences relative to males that could explain the higher rates. Other alternative explanations are that the gender differences are attributable to other risk factors for CTS symptoms such as reproductive factors (Vessey et al., 1990, Ekman-Ordeberg et al., 1987, Stevens et al., 1992), hormonal factors (Cannon et al., 1981, Dieck et al., 1985), or wrist dimensions (Bleeker, 1985). This will have important implications as more women enter traditionally male-dominated trade occupations. Symptom reporting differences between males and females may also explain the observed differences. Larger cohorts of female trade workers need to be studied to help explain these findings.

For the majority of trade workers (80%) that reported CTS symptoms, work assignments were not affected by their CTS symptoms. Workers probably do not have much choice in the work assignment they receive. They perform the work required in order keep their job. However, workers do report symptoms impacts in areas where they have some control or influence over, such as productivity, the way they perform their work and their leisure activities.

Medical and Personal Factors

Although some medical conditions and previous injuries were potential risk factors for CTS symptoms, for the most part, they were not confounding factors for the occupational exposures we analyzed. Our findings indicated that among trade and office workers medical conditions, previous injuries and other personal factors were not associated with occupational exposures to act as confounders. In most cases the amount of change introduced by controlling for medical conditions, previous injuries and other personal factors was small and would not indicate the need for analytical control (Greenland, 1989).

Our study is consistent with previous reports for the associations of cysts, nerve damage and tendinitis and CTS symptoms (Table 14). To some degree, we are also consistent with previous finding of an association between reproductive factors and CTS as reported in other studies (Canon et al., 1979; Dieck and Kelsey, 1985).

Our findings suggest that if there is an association between diabetes and CTS symptoms, it is probably small (Table 14). Two studies that evaluated diabetes as a risk factor or associated condition did not observe an association with CTS (de Krom et al., 1990, Cannon et al., 1981). Two other studies did observe an association (Stevens et al., 1992, Dieck and Kelsey, 1985). Hypertension has not been evaluated in epidemiologic

studies nor has its possible effect been suggested in the clinical literature. We found no association between CTS and hypertension.

It has been suggested that hormonal changes around menopause somehow play a role in CTS occurrence (Dieck and Kelsey, 1985). Gynecological surgeries mimic menopausal events hormonal changes and therefore we would expect a history of these surgeries to be associated with CTS symptoms. We did observe a modest association with hysterectomies and unilateral oophorectomies similar to previous studies (de Krom et al., 1990 and Cannon et al., 1981). However, we did not see an association between bilateral oophorectomies and CTS symptoms. The lack of a positive association with bilateral oophorectomies could be due to the small numbers involved. Age-specific prevalences and odds ratios suggest higher CTS prevalence around the ages of menopause. All of these trends suggest some forms of hormonal influences.

The lack of association between birth control pill use and CTS parallels the findings of the Dutch study (de Krom et al., 1990). However, the odds ratio estimates for reproductive factors are imprecise. Our findings of a possible association between obesity and CTS (Table 16) partially support those reported among another group of industrial workers (Nathan et al., 1992a). Differential misclassification for weight, where heavier people tend to underreport their weight, may bias our estimate towards the null value, but since we categorized the BMI index into groups, this misclassification would have to be large enough to move people from a higher to lower group, which probably does not occur as much as underreporting per say.

Inflammation of the tendon sheaths in the carpal tunnel area (e.g., nonspecific and rheumatoid tenosynovitis) has been labeled as the cause of CTS for the majority of CTS patients (Dawson et al., 1983). However, in the Mayo Clinic case series only 3.1% of the CTS cases were associated with nonspecific tenosynovitis and 5.3% with degenerative arthritis (Stevens et al., 1992). In the Mayo Clinic study, their medical chart review revealed that excessive use of the hands was associated with 60 of 1,016 cases (5.9%). Forty three percent of the Mayo clinic cases were labeled as idiopathic CTS.

After controlling for demographic factors and job duration, we observed odds ratios 2.3 and 2.4 for the presence of tendinitis (Table 14). Tendinitis is one of the conditions labeled as a "cumulative trauma disorder" for which repetitive exposures are probably a risk factor (Rempel et al., 1992). Tendinitis could also an intermediate factor in the pathway between occupational exposure and CTS. Because tendinitis could be a coexisting condition or an intermediate factor, we have not analyzed it as a confounding factor. Wrist sprains were an important factor across all worker groups. The consistent relationship to CTS suggests this condition should be monitored more closely. When wrist sprains occur, sufficient recovery time should be allowed before returning to normal work duties to minimize the potential development of CTS symptoms. Many of these sprains are probably not reported and workers tend to work in spite of these type of injuries.

The "leisure" activities of housework, carpentry, and use of power tools were the only outside-of-work activities that involved sufficient numbers of hours to analyze the relation with CTS symptoms. For these activities we see only modest elevations in the odds ratios (< 2) for ten or more hours per week of exposure. Interestingly, the effect of housework was modified by gender. Men had higher odds ratios (point estimates) than women. One possible explanation for this finding is that men are involved in qualitatively different types of housework that puts them at higher risk for CTS than women. The term housework can be interpreted quite broadly and men may be involved in more repair type activities which have higher biomechanical stresses. Our leisure activity score which combined activities indicated that a summary measure of all leisure activities was not associated with CTS symptoms.

When we examined sex differences within study groups we observed elevated odds ratios comparing females to males, especially among female trade workers. This finding is consistent with previous studies (Cannon et al., 1981; Nathan et al., 1992). We did not observe any effects on CTS symptoms associated with race/ethnicity classifications.

Although we did not observe important confounding effects of medical conditions, previous injuries, reproductive and other personal factors on CTS symptoms and occupational exposures in our study population (Table 18), this does not imply that they should not be evaluated in future studies. The fact that many of these factors were associated with CTS symptoms indicates they can potentially be confounders in other worker populations. These factors must also be carefully evaluated based on a conceptual framework for CTS etiology. Some may act as intermediate factors (e.g. tendinitis or nerve damage) and analytical methods that treat them as confounders would be inappropriate. The most important factors appear to be arthritis, nerve damage, previous injuries, and reproductive factors. If possible, information on these conditions should be included in any occupational study of CTS.

Psychosocial Factors

Job demand includes both mental and physical factors that serve as immediate stressors, and these may in turn have direct impact on the musculoskeletal system. We found that job demand consistently showed a moderate effect on hand/wrist symptoms as well as neck/shoulder pain and low back pain after controlling for physical, demographic, and other psychosocial factors. High job demand seemed to have a greater effect in female workers than males workers across all four musculoskeletal symptoms, especially for neck and shoulder pain. Many of the office workers in this study experience prolonged periods of sitting, probably involving prolonged static muscle contraction. Since stress can also increase muscular tension, it is not surprising that high job demand and static contraction jointly can produce a great impact on the musculoskeletal system than either alone.

In our study, after adjustment for the effects of demographic and physical factors, we found an association between the low level of social support and hand/wrist symptoms and neck/shoulder pain, but not low back pain. Low social support may produce a greater effect than the medium or higher social support at the same level of another psychosocial factor, but not always.

The degree of satisfaction in one's job has been consistently related to musculoskeletal complaint in general. We found that low job satisfaction produced an effect on hand/wrist symptoms, neck/shoulder pain, and low back pain. Comparing low versus high job satisfaction at the same level of another psychosocial factor, low job satisfaction almost invariable produced a greater effect for musculoskeletal symptoms. These results may suggest that low job satisfaction does have an effect on musculoskeletal symptoms. Alternatively, a temporal ambiguity is possible, in that workers who experience what they perceive as job-related symptoms become less satisfied with their work.

Evidence from our study indicates that high job demand, low decision latitude, low social support and low job satisfaction jointly may produce create impact on symptoms of the hand/wrist, neck/shoulder and lower back. The data suggest than, st least for office workers, carpenters, and sprinkler fitters, strategies that allow workers to change work pace, to establish flexible work schedules, to encourage participatory management, and to develop supportive relationship with colleagues and superiors may help workers to avoid or minimize musculoskeletal symptoms.

Study Limitations

Low Response Rates

Low response is a concern if there are differential rates of responding by symptom and exposure status, conditional on covariates. The overall response rate was 31% despite several mailings. To assess the magnitude and direction of potential response bias, we conducted a telephone survey among nonrespondents (Table 6). Compared to our telephone survey, we had more exposed people participating in the questionnaire survey, but an equal proportion of CTS cases participating in the two surveys. An important covariate, age, was on average similar between questionnaire respondents and telephone survey respondents. These patterns, which suggest a differential response rates for exposed individuals, but no differential response by disease status imply that our odds ratio estimates for work task exposure and our prevalence estimates for CTS symptoms may not be biased due to the low response rates.

This conclusion is based on the assumption that the telephone survey is providing reasonable indicators of the distribution of workplace exposures and symptom occurrence for all of the nonrespondents of the mail survey. Although the sample size

was small, we had very few refusals. However, we were not able to contact XX% of the randomly selected nonrespondents. This was due to the lack of available telephone numbers, wrong numbers or simply no answers. Our telephone survey results are preliminary, but the fact that we have any quantitative information about non-respondents is helpful to assess potential bias.

In addition to the previously described issues of low response rates, and health worker selection, other factors that may also limit our analyses are sampling error, reliance on self-reported symptoms, recall bias, and the use of prevalence data.

We had 78 cases of CTS symptoms (general hand/wrist symptoms at least once a week) but the number of CTS cases for each occupational group are small (Figure 1). There are even less cases for the more restrictive definitions of CTS [nocturnal hand/wrist = 66, post job hand/wrist symptoms = 50 (Figure 1)]. Because of the overlapping confidence intervals for many of these comparisons, we cannot rule out the explanation that our finding are the results of random error and chance association. We did not make any statistical adjustments to compensate for the multiple comparisons made in this study. Despite the small number of cases, we did observe several work-related factors associated with CTS symptoms.

CTS Definition

CTS symptoms can have a gradual onset and it is difficult to pinpoint exactly when disease occurs (with or without clinical measures). The challenging and still debated research question is when to label the constellation of symptoms as CTS (Baker et al. 1990; Dawson et al. 1983; Katz et al., 1990). Our hand/wrist symptoms definition required the presence of pain, tingling, and numbness in the hand and fingers. By requiring all of these symptoms, the likelihood of these set of symptoms representing a condition other than CTS or pre-CTS is reduced, but still possible.

Our outcome measure may result in misclassification relative to "definitive" CTS, yet our symptoms outcome still represents a potentially serious health problem that is a likely indicator for future CTS. Most clinicians and researchers agree that neuro-diagnostic testing should be the "gold standard" for diagnosing definitive CTS (Nathan et al., 1992, Hadler, 1992, Katz et al., 1990). However this test probably identifies the more severe CTS cases, whereas a public health prevention objective is to identify disease at an earlier stage when it is more easily reversible and has not caused permanent damage. There are no studies that have examined the natural history of hand/wrist symptoms and CTS to know what proportion of people with CTS-like symptoms will progress to become "definitive" (neurodiagnostically confirmed) CTS.

Recall Bias

The reporting of workplace exposures (hours performing specific job tasks) is subject to inaccuracies, especially if cases tend to recall exposures better, or report inflated levels of exposures. We designed job task questions to facilitate easy recall (e.g., for typical days, how many hours do they perform tasks). We also asked the questions regarding workplace factors, injury history, and medical conditions before asking about musculoskeletal symptoms. The order of questions and the question design should have helped to reduce potential recall bias.

Prevalence Data

Prevalence data are limited by the inability to distinguish accurately between the onset of disease and the initiation of exposure (Kleinbaum et al., 1982). To estimate the incidence rate ratio, we used the prevalence odds ratio, POR, which can be a biased estimator of the rate ratio (Newman 1988; Alho, 1992). In order to evaluate this bias, age-specific disease durations must be known. This type of information is not available for CTS, nor can it be derived from a cross-sectional study.

In our questionnaire, we asked about duration of symptoms, and from this information, we estimated the date of CTS symptoms onset. Occupational history data included current job title and duration of time in that job. From job duration and estimated CTS symptoms onset, we were able to identify cases that likely occurred after the start of their current position. We used this information in our "post-job" symptom definition of CTS. This outcome measure produced similar results to the general hand/wrist symptoms definition. As we used a definition that was closer to an incidence measure, we had similar results suggesting that our use of the prevalence odds ratio approximates an incidence ratio reasonably well.

Conclusions

Our results are consistent with the observations from other studies that computer keyboard use causes or exacerbates CTS symptoms. It is supported by our findings that keyboard use for all active county office workers was associated with CTS symptoms and the effects were higher among court reporters and data entry staff (Table 5). The observed effects were modest compared with previous studies among non-office occupations with repetitive motion, vibration, and high force exposures (Hagberg et al, 1992), but they were consistent in direction and magnitude with the effects observed in other studies of office workers in which most odds ratio estimates for keyboard usage range from 1.5 to 2.5 (NIOSH 1993; NIOSH, 1990; Heyer, 1990). NIOSH researchers reported prevalence of 22% and 23% among newspaper workers (NIOSH, 1993; NIOSH 1990) and in a study among VDT use in the Puget Sound area, the prevalence of hand/wrist symptoms was 31% (Heyer et al., 1990). These are similar to our prevalence for the general hand/wrist definition, where symptoms had to occur at least once a month.

Future studies should focus on improving exposure assessment and developing a standardized criteria for defining CTS in epidemiologic studies. More specific information about the nature of keyboard work, e.g., the pace and intensity, posture factors, and the type of VDT equipment need to be incorporated in future epidemiologic studies. Key exposure measures, such as hours of keyboard use, need to be validated. Nearly all studies on VDT workers have relied on self-reported hours of exposure, but few have validated this information.

The prevalence of hand and wrist symptoms that we observed (10-25%) are unacceptably high and indicate a potential for undesirable occupational health and productivity consequences. Increased efforts must be made to develop ways to reduce the prevalence of these conditions. In many cases, the symptoms have not forced workers to change their assignments, but we do see an impact on the way people do their work and on their leisure activities.

Computer keyboard use in today's modern office continues to increase as do trends toward increased specialization among computer operators. The result is that more operators are performing a narrower set of tasks at faster rates. The number of workers subject to keyboard exposures is increasing. As technology and industry develop in the information age, we can expect this worker population to increase. Another disturbing trend is the electronic monitoring of keyboard operators (e.g. number of keystrokes, and number of customer service calls handled). Ergonomic design improvements can potentially extend worker productivity or at least maintain productivity without inducing health problems but there are limitations. Administrative changes that reduce the number of hours, the intensity of keyboard use, and establish a variety of job tasks will help to reduce CTS risks due to keyboard use. We should keep in mind that the

computer is a tool for the worker and workers should not evolve to becoming tools to the computer.

Despite limitations, our study also suggests that CTS is a significant problem among carpenters and sprinkler fitters. The prevalence of CTS symptoms was higher than occupational CTS rates reported from workers' compensation databases (Franklin et al., 1991). This supports the hypothesis that there is a greater health problem than indicated by worker compensation records. A symptom survey will nearly always be the most sensitive indicator of musculoskeletal injury. Differences in injury reporting behavior is a key factor to assess how much claims surveillance systems may underestimate the magnitude of musculoskeletal problems. Underreporting is likely to be greater among trade workers than other occupations.

The results of this study showed that a stressful psychosocial work environment was associated with increased prevalence of hand/wrist symptoms, neck/shoulder pain, and low back pain. Controlling for the effects of demographic and physical factors, job demand and job satisfaction consistently produce an effect on the prevalence of musculoskeletal symptoms, while social support and decision latitude did not show notable independent effects. Job demand appeared to have a dose response relationship with all four outcomes. The effects of high job demand on all hand/wrist, neck/ shoulder and low back symptoms appeared stronger in females than males.

Although we observed an impact on CTS symptoms for repetitive activities, we were not able to identify specific tasks that explained this effect. Healthy- worker selection is an important source of bias to consider in an analysis of musculoskeletal injury and exposures or work in these trade occupations. This selection bias limits our ability to assess the true magnitude of musculoskeletal injury in these worker groups. The prevalence of hand/wrist symptoms that we observed (10-20%) were high, and increased efforts must be made to better understand the causes of these musculoskeletal problems and to develop ways to reduce their prevalence. Further job-task analyses are needed to identify aspects of the work that affect CTS symptoms and that can be used to redesign or modify work practices to minimize adverse ergonomic exposures.

The diagnosis of CTS and the classification of CTS for epidemiologic studies is subject to substantial misclassification, even when based on electrodiagnostic criteria. Two neurologists, experts in CTS care and diagnosis, reviewed the same EMG results and agreed fairly well (as measured by kappa coefficient), however, even with the most objective clinical data, the potential for misclassification exists as demonstrated by the differences in rating between two neurologists (Table 25). The agreement between symptom reporting, clinical tests, and EMG results was generally low. Historical symptom reporting had the highest association with electrodiagnostic results. These associations need further evaluation and verification in future studies. The goal should be to identify symptom indicators that best represent electrodiagnostic results.

There have been few studies that addressed both occupational and non-occupational factors and their effect on CTS. In this analysis we have found that most medical conditions, and personal factors do not confound the relationship between specific job task exposures and CTS symptoms. Some factors however, did act as confounders and should be considered or accounted for in future studies. These factors were the presence of ganglion cysts, a history of a hysterectomy and nerve damage. Although most medical conditions and personal factors did not act as confounders, we did observe that a variety of medical conditions and personal factors are associated with CTS symptoms.

The debate over the importance of occupational factors versus medical or personal factors should be based on the simultaneous analysis of both these types of factors in worker populations. In future studies, we need to go beyond analyzing exclusively occupational factors among worker populations and personal/medical factors among clinical populations and develop studies that can address both issues.

Table 1. Characteristics of Survey Respondents by Occupational Group, Employment Status, and Missing Data - Office Workers

Occupational group	Number of respondents	Number of active workers	Reason for exclusion	Number excluded	Number included in analysis
1. Court reporters	191	187	not active worker	3	183
			missing employment status	1	
			missing age, sex or both	4	
			age ≥ 70 years	0	
2. Data entry staff	119	111	not active worker	6	104
			missing employment status	2	
			missing age, sex or both	5	
			age ≥ 70 years	2	
3. Clerks	194	171	not active worker	15	165
			missing employment status	8	
			missing age, sex or both	4	
			age ≥ 70 years	2	
4. Administrative/ technical	58	55	not active worker	3	52
			missing employment status	0	
			missing age, sex or both	3	
			age ≥ 70 years	0	
5. Other non-office occupations	50	48	not active worker/not office worker	50	0
6. Missing	16	6	missing employment status/occupation	16	0
Totals exclude other and missing occupational group (#5 & 6)	628	578	not active worker	27*	504
		524	missing employment status	11*	
			missing age, sex or both	16*	
			age ≥ 70 years	4*	

Table 2. Characteristics of Active County Office Workers by Occupation, Age, Sex, and Job Duration

Factor	Occupation								Totals	
	Court reporter		Data entry		Clerks		Admininistrative/ technical			
	N	%	N	%	N	%	N	%	N	%
Age group										
20-29	14	7.7	2	1.9	4	2.4	3	5.8	23	4.6
30-39	77	42.1	33	31.7	46	27.9	19	36.5	175	34.7
40-49	53	29.0	34	32.7	55	33.3	18	34.6	160	31.7
50-59	30	16.4	19	18.3	45	27.3	9	17.3	103	20.4
60-69	9	4.9	16	15.4	15	9.1	3	5.8	43	8.5
Total	183	100	104	100	165	100	52	100	504	100
Sex										
female	165	90.2	98	94.2	140	84.9	41	78.9	444	88.1
male	18	9.8	6	5.8	25	15.1	11	21.1	60	11.9
Total	183	100	104	100	165	100	52	100	504	100
Job duration										
0-1.9 years	14	7.7	20	19.2	26	15.8	19	36.5	79	15.7
2-4.9 years	22	12.0	12	11.5	24	14.5	9	17.3	67	13.3
5-9.9 years	36	19.7	14	13.5	27	16.4	10	19.2	87	17.3
10-14.9 years	52	28.4	42	40.4	64	38.8	10	19.2	168	33.3
15+ years	56	30.6	10	9.6	12	7.3	4	7.7	82	16.2
Missing	3	1.6	6	5.8	12	7.3	0	0	21	4.2
Total	183	100	104	100	165	100	52	100	504	100

Table 3. Characteristics of Survey Respondents by Occupational Group, Employment Status, and Missing Data - Trade Workers

Occupational group	Number of respondents	Number of active workers	Reason for exclusion	Number excluded	Number included in analysis
1. Sprinkler fitter	393	362	Age missing	11	345
			Age ≥ 70	3	
			Sex missing	3	
			Retired/not working	31	
2. Carpenters	280	238	Age missing	8	208
			Age ≥ 70	15	
			Sex missing	7	
			Retired/not working	42	
3. Foreman/other trade	64	60	Age missing	2	56
			Age ≥ 70	1	
			Sex missing	1	
			Retired/not working	4	
4. Administration	74	66	Age missing	1	58
			Age ≥ 70	0	
			Sex missing	7	
			Retired/not working	8	
5. Other	28	11	Age missing	3	0
			Age ≥ 70	8	
			Sex missing	0	
			Retired/not working	17	
6. Missing	55	34	Age missing	7	0
			Age ≥ 70	21	
			Sex missing	6	
			Retired/not working	21	
Total (excludes other and missing (#5 & 6)	811	726		144	667

Table 4. Characteristics of Active Trade Workers by Occupation, Age, Sex, and Job Duration

Factor	Occupation								Totals	
	Sprinkler Fitter		Carpenter		Foreman/other		Admininistrative			
	N	%	N	%	N	%	N	%	N	%
Age group										
20-29	50	14.5	51	24.5	3	5.4	5	8.6	109	16.2
30-39	117	33.9	70	33.7	22	39.3	10	17.2	219	32.8
40-49	124	35.9	46	22.1	16	28.6	28	48.3	214	32.1
50-59	49	14.2	32	15.4	11	19.6	11	19.0	103	15.4
60-69	5	1.5	9	4.3	4	7.1	4	6.9	22	3.3
Total	345	100	208	100	56	100	58	100	667	100
Sex										
female	26	7.5	7	3.4	1	1.8	2	3.5	36	5.4
male	319	92.5	200	96.6	55	98.2	56	96.5	630	94.6
Total	345	100	207	100	56	100	58	100	666	100
Job duration										
0-1.9 years	43	12.5	101	48.6	10	17.8	14	24.1	168	25.2
2-4.9 years	48	13.9	27	13.0	11	19.6	8	13.8	94	14.1
5-9.9 years	55	15.9	28	13.5	9	16.1	12	20.7	104	15.6
10-14.9 years	46	13.3	15	7.2	8	14.3	10	17.2	79	11.8
15+ years	14.4	41.7	27	12.9	16	28.6	13	22.4	200	30.0
Missing	9	2.6	10	4.8	2	3.6	1	1.7	22	3.3
Total	345	100	208	100	54	100	58	100	667	100

Table 5. Crude and Adjusted Prevalence Odds Ratios for Court Reporter and Data Entry Job Titles Compared to Clerical/Technical Job Titles, Among All Active County Office Workers

Occupation group	Crude			Adjusted for age and job duration			Adjusted for age, job duration, and personal/ medical factors		
	POR	95%CI	Pvalue	POR	95%CI	Pvalue	POR	95%CI	Pvalue
Clerks	1.00	--	--	1.00	--	--	1.00	--	--
Court reporter	0.62	(0.35,1.10)	.1124	0.76	(0.40,1.44)	.4328	0.94	(0.45,1.95)	.8658
Data entry	0.88	(0.46,1.67)	.6942	0.99	(0.51,1.91)	.9753	1.08	(0.52,2.23)	.8330

a. Adjusted for age and job duration, and for age, job duration, and personal/medical factors
b. Personal/medical factors include Body Mass Index (BMI), self-reported history of sprain and nerve damage.

Table 6. Prevalence Odds Ratios for CTS Symptoms and Working as a Carpenter or Sprinkler Fitter

Job Category	Crude		Adjusted[a]	
	POR	95% CI	POR	95% CI
Foreman/administrative[b]	1.00	--	1.00	--
Carpenter	2.07	(0.87, 4.96)	2.32	(0.89, 6.08)
Sprinkler fitter	3.13	(1.38, 7.06)	4.31	(1.73, 10.77)

a. Controlling for age, sex, job duration, and history of wrist sprain.
b. Reference group.

Table 7. Crude and Age-Adjusted Prevalence Odds Ratios for CTS Symptoms by Job Duration Categories, Among All Active County Workers

Job duration			Crude POR			Age-Adjusted POR		
(years)	(n)	Prevalence	POR	95% CI	Pvalue	POR	95% CI	Pvalue
0-1.9	79	15.4	1.0	--	.3724[a]	1.0	--	.1428[a]
2-4.9	141	19.4	1.67	(0.66, 4.25)	.2804	1.66	(0.64, 3.25)	.2953
5-9.9	227	27.9	2.76	(1.19, 6.41)	.0184	2.87	(1.11, 6.75)	.0158
10-14.9	400	11.0	0.98	(0.42, 2.28)	.9580	0.89	(0.38, 2.09)	.7822
15 +	483	10.8	0.95	(0.36, 2.53)	.9103	0.68	(0.25, 1.88)	.4499

a. Chi-squared test for trend.

Table 8. Crude and Adjusted Odds Ratios for General CTS Symptoms by Job Duration Among Active Trade Workers

Job Duration	Crude Effects		Adjusted Effects[a]	
	POR	95% CI	POR	95% CI
0 - 1.9 years	1.00	.059 [b]	1.00	.014 [b]
2 - 4.9 years	1.14	(0.58, 2.26)	1.17	(0.56, 2.44)
5 - 9.9 years	1.00	(0.51, 1.96)	0.84	(0.41, 1.71)
10 - 14.9 years	0.89	(0.42, 1.91)	0.68	(0.31, 1.51)
15 + years	0.58	(0.31, 1.08)	0.49	(0.25, 0.97)

a. Adjusted for age, sex, hours/week and history of wrist sprain.
b. P value test for trend

Table 9. Crude and Adjusted Prevalence Odds Ratios for Hours of Keyboard Use and CTS Symptoms Among All Active County Office Workers and Specific Occupational Groups

Study group/ exposure (hours)	percent exposed	Crude POR	Crude 95% CI	Crude Pvalue	Adjusted for age and job duration POR	Adjusted for age and job duration 95% CI	Adjusted for age and job duration Pvalue	Adjusted for age, job duration, and personal/medical factors[a] POR	Adjusted for age, job duration, and personal/medical factors[a] 95% CI	Adjusted for age, job duration, and personal/medical factors[a] Pvalue
All active County office workers										
0-2.9	25.9	1.0	--	.0871[c]	1.0	--	.0593[c]	1.0	--	.0453[c]
3-5.9	34.9	1.50	(0.73, 3.06)	.2667	1.55	(0.74, 3.22)	.2435	1.45	(0.66, 3.20)	.3592
6+	39.2	1.83	(0.92, 3.63)	.0850	1.99	(0.97, 4.06)	.0595	2.17	(1.00, 4.71)	.0506
> 5[b]	38.7	1.52	(0.93, 2.50)	.0964	1.82	(1.08, 3.08)	.0257	1.98	(1.11, 3.53)	.0209
Court reporters										
>5[b]	62.8	4.02	(1.14, 14.2)	.0307	5.34	(1.41, 20.3)	.0139		no convergence	
Data entry staff										
>5[b]	32.7	1.76	(0.59, 5.22)	.3093	1.86	(0.58, 5.94)	.2944	2.17	(0.56, 8.37)	.2607
Clerks/technical staff										
>5[b]	21.2	1.52	(0.67, 3.43)	.3106	1.54	(0.67, 3.53)	.3043	1.75	(0.70, 4.40)	.2350

a. Logistic model includes age, $(age)^2$, job duration, $(job\ duration)^2$, history of wrist sprain, nerve damage, and body mass index.
b. Reference group: those with ≤ 5 hours of keyboard work.
c. Chi-squared test for trend.

Table 10. Crude and Adjusted Prevalence Odds Ratios for General CTS Symptoms (1 / week) by Work Task Exposures Among All Active Trade Workers

Work Exposure	Proportion Exposed	Crude		Adjusted[a]	
		POR	95% CI	POR	95% CI
Repetitive motion					
(> 1/2 time)	0.66	3.79	(2.02, 7.13)	3.20	(1.62, 6.34)
Hand tool use					
0 - 2.9 hrs/day	0.20	1.00	0.22[b]	1.00	0.50[b]
3 - 5.9 hrs/day	0.26	0.34	(0.66, 2.72)	1.30	(0.60, 2.82)
6 + hrs/day	0.54	1.49	(0.80, 2.79)	1.38	(0.69, 2.75)
Power tool use					
0 - 2.9 hrs/day	0.46	1.00	0.60[b]	1.00	0.43[b]
3 - 5.9 hrs/day	0.20	1.56	(0.88, 2.72)	1.65	(0.90, 3.01)
6 + hrs/day	0.33	1.12	(0.66, 1.88)	1.22	(0.70, 2.14)
Extending arms above shoulder					
0 - 2.9 hrs/day	0.27	1.00	0.071[b]	1.00	0.072[b]
3 - 5.9 hrs/day	0.26	1.36	(0.71, 2.63)	1.55	(0.75, 3.21)
6 + hrs/day	0.47	1.69	(0.95, 3.00)	1.83	(0.96, 3.49)

a. Adjusted for age, sex, job duration, hours/week, history of wrist sprain.
b. P value test for trend.

Table 11. Crude and Adjusted Prevalence Odds Ratios for Repetitive Motion Activities and CTS Symptoms Among All Active County Office Workers and Selected Occupational Groups.

		Crude			Adjusted for age and job duration			Adjusted for age, job duration, and personal/medical factors[a]		
Study group	% exposed	POR[b]	95% CI	Pvalue	POR	95% CI	Pvalue	POR	95% CI	Pvalue
All active County office workers	81.7	1.95	(0.90, 4.22)	.0898	2.53	(1.11, 5.74)	.0262	2.03	(0.87, 4.80)	.1028
Data entry	79.4	1.99	(0.42, 9.17)	.3910	1.83	(0.34, 9.70)	.4772	1.52	(0.26, 8.78)	.6399
Clerks	68.9	2.65	(1.05, 6.71)	.0397	3.17	(1.16, 8.63)	.0240	2.41	(0.83, 7.01)	.1074
Court reporters[c]	98.3	--	--	--	--	--	--	--	--	--

a. Logistic model includes age, $(age)^2$, job duration, $(job\ duration)^2$, history of wrist sprain, nerve damage, and body mass index.
b. Exposed: workers with greater than 1/2 time in repetetive tasks. Reference group: those who report that job requires 1/2 time or less in repetitive motion acitivities of hands and fingers.
c. PORs not calculated, no reference group for odds ratio calculations, only small number (3) of court reporters with 1/2 time or less in repetitive activities.

Table 12. Comparison of Symptom Prevalence, Exposure Hours, and Age between Questionnaire Survey Respondents and Telephone Survey Respondents - Trade Workers

Factor	Carpenter's Union (409)		Sprinkler Fitter's Union (709)	
	Questionnaire	Telephone	Questionnaire	Telephone
Symptoms				
hand/wrist symptoms (%)[a]	15.5	15.9	18.4	24.5
tingling (%)	31.6	31.8	36.7	37.7
numbness (%)	28.9	25.0	35.1	34.0
any symptoms (%)[b]	52.5	43.2	57.7	52.8
Exposure factor				
hand tools (mean hrs/day)	5.1	3.4	5.3	5.0
hand tools (% >5 hours)	48.2	2.3	56.4	67.7
power tools (mean hrs/day)	4.3	2.5	3.4	1.8
power tools (% >5 hours)	37.4	1.9	25.8	9.3
Demographic/employment status				
age (mean total- years)	46.3	44.8	42.8	43.6
age (mean active - years)	40.2	37.7	40.2	40.5
active (%)	70.0	45.5	85.5	75.5
retired (%)	21.0	13.6	10.4	9.4
other inactive (%)	9.1	40.9	4.1	15.1

a. General hand/wrist symptoms occurring at least 1 time per month.
b. Presence of hand/wrist symptom: pain, tingling, or numbness.

Table 13. Proposed Mechanisms and Risk Factors for Carpal Tunnel Syndrome

Factors affecting the carpal canal and potential expression of CTS	References
Fluid retention mechanisms	
Pregnancy	Vessey et al., 1990; Ekman-Ordeberg et al., 1987; Stevens et al, 1992
Recent weight gain	Dieck et al., 1985
Obesity	Nathan et al., 1992b; Dieck et al, 1985
Hypertension ? ?	
Hormonal changes	
History of gynecological surgeries	Canon et al., 1981; Bjorkvist et al, 1977
Birth control pill use	Sabon et al, 1970
Menopause factors	Dieck et al., 1985; Vessay et al, 1990
Space occupying mechanisms	
Ganglionic cysts (rare)	Dawson et al., 1983
Cancer (rare)	Dawson et al., 1983
Swelling/inflammation of tendon sheaths (e.g., flexor tenosynovitis)	Dawson et al., 1983; Phalen, 1966
Arthritis	Phalen, 1966; Stevens at al, 1992
Scar tissue from previous injury	Phalen, 1966; Steven et al, 1992
Biomechanical mechanisms	
Awkward wrist position (flexion or extension)	Rempel et al., 1992; Feldman et al, 1983; Armstrong et al, 1979
Repetitive tasks	Armstrong et al., 1979; Rempel et al., 1992; Siverstein et al, 1987
Vibration	Weislander et al, 1969
Hand Dominance	Reinstein, 1981
Susceptibility Factors	
Wrist dimension (ratio width/depth)	
Carpal canal size	Bleeker et al, 1985
Obesity	Nathan et al., 1992b; Dieck et al., 1985
Diabetes - nerve sensitivity/degeneration	Stevens et al, 1992
Nerve degeneration	Dawson et al., 1983
Peripheral neuropathies	Stevens et al , 1992
Metabolic dysfunctions (hypothyroidism, myxedema)	Phalen, 1966; Dawson et al, 1983; Stevens et al, 1992
Previous injury, scar tissue	Phalen, 1966; 1983; Stevens et al, 1992
Toxic solvents, chemicals	
Vibration	Weislander et al, 1989
Biochemical/other potential mechanisms	
Vitamin deficiencies ??	Folkers et al, 1978
Smoking ??	

Table 14. Adjusted Prevalence Odds Ratios for CTS Symptoms[a], for Medical Conditions, Reproductive Factors, and Previous Injuries among Active Trade and County Office Workers, Adjusted for Age, Sex, and Job Duration, Estimated from Logistic Regression Model

Factor	N (with condition)	Age and sex			Age, sex and job duration		
		POR	95% CI	Pvalue	POR	95% CI	Pvalue
Medical factors							
Diabetes	(27)	1.33	(0.48, 3.62)	.5747	1.55	(0.55, 4.33)	.4030
Arthritis	(67)	2.18	(1.19, 4.00)	.0122	2.20	(1.19, 4.08)	.0126
Hypertension	(202)	1.02	(0.65, 1.68)	.9470	1.06	(0.69, 1.68)	.8185
Lupus	(8)	2.10	(0.41, 10.8)	.3868	2.11	(0.41, 10.8)	.3713
Ganglion cyst	(62)	3.03	(1.70, 5.39)	.0002	3.09	(1.70, 5.61)	.0002
Nerve damage	(51)	6.00	(3.33, 10.8)	.0001	6.14	(3.34, 11.3)	.0001
Tendinitis	(60)	2.31	(1.24, 4.31)	.0085	2.41	(1.28, 4.54)	.0065
Previous injury							
Wrist sprain	(150)	2.35	(1.52, 3.64)	.0001	2.40	(1.54, 3.75)	.0001
Arm fracture	(51)	0.68	(0.26, 1.75)	.4198	0.71	(0.28, 1.83)	.4752
Wrist fracture	(102)	1.54	(0.89, 2.67)	.1257	1.56	(0.89, 2.72)	.1171
Hand injury	(70)	1.79	(0.96, 3.35)	.0702	1.85	(0.98, 3.50)	.0582
Reproductive factors[b]							
Tubal ligation	(104)	1.02	(0.54, 1.91)	.9851	1.01	(0.54, 1.90)	.9884
Hysterectomy	(75)	1.80	(0.93, 3.48)	.0793	1.75	(0.90, 5.35)	.0980
Bilateral oophorectomy	(20)	0.52	(0.11, 2.34)	.3876	0.48	(0.11, 2.17)	.3433
Unilateral oophorectomy	(25)	1.58	(0.59, 4.20)	.3576	1.49	(0.55, 4.06)	.4385
Current birth control pills	(34)	0.98	(0.32, 3.04)	.9656	1.36	(0.49, 3.78)	.5540
Previous birth control pills	(157)	0.79	(0.43, 1.44)	.4500	0.75	(0.44, 1.27)	.2712

a. Hand and wrist pain, tingling, and numbness at least once a week.
b. Among females only.

Table 15. Prevalence Odds Ratios by Age Among Male and Female Active Trade and Office Workers, Estimated from Logistic Regression Models

Sex	Age	Crude			Adjusted		
		POR	95% CI	Pvalue	POR	95% CI	Pvalue
Males	20 - 29[a]	1.0	--	.0005[b]	1.0	--	.0005[b]
	30 - 39	3.40	(1.37,8.41)	.0081	3.44	(1.38,9.03)	.0079
	40 - 49	3.84	(1.57,9.38)	.0031	4.56	(1.82,11.4)	.0012
	50 - 59	2.45	(0.90,6.67)	.0801	3.63	(1.04,10.2)	.0147
	60 - 69	0	--	.--	0	--	.--
Females	20 - 29	1.02	(0.21,4.94)	.--	0.86	(0.17,4.31)	.--
	30 - 39	1.0	--	.9345[b]	1.0	--	.6139[b]
	40 - 49	1.25	(0.67,2.34)	.4877	1.35	(0.72,2.55)	.3352
	50 - 59	1.66	(0.84,3.27)	.1409	1.87	(0.93,3.75)	.0789
	60 - 69	1.27	(0.48,3.38)	.6312	1.26	(0.55,3.64)	.6650

a. Reference categories - males: 20-29 years old, females: 30-39 years old.
b. Chi-square test for trend; excludes 20-29 age group for ffemales, 60-69 age group for males.

Table 16. Crude and Adjusted Prevalence Odds Ratios for Obesity, Handedness and Hand Dominance, Smoking, and Leisure Activities, and CTS Symptoms Among All Active Trade and Office Workers, Estimated from Logistic Regression Models

Personal factor	Category	Number with condition	Crude			Adjusted[a]		
			POR	95% CI	Pvalue	POR	95% CI	Pvalue
Obesity (BMI)	slender (<21)	(85)	1.0	--	.0234[b]	1.0	--	.0379[b]
	medium (21-24.9)	(367)	0.79	(0.40,1.57)	.4943	0.82	(0.40,1.67)	.5864
	overweight (25-30)	(439)	0.98	(0.50,1.91)	.9568	1.01	(0.50,2.03)	.7943
	obese (30 +)	(180)	1.32	(1.64,2.71)	.4558	1.41	(0.68,2.94)	.3590
Handed-ness	mixed	(451)	1.0	--	--	1.0	--	--
	left	(114)	0.73	(0.38,1.40)	.3500	0.73	(0.38,1.41)	.3478
	right	(549)	0.93	(0.65,1.34)	.6898	0.89	(0.61,1.30)	.5128
Hand dominance	not dominant	(142)	1.0	--	.4274[b]	1.0	--	.2700[b]
	dominant	(389)	1.83	(0.48,1.43)	.4876	0.78	(0.45,1.35)	.3730
	strongly dominant	(583)	0.079	(0.47,1.32)	.3753	0.72	(0.42,1.22)	.2298
Smoking	non-smokers	(543)	1.0		.4039[b]	1.0	--	.4208[b]
	current smokers	(255)	1.39	(0.95,2.65)	.0927	1.38	(0.93,2.04)	.1078
	history of smoking[c]	(591)	1.10	(0.78,1.55)	.5775	1.09	(0.77,1.55)	.6454
Leisure activities	< 6 hours	(360)	1.0	--	.6111[b]	1.0	--	.8747[b]
	6 - 11 hours	(393)	0.92	(0.61,1.39)	.7035	0.95	(0.66,1.45)	.8014
	12 + hours	(285)	0.89	(0.57,1.40)	.6202	0.97	(0.59,1.59)	.9005

a. Adjusted for age, sex, and job duration
b. Chi-square test for trend
c. Includes current smokers

Table 17. Crude and Adjusted Prevalence Odds Ratios for Self-Reported Race / Ethnicity, and CTS Symptoms, Adjusted for Demographic and Occupational[a] Factors from Logistic Regression Models

Race / Ethnicity Group	Crude			Adjusted for Age, Demographic, and Occupational Factors		
	POR	95% CI	Pvalue	POR	95% CI	Pvalue
White[b]	1.00	--	--	1.0	--	--
Asian	1.07	(0.81, 2.80)	.866	0.86	(0.40, 1.86)	.7026
Black	0.95	(0.86, 1.83)	.8127	0.76	(0.47, 1.24)	.2644
Latino	0.77	(0.66, 1.58)	.3312	0.69	(0.40, 1.19)	.1901
Other	1.68	(0.59, 2.71)	.1872	1.63	(0.74, 3.58)	.2206

a. Logistic regression model, terms included: age, sex, job duration, (months), and quadratic term for age.
b. Reference category.

Table 18. Adjusted Prevalence Odds Ratios[a] for the Effects of Occupational Exposures for CTS Symptoms[b] After Controlling for Non-Occupational Factors Among Active Trade and County Office Workers, Estimated from Logistic Regression Models.

Worker group	Occupation exposure	Medical or injury factor	Adjusted POR[2]	95% CI	Pvalue	Bias[d]
County office workers	Repetitive motion activity (> 1/2 time) (uPOR[c] = 2.45)	arthritis	2.53	(1.15, 5.54)	.0205	-.034
		ganglion cyst	2.25	(1.06, 4.78)	.0347	.089
		tendinitis	2.43	(1.11, 5.34)	.0271	.049
		nerve damage	2.08	(0.97, 4.44)	.0582	.178
		body mass index	2.27	(1.07, 4.81)	.0326	.079
		wrist sprain	2.58	(1.21, 5.49)	.0140	.083
		hand injury	2.43	(1.15, 5.12)	.0194	.049
Trade workers	Repetitive motion activity (> 1/2 time) (uPOR[c] = 3.24)	Arthritis	3.47	(1.69, 7.12)	.0007	-.066
		Ganglion cyst	3.91	(1.85, 8.27)	.0004	-.171
		Tendinitis	3.40	(1.65, 7.00)	.0019	-.047
		Nerve damage	3.46	(1.68, 7.43)	.0008	-.064
		Body mass index	3.36	(1.62, 6.96)	.0011	-.036
		Wrist sprain	3.29	(1.60, 6.75)	.0012	-.015
		Hand Injury	3.16	(1.58, 6.31)	.0011	.025
County office workers	Keyboard use (> 3 hours) (uPOR[c] = 1.57)	arthritis	1.60	(0.96, 2.67)	.0750	-.019
		ganglion cyst	1.52	(0.90, 2.56)	.1174	.033
		tendinitis	1.48	(0.88, 2.50)	.1450	.061
		nerve damage	1.63	(0.96, 2.78)	.0736	-.037
		body mass index	1.54	(0.92, 2.35)	.1025	.019
		wrist sprain	1.66	(0.99, 2.77)	.0548	-.054
		hand injury	1.55	(0.93, 2.57)	.0903	-.013

a. Adjusted using logistic regression model controlling for age, job duration, occupation (trade workers only). Model also includes $(age)^2$ term [and $(job\ duration)^2$ for office workers only].
b. Hand and wrist pain, tingling, and numbeness at least once per week.
c. "Unadjusted" prevalence odds ratios: this is adjusted for demographic and occupational factors only.
d. Apparent bias calculated as: unadjusted POR - adjusted POR / adjusted POR.

Table 19. Prevalence of Neck/Shoulder Pain and Low Back Pain by Demographic Factors

Demographic information	Neck/shoulder pain			Low back pain		
	n/N†	%	p-value¥	n/N†	%	p-value¥
Total sample	714/1273	56.1		635/1224	51.9	
Gender						
Male	369/715	51.6		376/687	54.7	
Female	334/544	61.4	0.001	251/524	47.9	0.018
Ethnic group						
Black	122/248	49.2		114/237	48.1	
Hispanic	110/198	55.6		103/195	52.8	
White	408/705	57.9		356/679	52.4	
Others	63/102	61.8	0.070	51/95	53.7	0.655
Smoking status						
Never smoker	328/592	55.4		276/578	47.8	
Ex-smoker	191/364	52.5		189/347	54.5	
Smoker	182/288	63.2	0.019	161/280	57.5	0.015
Work hours/ wk						
<= 40	585/1056	55.4		535/1013	52.8	
> 40	129/217	59.5	0.274	100/211	47.4	0.152
Age						
20 - 29	74/136	54.4		78/135	57.8	*
30 - 39	252/417	60.4		218/403	54.1	
40 - 49	222/389	57.1		194/372	52.2	
> = 50	145/299	48.5	0.015	130/283	45.9	0.083

† n = number with symptoms; N = sample size in corresponding subgroup.
¥ P-value of chi-square test for difference between the prevalences.
* A test for trend p = 0.013

Table 20. Prevalence of Neck/Shoulder Pain and Low Back Pain by Occupational Subgroups

Occupational subgroup	Neck/shoulder pain			Low back pain		
	n/N†	%	p-value¥	n/N†	%	p-value¥
Carpenters						
Workmen	117/216	54.2		127/207	61.4	
Foremen	5/15	33.3		7/14	50.0	
Administrators	13/35	37.1	0.066	16/34	47.1	0.230
Office workers						
Court reporters	119/187	63.6		74/184	40.2	
Data entry	69/111	62.2		51/110	46.4	
Clerks	84/171	49.1		69/163	42.3	
Foremen	13/23	56.5		14/20	70.0	
Administrators	31/55	56.4	0.066	33/53	62.3	0.009
Sprinkler fitters						
Workmen	200/358	55.9		188/339	55.5	
Foremen	18/29	62.1		15/29	51.7	
Administrators	12/24	50.0	0.675	16/23	69.6	0.373

† n = number with symptoms; N = sample size in corresponding subgroup.
¥ P-value of chi-square test for prevalence distribution.

Table 21. Crude and Adjusted Prevalence Odds Ratio (POR) for each Psychosocial Factor on Presence of Three Hand/Wrist Symptoms: Results of Logistic Regression Analyses

Psychosocial factor	Crude			Adjusted for non-psychosocial factors†			Adjusted for non-psychosocial and psychosocial factors¥		
	POR	95% CI	p-value	POR	95% CI	p-value	POR	95% CI	p-value
Job demand									
low	1.00	--	**<0.001***	1.00	--	**<0.001**	1.00	--	**0.003**
medium	1.57	0.99, 2.48	0.043	1.49	0.88, 2.51	0.135	1.22	0.72, 2.07	0.467
high	2.74	1.54, 3.61	<0.001	2.45	1.45, 4.13	<0.001	2.03	1.19, 3.46	0.009
Decision latitude									
high	1.00	--	**0.037**	1.00	--	**0.695**	1.00	--	**0.497**
medium	1.26	0.90, 1.76	0.163	1.15	0.78, 1.68	0.478	1.03	0.69, 1.55	0.876
low	1.45	1.01, 2.08	0.045	1.08	0.70, 1.68	0.732	0.84	0.52, 1.35	0.469
Job satisfaction									
high	1.00	--	**0.001**	1.00	--	**<0.001**	1.00	--	**0.004**
medium	0.98	0.66, 1.45	0.923	1.06	0.68, 1.65	0.789	0.95	0.60, 1.49	0.806
low	1.73	1.26, 2.38	<0.001	1.92	1.32, 2.80	<0.001	1.75	1.16, 2.64	0.008
Social support									
high	1.00	--	**0.078**	1.00	--	**0.075**	1.00	--	**0.315**
medium	1.03	0.73, 1.47	0.851	0.90	0.61, 1.35	0.618	0.84	0.56, 1.27	0.409
low	1.39	0.98, 1.97	0.068	1.45	0.96, 2.17	0.076	1.23	0.80, 1.89	0.345

† Including age, gender, union membership, weekly work hours, duration on the job, and repetitive motion of the hand and wrist.

¥ Including all non-psychosocial factors listed above and all four psychosocial factors in the model.

* Boldface indicates p-values for Mantel-Haenszel chi-square test for trend, using the median of the score range of each category as the exposure score.

Table 22. Crude and Adjusted Prevalence Odds Ratio (POR) for each Psychosocial Factor on Neck and Shoulder Pain: Results of Logistic Regression Analyses

Psychosocial factor	Crude			Adjusted for non-psychosocial factors†			Adjusted for non-psychosocial and psychosocial factors¥		
	POR	95% CI	p-value	POR	95% CI	p-value	POR	95% CI	p-value
Job demand									
low	1.00	--	**<0.001***	1.00	--	**<0.001**	1.00	--	**<0.001**
medium	2.16	1.57, 2.97	<0.001	1.94	1.32, 2.86	<0.001	1.91	1.29, 2.82	0.001
high	2.93	2.14, 4.01	<0.001	2.53	1.69, 3.78	<0.001	2.29	1.53, 3.43	<0.001
Decision latitude									
high	1.00	--	**0.090**	1.00	--	**0.199**	1.00	--	**0.604**
medium	1.04	0.80, 1.36	0.743	1.10	0.80, 1.51	0.563	1.02	0.73, 1.42	0.923
low	1.32	0.98, 1.77	0.071	1.27	0.88, 1.84	0.199	1.12	0.75, 1.67	0.583
Job satisfaction									
high	1.00	--	**<0.001**	1.00	--	**0.004**	1.00	--	**0.157**
medium	1.64	1.22, 2.21	<0.001	1.74	1.23, 2.47	0.002	1.53	1.07, 2.19	0.019
low	1.57	1.20, 2.04	<0.001	1.65	1.20, 2.28	0.002	1.32	0.93, 1.88	0.116
Social support									
high	1.00	--	**0.075**	1.00	--	**0.035**	1.00	--	**0.245**
medium	1.09	0.83, 1.43	0.527	1.05	0.76, 1.44	0.777	1.02	0.74, 1.41	0.901
low	1.30	0.98, 1.73	0.071	1.46	1.03, 2.08	0.033	1.25	0.87, 1.81	0.227

† Including age, gender, union membership, body mass index, weekly work hours, duration on the job, and repetitive motion of the hand and wrist.

¥ Including all non-psychosocial factors listed above and all four psychosocial factors in the model.

* Boldface indicates p-values for Mantel-Haenszel chi-square test for trend, using the median of the score range of each category as the exposure score.

Table 23. Crude and Adjusted Prevalence Odds Ratio (POR) for each Psychosocial Factor on Low Back Pain: Results of Logistic Regression Analyses

Psychosocial factor	Crude			Adjusted for non-psychosocial factors†			Adjusted for non-psychosocial and psychosocial factors¥		
	POR	95% CI	p-value	POR	95% CI	p-value	POR	95% CI	p-value
Job demand									
low	1.00	--	**<0.001***	1.00	--	**<0.001**	1.00	--	**0.003**
medium	1.50	1.09, 2.07	0.010	1.24	0.85, 1.81	0.259	1.14	0.78, 1.68	0.498
high	1.95	1.42, 2.69	<0.001	1.91	1.29, 2.82	0.001	1.71	1.15, 2.56	0.009
Decision latitude									
high	1.00	--	**0.977**	1.00	--	**0.531**	1.00	--	**0.847**
medium	0.97	0.74, 1.26	0.806	0.93	0.68, 1.28	0.662	0.88	0.64, 1.23	0.460
low	1.02	0.75, 1.37	0.924	1.14	0.80, 1.63	0.479	1.05	0.71, 1.55	0.815
Job satisfaction									
high	1.00	--	**0.015**	1.00	--	**0.023**	1.00	--	**0.103**
medium	1.49	1.10, 2.00	0.007	1.47	1.05, 2.07	0.026	1.37	0.97, 1.95	0.078
low	1.36	1.04, 1.77	0.025	1.46	1.07, 2.00	0.017	1.36	0.97, 1.92	0.077
Social support									
high	1.00	--	**0.331**	1.00	--	**0.902**	1.00	--	**0.457**
medium	0.82	0.63, 1.09	0.154	0.88	0.64, 1.20	0.419	0.84	0.61, 1.16	0.284
low	0.88	0.66, 1.17	0.387	0.98	0.70, 1.38	0.914	0.88	0.62, 1.26	0.482

† Including age, gender, union membership, body mass index, weekly work hours, duration on the job, and smoking status.

¥ Including all non-psychosocial factors listed above and all four psychosocial factors in the model.

* Boldface indicates p-values for Mantel-Haenszel chi-square test for trend, using the median of the score range of each category as the exposure score.

Table 24. CTS Nested Case-Control Study. Summary of Contact Efforts, Participation, and Refusals

Union†	Case control status	Sex	Number eligible	Number contacted	Unable to contact	No attempt to contact	Refused	Interviewed
409	cases	male	51	32	19	1	22	11
409	controls	male	160	34	108	18	23	12
709¥	cases	male	66	40	26	0	23	19
709	controls	male	164	44	79	41	25	21
660	cases	male	15	5	8	2	3	2
660	controls	male	28	6	15	7	0	2
660	cases	female	114	71	43	0	37	34
660	controls	female	213	83	129	1	51	32
Totals			810	315	427	70	184	133

† 409 = carpenter's union, 709 = sprinkler fitter's, 660 = County office worker's.
¥ Two females cases and controls were interviewed from union 709 for a total of 137 participants. (68 cases and 69 controls).

Table 25. Inter-Rater Agreement for Electrodiagnosis of CTS

Neurologist A→ Neurologist B ↘	Positive CTS	Equivocal	Negative CTS	Total
Positive CTS	49	8	10	67
Equivocal	2	3	6	11
Negative CTS	10	2	47	59
Total	61	13	63	137

Table 26. Weighted and Unweighted Kappa Coefficients for Physician Rating of Electrodiagnosis Results

Kappa coefficient (type)	Value	95% CI
Unweighted	0.51894	(0.38892, 0.64897)
Weighted (linear)	0.57376	(0.43602, 0.7150)
Weighted (quadratic)	0.60837	(0.46784, 0.74890)

Table 27. Final Diagnosis of Nerve Conduction Abnormality

Category	Number	Percent
CTS Positive	65	47.4%
Equivocal	12	8.8%
CTS Negative	60	43.8%
Total	137	100.0%

Table 28. CTS Nested Case-Control Study Comparison of EMG Global Diagnosis to Symptom Reporting and Usual Tests

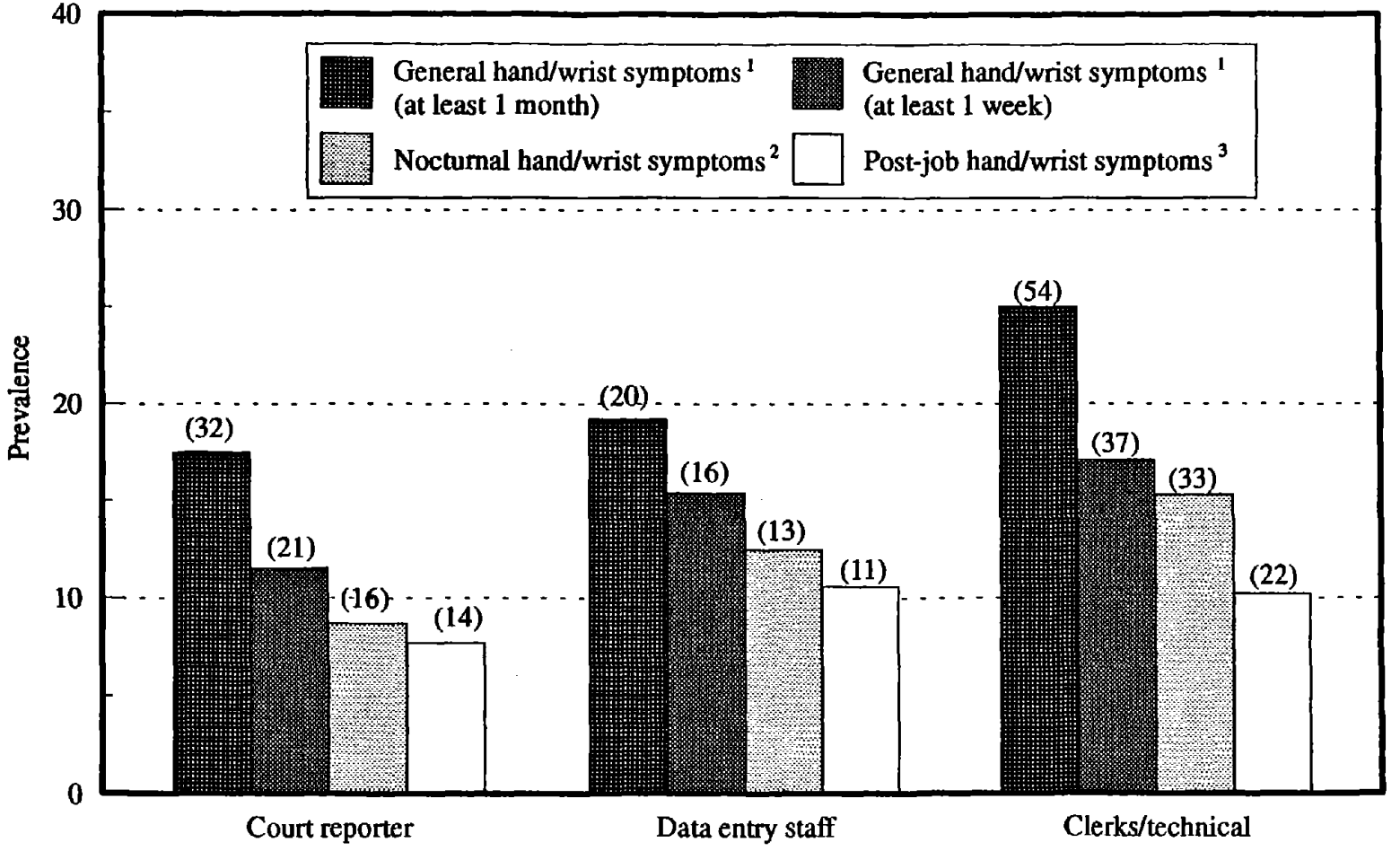
Symptom or Test Measure	EMG Diagnosis Category								
	Positive		Equivocal		Negative		Total number[2]	Sensitivity[3]	Specificity[3]
	number	percent[1]	number	percent[1]	number	percent[1]			
1. Mail survey symptom reporting[4]									
positive	37	54.4	4	5.9	27	39.7	68		
negative	27	39.7	8	11.8	33	48.5	68		
total	64	47.1	12	8.8	60	44.1	136	0.578	0.569
2. Case-control interview symptom reporting[4]									
positive	23	52.3	2	4.6	19	43.2	44		
negative	41	44.6	10	10.8	41	44.6	92		
total	64	47.1	12	8.8	60	44.1	136	0.359	0.708
3. Phalen's test									
positive	19	44.2	5	11.6	19	44.2	43		
negative	43	47.8	7	7.8	40	44.4	90		
total	62	46.6	12	9.0	59	44.4	133	0.306	0.620
4. Tinel's test									
positive	8	44.4	2	11.1	8	44.4	18		
negative	54	45.0	10	8.7	51	44.4	115		
total	62	46.6	12	9.0	59	44.4	133	0.129	0.859

1. Row percent
2. Missing data: EMG data: 1 subject, Tinel's and Phalen's test: 3 subjects.
3. Sensitivity and specificity calculated by collapsing equivocal and negative categories compared to positive category.
4. Presence of tingling, numbness and pain in hand/wrist area.

Table 29. CTS Nested Case-Control Study Correlation of Initial Case-Control Symptom Criteria (Mail Survey Symptom Reporting) with Clinical Tests and Current Symptoms

Symptom criteria	Mail Survey Symptom Reporting				
	Positive		Negative		Total
	number	percent	number	percent	
Case control symptom reporting					
positive	37	54.4	8	11.6	45
negative	31	45.6	61	88.4	92
total	68	100.0	69	100.0	137
Phalen's test					
positive	29	43.3	15	22.4	44
negative	38	56.7	52	77.6	90
total	67	100.0	67	100.0	134
Tinel's test					
positive	7	10.4	11	16.4	18
negative	60	89.6	56	83.6	116
total	67	100.0	67	100.0	134

Figure 1. CTS Symptom Prevalence by Occupational Group and CTS Symptom Definition Among Active County Office Workers



1. Reported pain, tingling and numbness in hand/wrist.
2. Pain, tingling plus night symptoms in hand/wrist.
3. Nocturnal symptoms plus onset after start of job.
4. Numbers of cases are in parentheses.

Figure 2. CTS Symptom Prevalence (> 1 per week) and 95% Confidence Intervals by 10 Year Age Groups Among All County Office Workers

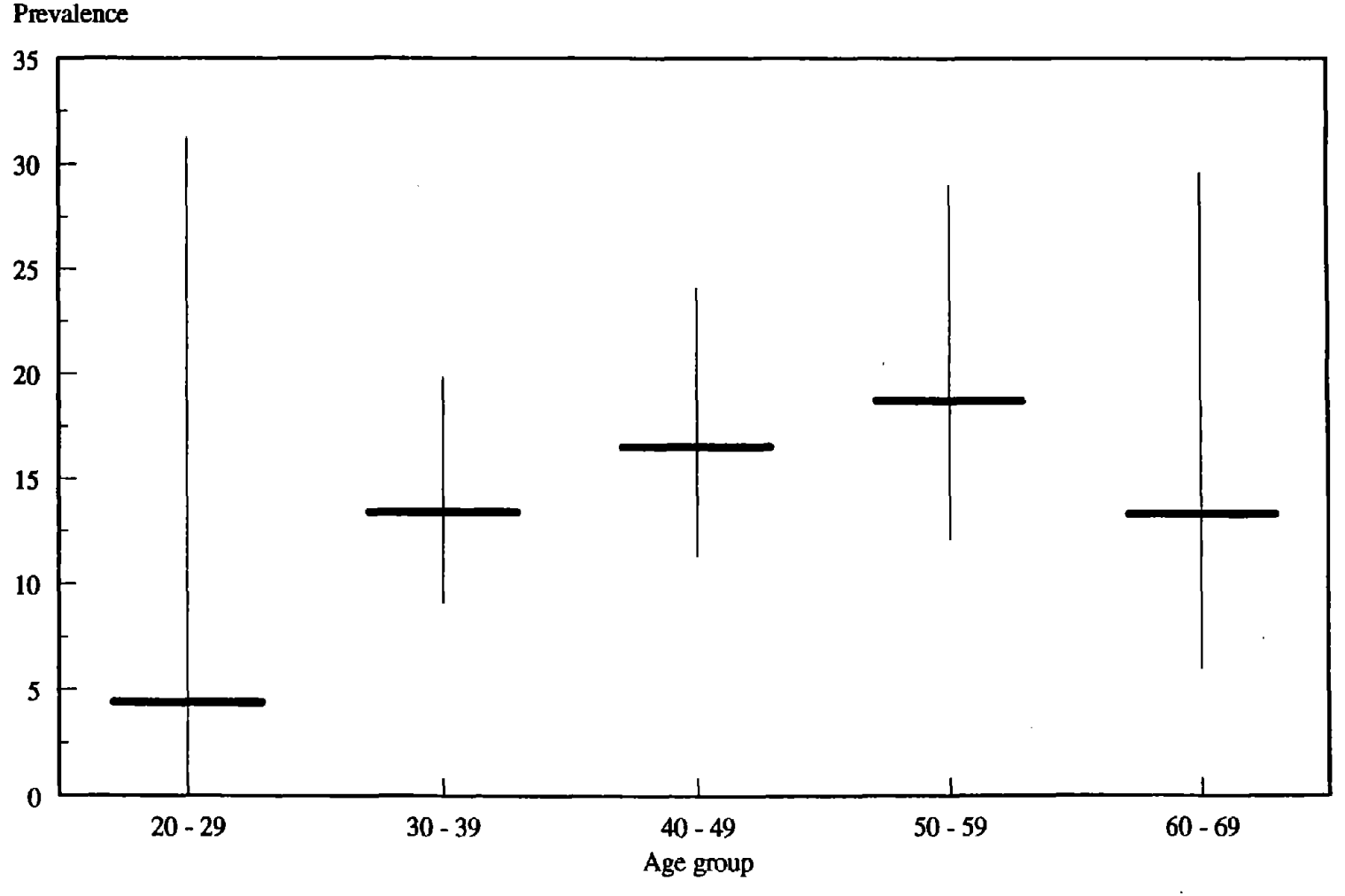


Figure 5. Self-Reported Impacts of CTS Symptoms on Work and Leisure Activities Among Those with Hand/Wrist Symptoms (1 / week or more) by Activity

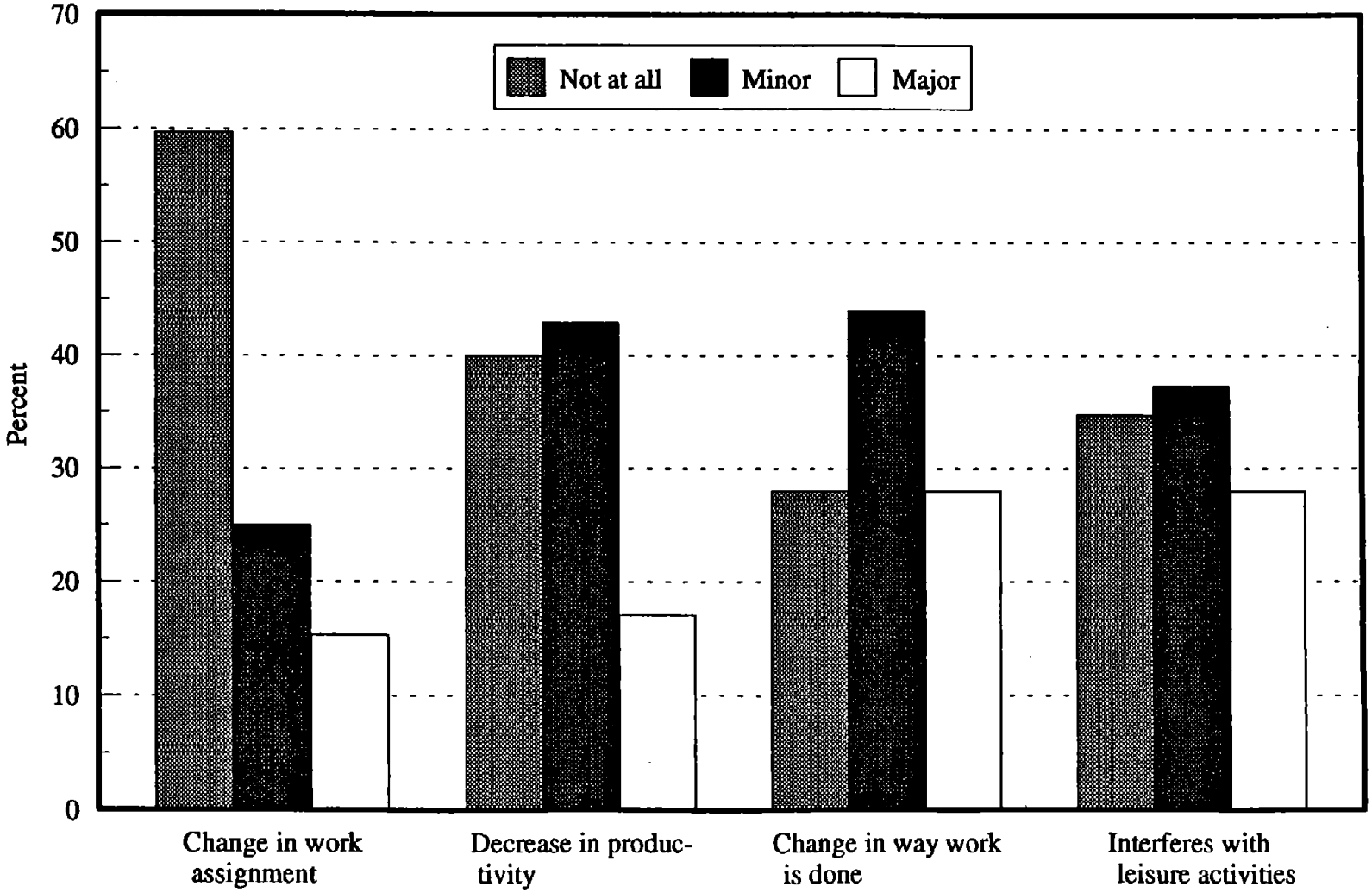


Figure 4. CTS Symptom Prevalence (> 1 per week) and 95% Confidence Intervals by 10 Year Age Groups Among Active Trade Workers

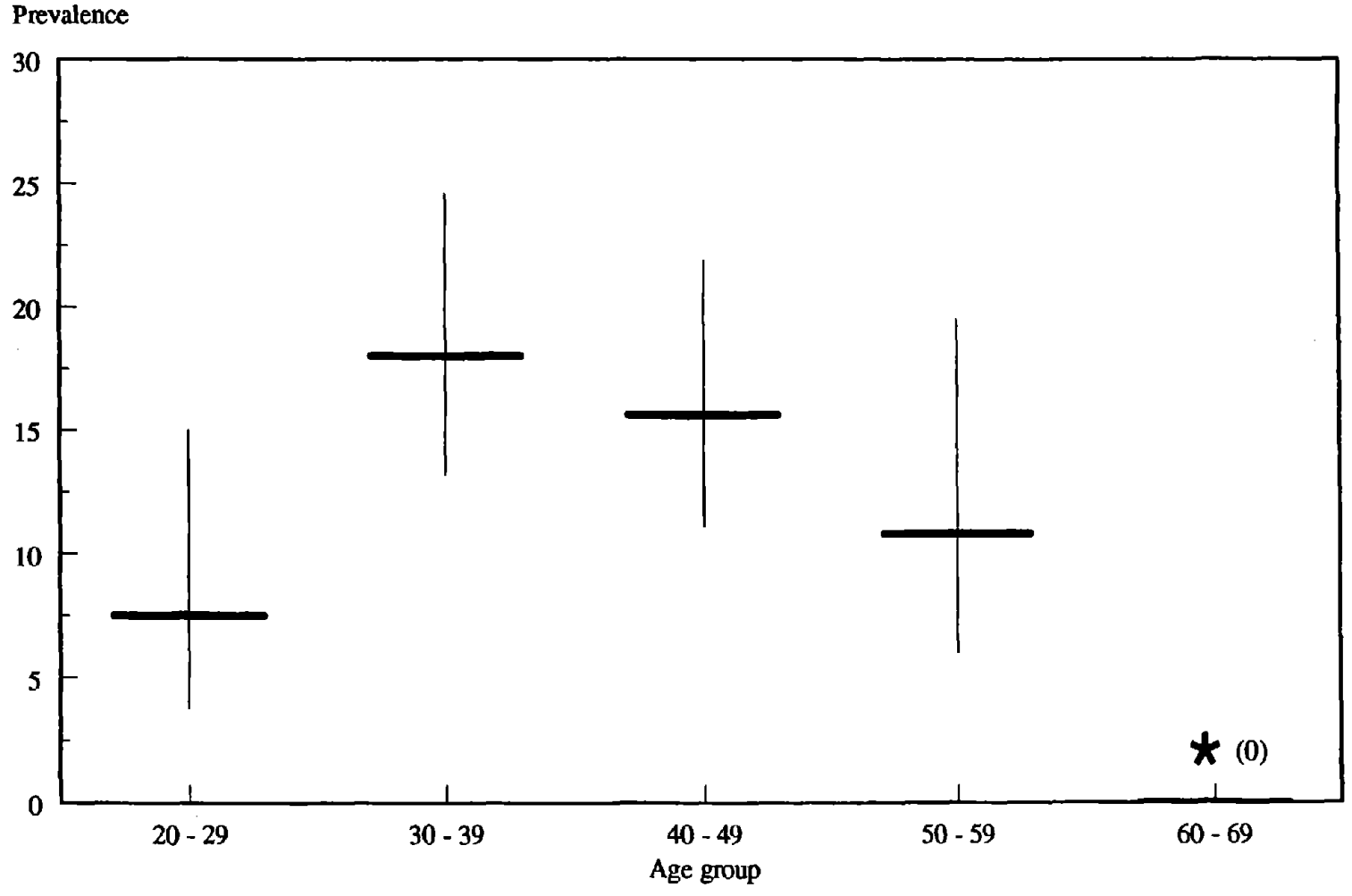
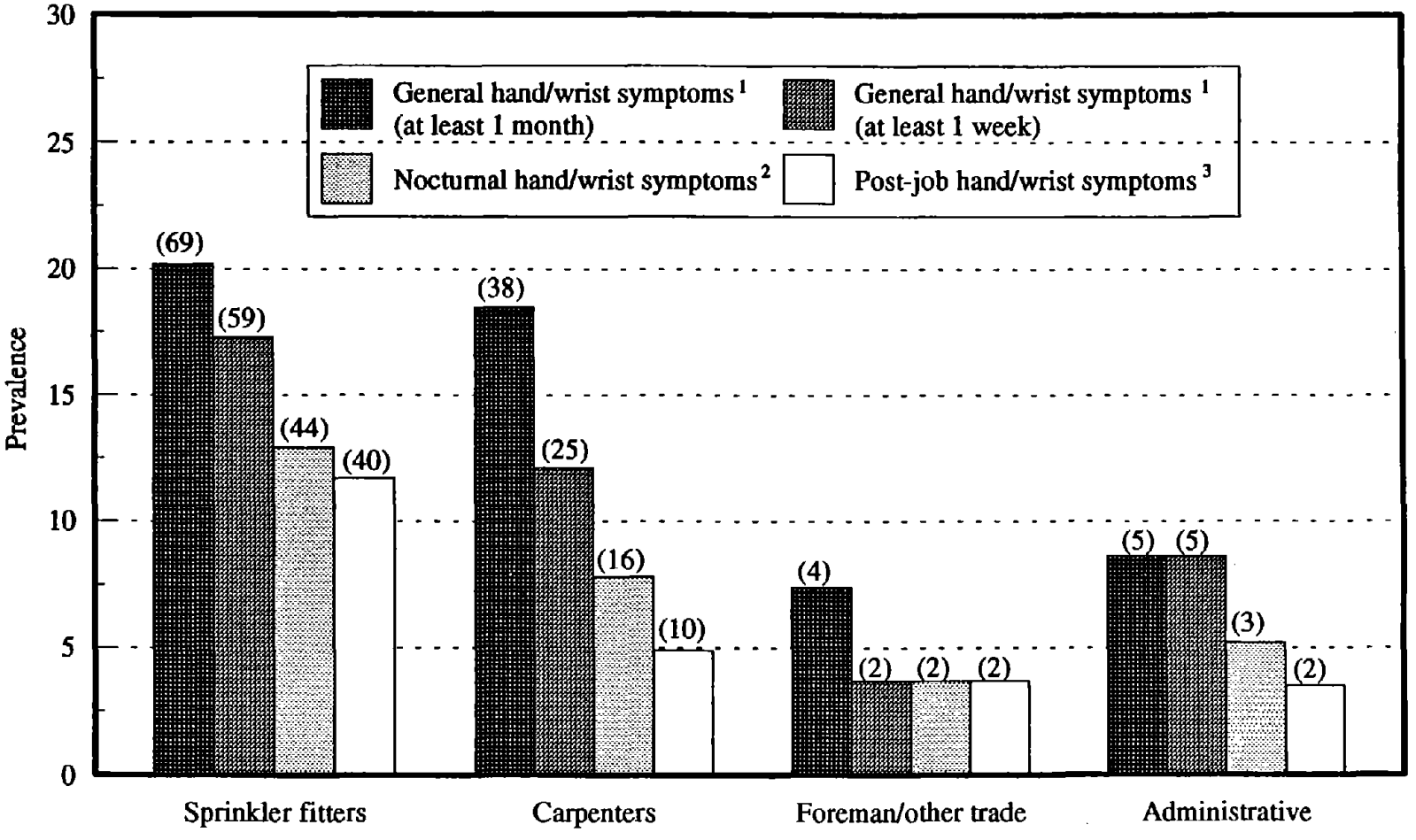
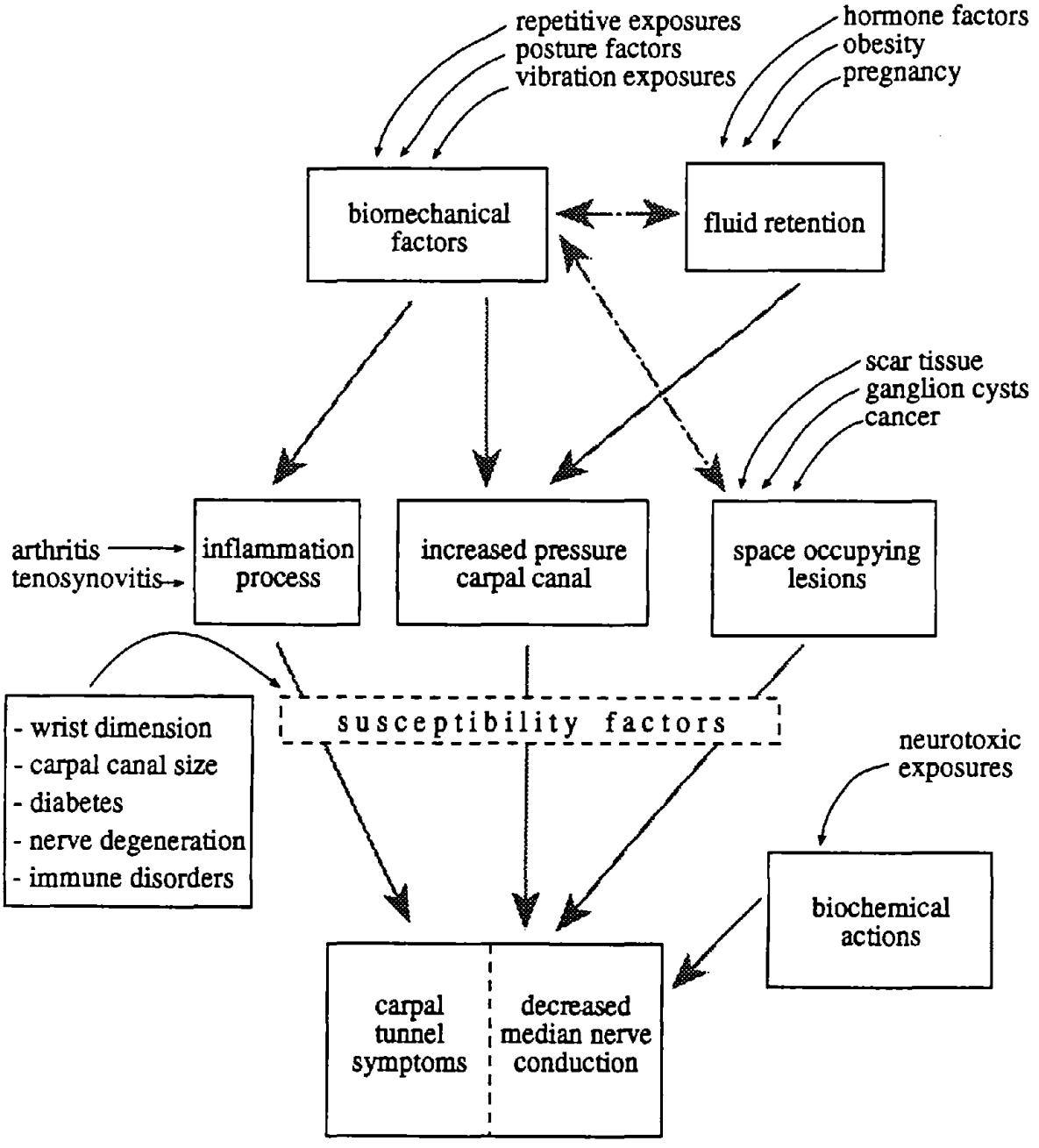


Figure 3. CTS Symptom Prevalence by Occupational Group and CTS Symptoms Criteria Among All Active Trade Workers



1. Reported pain, tingling and numbness in hand/wrist.
2. Pain, tingling plus night symptoms in hand/wrist.
3. Nocturnal symptoms plus onset after start of job.
4. Numbers of cases are in parentheses.

Figure 6. Potential Framework for Risk Factors and Causal Mechanisms for CTS



Acknowledgements

This study would not have been possible without the many hours of voluntary assistance of Dr. Steven Levine and Dr. Charlene Hafer. We would also like to acknowledge Reina Haque, Max Hechter, and Nola Kennedy for their efforts as research assistants, Betty Tenney and Karen Haines for programming asssistance, Dena Sherick for manuscript preparation, Delia Garnes for data coding, and Suzanna Garcia for for assistance in EMG testing. We would also like to express our thanks to Jack Sahl of the the Southern California Edison Company and to EcoAnalysis Inc. for their administrative support for this project.

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List of Project-Related Present and Future Publications

Publications

Kelsh MA. An Epidemiologic Study of Carpal Tunnel Syndrome Symptoms among Office Workers, Court Reporters, Carpenters and Sprinkler Fitters. Dissertation Report. UCLA School of Public Health. September, 1993

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Conference Presentations

M.A. Kelsh, D. Ke, and H. Morgenstern. October, 1993. Shoulder, neck, and back pain among trade and office workers. Presented at the American Public Health Association Annual Meetings. San Francisco, CA

M. A. Kelsh, D. Ke, and H. Morgenstern. June, 1993. The importance of non-occupational risk factors in the assessment of occupationally-related carpal tunnel syndrome. Presented at Society for Epidemiologic Research Annual Meetings. June, 1993 Keystone, CO

M. A. Kelsh, H. Morgenstern, and D. Ke. September 1992. A cross-sectional study of carpal tunnel syndrome symptoms among trade and office workers. Presented at the Ninth International Symposium, Epidemiology in Occupational Health. Cincinnati, OH.

Future Publications

Kelsh MA and Morgenstern H. The prevalence of hand/wrist symptoms consistent with carpal tunnel syndrome among county office workers and court reporters

Kelsh MA and Morgenstern H. The impact of occupational factors on the prevalence of carpal tunnel syndrome symptoms among carpenters and sprinkler fitters.

Kelsh MA, Ke D, Morgenstern H. The impact of medical conditions, previous injury, and other personal factors on the occurrence of carpal tunnel syndrome symptoms among trade and office workers.

Appendices

Survey Questionnaire

Survey Cover Letters and reminder forms

Case-control interview form

Case-control electrodiagnostic data form

UNIVERSITY OF CALIFORNIA, LOS ANGELES UCLA

BERKELEY · DAVIS · IRVINE · LOS ANGELES · RIVERSIDE · SAN DIEGO · SAN FRANCISCO SANTA BARBARA · SANTA CRUZ

OCCUPATIONAL STUDY OF MUSCULOSKELETAL CONDITIONS
DEPARTMENT OF EPIDEMIOLOGY

SCHOOL OF PUBLIC HEALTH
10833 LE CONTE AVENUE
LOS ANGELES, CALIFORNIA 90024-1772

January, 1991

Dear Union Member,

You are receiving this questionnaire as part of a health study among trade, professional and office workers. This research is being conducted by colleagues and me of the UCLA School of Public Health. Your name and address was randomly selected from your union roster, which was made available to us by your union's Board of Directors or appropriate governing committee.

The purpose of this research is to examine health problems among selected trade, professional and office workers. All the information you provide in this questionnaire will be confidential. Your individual results will not be released to anyone.

We appreciate your participation in this survey. It should only require 15-20 minutes of your time. Please return it to our research office as soon as possible. A self-address stamped envelope is enclosed for your convenience.

If you have any questions or comments regarding this health survey please feel free to call or write to the address listed below. Thank you in advance for your assistance on this project.

Sincerely,

Hal Morgenstern

Hal Morgenstern, Ph.D.
Associate Professor
Department of Epidemiology
UCLA School of Public Health
Los Angeles, CA 90024-1772

(213) 206-4756

UNIVERSITY OF CALIFORNIA, LOS ANGELES UCLA

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OCCUPATIONAL STUDY OF MUSCULOSKELETAL CONDITIONS
DEPARTMENT OF EPIDEMIOLOGY

SCHOOL OF PUBLIC HEALTH
10833 LE CONTE AVENUE
LOS ANGELES, CALIFORNIA 90024-1772

May, 1991

Dear Union Member,

Several months age you received this questionnaire as part of a new health study being conducted among trade, professional and office workers. Although we recognize that you may have been too busy to complete the survey, **your participation in this project is extremely important for the success of our research.** The information obtained in this study will be valuable in understanding and preventing occupational health problems. Please take 10-15 minutes and make your contribution to this effort. ***We want your responses whether or not you have any health problems to report.***

This research is being conducted in cooperation with your union by the UCLA School of Public Health. Your name and address was provided to us by your union's Executive Committee or appropriate union officials. Please return the questionnaire in the self-addressed stamped envelope. All responses will be confidential; individual results will not be released to anyone.

We appreciate your participation in this survey. If you have any questions or comments regarding this health survey, please write or call us at the address and telephone number listed below. Thank you in advance for your assistance on this project.

Sincerely,

Hal Morgenstern, Ph.D.
Associate Professor
Department of Epidemiology
UCLA School of Public Health
Los Angeles, CA 90024-1772

(213) 206-4756

Dear Union Member,

You should have recently received a questionnaire from the UCLA School of Public Health.

Your participation is essential for the success of this scientific research.

Please take 15 - 20 minutes to fill it out and return it in the self-addressed envelope as soon as possible.

If you did not receive or you have misplaced your questionnaire, please call or write to our office and we will gladly send you another copy. Thank you for your participation in this study.

UCLA Occupational Study of Musculoskeletal Conditions
School of Public Health EY14

10833 Le Conte Avenue
Los Angeles, CA 90024-1772
(213) 206-4756

Have you returned your UCLA Health Survey?

If not, please take a few minutes to complete it.

Remember, your participation is extremely important. We need your response whether or not you have any health problems to report.

Please fill out your questionnaire, and return it in the postage-paid envelope.

If you've already mailed your questionnaire, thank you for your cooperation.

If you need another questionnaire or have any questions, please call (213) 206-4756.

UCLA Occupational Study of Musculoskeletal Conditions

Occupational Study of Musculoskeletal Conditions

A Survey among members of:

Carpenters Union - Local 409

Service Employees International Union - Local 660

Sprinkler Fitters Union - Local 709

PLEASE ANSWER THE FOLLOWING QUESTIONS BY CHECKING THE MOST APPROPRIATE ANSWER OR FILLING IN THE SPACE PROVIDED.

1. Have you been employed or self-employed in the **past 6 months?**
   - 1☐ Yes →→→ Skip to question #3.
   - 2☐ No, retired
   - 3☐ No, quit work or laid off
   - 4☐ No, because of family reasons (for example, child care)
   - 5☐ No, because of pregnancy
   - 6☐ No, because of health reasons (Please describe) _____
   - 7☐ No, other reason (Please describe)_____

2. If you answered No to question #1, when were you last employed? (month/year) ____/____

3. What is your current or most recent job title?_____

   A. Please describe your responsibilities and typical job tasks (for example, computer data entry, supervising, loading materials, framing, threading and fitting pipe).

   _____

   _____

4. When did you first begin this job? (month/year) ____/____

5. How many hours per week, on the average, do/did you work in this job? _____ hours per week

6. How many weeks were you **not** employed in the **past 12 months?** (Do not include vacations.)

   _____ weeks **not** employed

7. In a typical work day, how many hours per day do you spend in the following activities? (If you do not perform the activity, please write 0.)

   A. Using a computer keyboard or typewriter

   _____ hours per day

   B. Using hand tools, for example, pliers, planes, screwdrivers, hammers

   _____ hours per day

   C. Using power tools, for example, power drills, power saws, boring tools, power hammers, power screwdrivers

   _____ hours per day

   D. Extending your hands above your shoulders to reach something or perform a work task

   _____ hours per day

8. Does this job require the same type of arm, hand, or finger action to be repeated many times each work day?

1 ☐ No, never
2 ☐ Yes, but less than one quarter of the time
3 ☐ Yes, between one quarter and one half of the time
4 ☐ Yes, more than one half of the time

9. **During the past year,** how much time, on the average, did you spend in the following activities outside of work? PLEASE CHECK THE APPROPRIATE BOX FOR EACH ACTIVITY.

Activity	Rarely or never	Less than 1 hour per week	1-4 hours per week	5-9 hours per week	10 or more hours per week
	1	2	3	4	5
A. gardening	☐	☐	☐	☐	☐
B. housework	☐	☐	☐	☐	☐
C. knitting or crocheting	☐	☐	☐	☐	☐
D. machine sewing	☐	☐	☐	☐	☐
E. playing musical instruments	☐	☐	☐	☐	☐
F. carpentry or woodworking	☐	☐	☐	☐	☐
G. using power tools	☐	☐	☐	☐	☐
H. racquet sports	☐	☐	☐	☐	☐

QUESTIONS 10-12 FOR WOMEN ONLY – MEN SKIP TO QUESTION 13

10. Are you currently pregnant?

1 ☐ No or don't know
2 ☐ Yes →→ What month are you in? _____ month

11. Have you ever used birth control pills?

1 ☐ No, never used
2 ☐ Yes, used before, but **not** currently using →→ Last used? (month/year) ____/____
3 ☐ Yes, currently using →→ How long have you used? ____ months **or** ____ years

12. Have you ever had any of the following types of surgery?

A. Tubal ligation (artificial sterilization)	1 ☐ No	2 ☐ Yes
B. Hysterectomy (removal of uterus)	1 ☐ No	2 ☐ Yes
C. Unilateral oophorectomy (removal of one ovary)	1 ☐ No	2 ☐ Yes
D. Bilateral oophorectomy (removal of both ovaries)	1 ☐ No	2 ☐ Yes

13. For each of the activities below, indicate which hand you prefer to perform the activity.

Activity	Always use left	Usually use left	Use both equally	Usually use right	Always use right
	1	2	3	4	5
Writing	☐	☐	☐	☐	☐
Throwing	☐	☐	☐	☐	☐
Using a toothbrush	☐	☐	☐	☐	☐
Opening a bottle or can	☐	☐	☐	☐	☐
Holding a knife to cut food	☐	☐	☐	☐	☐
Using hand tools	☐	☐	☐	☐	☐

14. Have you ever been told by a doctor that you have any of the following medical conditions? If yes, indicate the date of diagnosis.

Medical Condition			Date of Diagnosis (month/year)
A. Hypertension (high blood pressure)	1☐ No	2☐ Yes →→→	___/___
B. Diabetes (high blood sugar)	1☐ No	2☐ Yes →→→	___/___
C. Rheumatoid arthritis	1☐ No	2☐ Yes →→→	___/___
D. Systemic lupus erythematosus (Lupus)	1☐ No	2☐ Yes →→→	___/___
E. Raynaud's disease (white finger)	1☐ No	2☐ Yes →→→	___/___
F. Nerve damage (for example, neuropathies)	1☐ No	2☐ Yes →→→	___/___
G. Tendinitis in the wrist	1☐ No	2☐ Yes →→→	___/___
H. Ganglion cyst or tumor of the wrist	1☐ No	2☐ Yes →→→	___/___
I. Carpal tunnel syndrome	1☐ No	2☐ Yes →→→	___/___
If yes, did you have surgery for carpal tunnel syndrome?	1☐ No	2☐ Yes →→→	___/___ (Date of Surgery)

15. Have you ever experienced any of the injuries listed below? For each type of injury you have had, please provide the following details **for the most recent event:** 1) Which side is affected: right, left, or both sides? 2) When did the injury occur? 3) Did you seek medical care for the injury?

Type of injury	Ever had this?	Side affected	Date of injury (month/year)	Did you seek medical care?
Wrist fracture	1☐ No 2☐ Yes →→→	1☐ Right 2☐ Left	___/___ ___/___	1☐ No 2☐ Yes 1☐ No 2☐ Yes
Wrist sprain	1☐ No 2☐ Yes →→→	1☐ Right 2☐ Left	___/___ ___/___	1☐ No 2☐ Yes 1☐ No 2☐ Yes
Forearm fracture	1☐ No 2☐ Yes →→→	1☐ Right 2☐ Left	___/___ ___/___	1☐ No 2☐ Yes 1☐ No 2☐ Yes
Crushing injury to hand	1☐ No 2☐ Yes →→→	1☐ Right 2☐ Left	___/___ ___/___	1☐ No 2☐ Yes 1☐ No 2☐ Yes

16. **Within the past month,** have you experienced the following symptoms? If yes, which side is affected?

A. Pain in hands or fingers	1☐ No 2☐ Yes →→→	1☐ Right	2☐ Left	3☐ Both
B. Tingling in hands or fingers	1☐ No 2☐ Yes →→→	1☐ Right	2☐ Left	3☐ Both
C. Numbness in hands or fingers	1☐ No 2☐ Yes →→→	1☐ Right	2☐ Left	3☐ Both
D. Pain/discomfort in wrists	1☐ No 2☐ Yes →→→	1☐ Right	2☐ Left	3☐ Both
E. Greater frequency of dropping objects	1☐ No 2☐ Yes →→→	1☐ Right	2☐ Left	3☐ Both
F. Difficulty in buttoning	1☐ No 2☐ Yes →→→	1☐ Right	2☐ Left	3☐ Both

IF YOU INDICATED ONE OR MORE OF THE ABOVE SYMPTOMS (QUESTION 16), PLEASE ANSWER QUESTIONS 17-27 -- OTHERWISE SKIP TO QUESTION 28 (PAGE 7).

IF YOU HAVE NONE OF THE SYMPTOMS LISTED ON QUESTION 16 -- SKIP THIS PAGE AND CONTINUE WITH QUESTION 28 ON PAGE 7.

17. How long have you had any of these symptoms? ____ years or ____ months

18. How often do these symptoms occur?
    - 1 ☐ Less than once a month
    - 2 ☐ Once or twice a month
    - 3 ☐ About once a week
    - 4 ☐ Several times a week
    - 5 ☐ Every day or nearly every day

19. How often do these symptoms cause you to wake up at night?
    - 1 ☐ Never or less than once a month
    - 2 ☐ Once or twice a month
    - 3 ☐ About once a week
    - 4 ☐ Several times a week
    - 5 ☐ Every night or nearly every night

20. How often do you use a splint for these symptoms?
    - 1 ☐ Never or less than once a month
    - 2 ☐ Once or twice a month
    - 3 ☐ About once a week
    - 4 ☐ Several times a week
    - 5 ☐ Every day or nearly every day

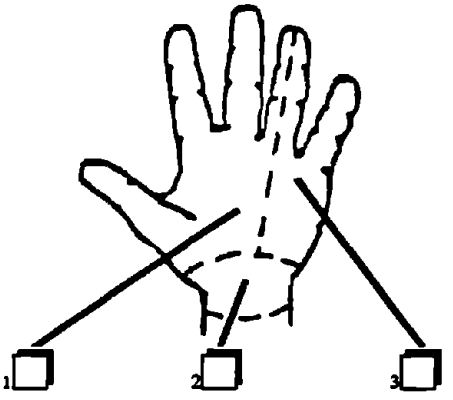
21. How often do you use prescription or nonprescription pain medications (such as aspirin, Tylenol, Advil, Naprosyn and Motrin) for these symptoms?
    - 1 ☐ Never or less than once a month
    - 2 ☐ Once or twice a month
    - 3 ☐ About once a week
    - 4 ☐ Several times a week
    - 5 ☐ Every day or nearly every day

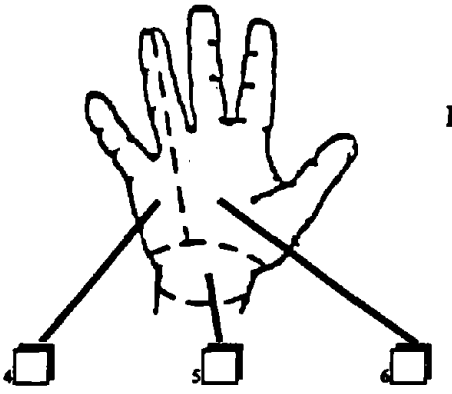
22. Did you have surgery for these symptoms?
    - 1 ☐ No
    - 2 ☐ Yes →→ Which side? 1 ☐ Right 2 ☐ Left 3 ☐ Both

IF YOU HAVE NONE OF THE SYMPTOMS LISTED ON QUESTION 16 -- SKIP THIS PAGE AND CONTINUE WITH QUESTION 28 ON PAGE 7.

23. In the diagrams below, the palm side of each hand is divided into three parts. Indicate which parts of your hands are affected by these symptoms. Check the boxes for all parts that apply.

Left





Right

24. To what extent have these symptoms affected your work or leisure activities?

	Not at all	**Minor or moderate**	**Major or substantial**
	1	2	3
A. Change in work assignments?	☐	☐	☐
B. Decrease in productivity?	☐	☐	☐
C. Change in the way you do work tasks?	☐	☐	☐
D. Interference with leisure or household activities?	☐	☐	☐

25. Does your work trigger or worsen these symptoms?
    - 1 ☐ Rarely or never
    - 2 ☐ Sometimes or occasionally
    - 3 ☐ Frequently

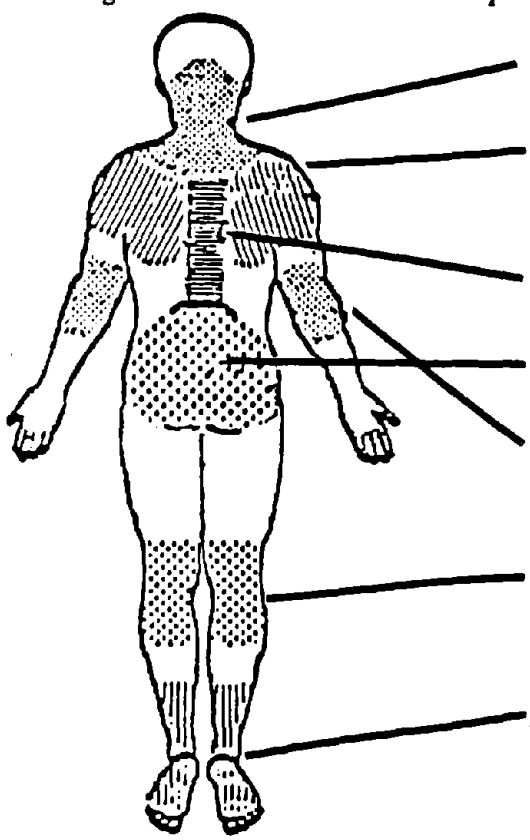
26. Have you ever filed a workers' compensation claim because of these symptoms?
    - 1 ☐ No
    - 2 ☐ Yes

27. **Right now**, do you have one or more of these symptoms?
    - 1 ☐ No
    - 2 ☐ Yes →→ Which symptoms? _____

28. **Within the past month,** have you experienced the following symptoms? If yes, indicate which side is affected.

A.	Pain in forearm	☐ No	☐ Yes →	☐ Right	☐ Left	☐ Both
B.	Pain in arm when elevated	☐ No	☐ Yes →	☐ Right	☐ Left	☐ Both
C.	Pain radiating from shoulder downward	☐ No	☐ Yes →	☐ Right	☐ Left	☐ Both
D.	Numbness in lower leg	☐ No	☐ Yes →	☐ Right	☐ Left	☐ Both

29. **Within the past month**, have you had numbness, tingling, soreness, or pain in your body? Please use the diagram below to indicate which parts of the body are affected.



Neck		☐ No	☐ Yes
Shoulder	Right	☐ No	☐ Yes
	Left	☐ No	☐ Yes
Upper back		☐ No	☐ Yes
Lower back		☐ No	☐ Yes
Elbow	Right	☐ No	☐ Yes
	Left	☐ No	☐ Yes
Knee	Right	☐ No	☐ Yes
	Left	☐ No	☐ Yes
Ankle/foot	Right	☐ No	☐ Yes
	Left	☐ No	☐ Yes

30. How tall are you? _____ feet _____ inches

31. How much do you weigh? _____ pounds

32. What is your history of cigarette smoking?
    - ☐ Never smoked
    - ☐ Ex-smoker → Quit _____ years ago
    - ☐ Current smoker → Smoke _____ cigarettes per day

33. Please indicate how often each of the following statements is true of your current job.

	Rarely or never	Sometimes or occasionally	Frequently
	1	2	3
A. You are required to work very fast.	☐	☐	☐
B. You have a good deal of influence over things that affect your job.	☐	☐	☐
C. You think that the amount of work you have to do may interfere with how well it gets done.	☐	☐	☐
D. You are given a lot of freedom to decide how to do your work.	☐	☐	☐
E. You enjoy your work.	☐	☐	☐
F. You are required to work very hard (mentally and/or physically).	☐	☐	☐
G. You have the opportunity to develop your own special skills and abilities.	☐	☐	☐
H. You have thought seriously about leaving your job.	☐	☐	☐

34. How much can each of these people be relied on for help or support when things get tough at work?

	Not at all	A little	Somewhat	Very much	
	1	2	3	4	
A. Your immediate supervisor (boss)	☐	☐	☐	☐	
B. Other people at work	☐	☐	☐	☐	
C. Your husband, wife or mate	☐	☐	☐	☐	☐ No Spouse or mate
D. Your friends and/or relatives	☐	☐	☐	☐	

35. How often do you see your friends?

1. ☐ Less than once a month
2. ☐ Once or twice a month
3. ☐ Once a week
4. ☐ Several times a week
5. ☐ Every day or nearly every day

36. What is your current marital status?

- 1 ☐ Married
- 2 ☐ Separated
- 3 ☐ Divorced
- 4 ☐ Widowed
- 5 ☐ Never married

37. How many children do you have? _____ How many live at home? _____

38. Do you live with other adults?

- 1 ☐ No
- 2 ☐ Yes, with a spouse or mate
- 3 ☐ Yes, but not with a spouse or mate

39. What is your date of birth? (month/day/year) ___/___/___

40. Are you male or female?

- 1 ☐ Male
- 2 ☐ Female

41. Which group best describes your racial/ethnic background?

- 1 ☐ African American/Black
- 2 ☐ American Indian or Alaskan Native
- 3 ☐ Asian or Pacific Islander
- 4 ☐ Latino/Hispanic
- 5 ☐ Latino and African American
- 6 ☐ White, non-Hispanic
- 7 ☐ Other (Specify)_____

42. Have you attended a vocational or trade school?

- 1 ☐ No
- 2 ☐ Yes

43. What is the highest grade or year of school you completed?

- 1 ☐ 8th grade or less
- 2 ☐ Some high school (9th-11th grade)
- 3 ☐ High school graduate
- 4 ☐ Some college (less than 4 years)
- 5 ☐ Bachelor's degree or higher

PLEASE CONTINUE ➡➡➡

The UCLA School of Public Health will be conducting a follow-up research project with a small group of respondents to this survey. If you would prefer **not** to participate in this follow-up phase, please check the box below.

☐ I prefer **not** to participate.

If you are interested, it would be very helpful if you would provide your first name and phone number below. This information will be treated confidentially and will not be released to anyone.

First name _____ Phone number (_____)_____

Thank you for your participation. If you have any questions regarding the UCLA Occupational Study of Musculoskeletal Conditions, feel free to call the project office at (213) 206-4756.

INFORMED CONSENT FORM
UCLA OCCUPATIONAL STUDY OF MUSCULOSKELETAL CONDITIONS

1. I hereby authorize Hal Morgenstern, Ph.D. and his research staff of technicians and interviewers from the UCLA School of Public Health and Reed Neurological Research Center to include me in the research study "UCLA Occupational Study of Musculoskeletal Conditions."

2. The purpose of this study is to learn more about occupational health problems among trade, professional and office workers. It has been explained to me that the reason for my inclusion in this study is because I am a member of a trade, office workers', or professional workers' union, and I indicated an interest in further participation in this study on an earlier questionnaire.

3. This phase of the research involves the following activities: 1) a personal interview, 2) two common clinical tests: one involving the tapping of my wrist to observe what sensation this causes, and the second involving the bending of my wrists at an approximate ninety degree angle to see if this causes any sensations in my hand, and 3) wrist dimension measurements: the technician will measure the width, thickness, and circumference of my wrist, and 4) nerve conduction velocity measurements: the technician will apply a small electrical stimuli on my wrist and measure the response electronically at my index finger, or my palm.

4. The personal interview will be conducted by well-trained interviewers under the direction of the Principal Investigator, Dr. Hal Morgenstern. The interviewers will be asking questions about myself, my work, and health related information including clinical symptoms and past medical history.

5. The clinical tests, wrist measurements, and nerve conduction velocity measurements are routine diagnostic tests and carry no known risk. The nerve conduction measurements may be uncomfortable but not painful.

6. I understand that this type of examination is done on many patients and that the procedure is so harmless that a consent form is not ordinarily used. I understand that I am asked to sign a consent form because the results will be used in research.

7. I understand that I can decline any of the above parts of these research activities.

8. I understand that I can refuse to participate or withdraw from this research at any time without prejudice. I can refuse to answer any question and I can end the interview at any time.

HSPC #G90-02-016 -3
Expiration Date: March 19, 1993

9. My participation in this project will not be of any direct benefit to me. This research may provide benefits to society through a better understanding of health problems among trade, professional and office workers.

10. I understand that any question that I may have at any time about the research project will be answered by the investigator, whose name and address are given below.

11. I understand that circumstances may arise which might cause the investigator to terminate my participation before completion of the study.

12. I also understand that no information which identifies me will be released without my separate consent except as specifically required by law.

13. If the study design or the use of the data is to be changed, I will be so informed and my consent reobtained.

14. I understand that I will receive $15 for my participation in this study. This money is provided to compensate for my time and to cover parking and transportation costs.

15. I understand that if I have any questions, comments, or concerns about the study or the informed consent process, I may write or call the office of the Vice Chancellor-Research Programs, 3134 Murphy Hall, UCLA, Los Angeles, CA 90024-1405, (310) 825-8714.

16. I acknowledge that I have received a copy of this form.

DATE _____ SIGNATURE _____

WITNESS _____

Principal Investigator:

Hal Morgenstern, PhD
Professor
Department of Epidemiology
UCLA School of Public Health
Los Angeles, CA 90024-1772
(310) 206-4756

HSPC #G90-02-016 -3
Expiration Date: March 19, 1993

ID # ___ ___ ___ ___
1 - 4

WORK HISTORY

Now I am going to ask you a few questions about your work history.

1. What is your current Job Title? ___ ___
5 6

___1. Sprinkler Fitter
___2. Carpenter Contractor
___3. Court Reporter
___4. Typist Clerk/Medical Typist
___5. Clerk
___6. Data Entry Operator
___7. Secretary
___8. Analyst
___9. Staff Assistant
___10. Other (specify)_____

2. How long have you held this job? ___Months ___Years ___ ___
7 8

___ ___
9 10

3. Is that your usual occupation? ___Yes ___No ___
11

[If no, ask questions 4-5. Otherwise skip to question 6.]

4. What is your usual occupation? ___ ___
12 13

___1. Sprinkler Fitter
___2. Carpenter Contractor
___3. Court Reporter
___4. Typist Clerk/Medical Typist
___5. Clerk
___6. Data Entry Operator
___7. Secretary
___8. Analyst
___9. Staff Assistant
___10. Other (specify)_____

5. How long have you worked as **[name usual occupation]**?
___ Months ___ Years

___ ___
14 15

___ ___
16 17

[Ask everyone]

6. Do you generally work full or part time?
___ Full Time ___ Part Time

___
18

7. In general how many hours do you work per week?
___ Hours

___ ___
19 20

8. In the past year, how many weeks have you been laid off or not actively working? ___ Weeks

___ ___
21 22

9. Now I am going to ask you some questions about your employment history and jobs you have worked on during the last two years.

Job Task Recording Sheet - Office Workers/Court Reporters

10 Do you work for LA County? ___Yes ___No **(IF YES ASK 10a, IF NO ASK 10b)**

10a. What department do you work for? _____

10b. What company do you work for? _____

ASK EVERYONE: 10c. When did you start working in **(Dept/Com)**? ___/___
When did stop working in **(Dept/Com)**? ___/___

11. What is your current job title and when did you start working in this job?
_____ ___/___

11a. What are you tasks and responsibilities for this job?

1. _____
2. _____
3. _____
4. _____

12. In you work as **(job title)**:

12a. How many hours per day are you working on the keyboard? ____ h/d

12b. When you are working on the keyboard are you entering data continuously or sporadically?
___ continuously ___ sporadically

[FOR COURT REPORTERS ONLY:]
12c. How many hours per day are you using a stenography machine?___h/d

[ASK EVERYONE]
12d. How many hours per day are you using an adding machine? ___h/d

12e. How many hours per day are you using a typewriter? ___h/d

12f. How many hours per day are you involved in office work such as: photocopying, filing or organizing paper work? ___h/d

12g. How many hours per day are you involved with phone work? ___h/d

12h. How many hours per day are you involved in supervisory work (e.g. supervising, scheduling, attending meetings, planning) ___h/d

12i. How many hours per day are you involved in moving/lifting/unloading materials? ____ h/d

Job Task Recording Sheet - Office Workers/Court Reporters - 2

IF LESS THAN TWO YEARS WORK HISTORY ASK:

13. Before working as (OCCUPATION) did you work for LA County? ___Yes ___No
(IF YES ASK 13a, IF NO ASK 13b)

13a. What department do you work for? _____

13b. What company do you work for? _____

ASK EVERYONE: 13c. When did you start working in **(Dept/Com)**? ___/___
When did stop working in **(Dept/Com)**? ___/___

14. What was your previous job title and when did you start working in this job?

_____ ___/___

14a. What were you tasks and responsibilities for this job?

1. _____
2. _____
3. _____
4. _____

15. In you work as **(job title)**:

15a. How many hours per day were you working on the keyboard? ____ h/d

15b. When you were working on the keyboard are you entering data continuously or sporadically?
___ continuously ___ sporadically

[FOR COURT REPORTERS ONLY:]
15c. How many hours per day were you using a stenography machine?___h/d

[ASK EVERYONE]
15d. How many hours per day were you using an adding machine? ___h/d

15e. How many hours per day were you using a typewriter? ___h/d

15f. How many hours per day were you involved in office work such as: photocopying, filing or organizing paper work? ___h/d

15g. How many hours per day were you involved with phone work? ___h/d

15h. How many hours per day were you involved in supervisory work (e.g. supervising, scheduling, attending meetings, planning) ___h/d

15i. How many hours per day were you involved in moving/lifting/unloading materials? ____ h/d

Job Task Recording Sheet - Office Workers/Court Reporters - 3

IF LESS THAN TWO YEARS OF WORK HISTORY ASK:

16. Before working as (OCCUPATION) did you work for LA County? ___Yes ___No
(IF YES ASK 13a, IF NO ASK 13b)

16a. What department do you work for? _____

16b. What company do you work for? _____

ASK EVERYONE: 16c. When did you start working in (Dept/Com)? ___/___
When did stop working in (Dept/Com)? ___/___

17. What was your previous job title and when did you start working in this job?

_____ ___/___

17a. What were you tasks and responsibilities for this job?

1. _____

2. _____

3. _____

4. _____

18. In you work as (job title):

18a. How many hours per day were you working on the keyboard? ____ h/d

18b. When you were working on the keyboard are you entering data continuously or sporadically?
___ continuously ___ sporadically

[FOR COURT REPORTERS ONLY:]
18c. How many hours per day were you using a stenography machine?___h/d

[ASK EVERYONE]
18d. How many hours per day were you using an adding machine? ___h/d

18e. How many hours per day were you using a typewriter? ___h/d

18f. How many hours per day were you involved in office work such as: photocopying, filing or organizing paper work? ___h/d

18g. How many hours per day were you involved with phone work? ___h/d

18h. How many hours per day were you involved in supervisory work (e.g. supervising, scheduling, attending meetings, planning) ___h/d

18i. How many hours per day were you involved in moving/lifting/unloading materials? ____ h/d

13.1 Do you have your own workstation? In other words a desk, table, or work area that is not generally used by a co-worker or workers on another shift. ___ 52

____ yes ____no

[Wait for response, prompt if necessary]

13.2 In the past year, how many time have you switched to a different workstation? ___ 53

____ None (have not changed)
____ Once or twice per year
____ Every few months
____ About once a month
____ More than once a month, but not every week
____ Once a week
____ More than once a week

13.3 Do you have an adjustable chair? ___ 54

____yes ____no

13.3a Have you adjusted your work chair? ___ 55

____yes ____no

13.3b How long have you had this chair? ___ ___ 56 57

____months or ____years

___ ___ 58 59

13.4 Do you have a keyboard table or drawer? ___ 60

____yes ____no

13.4a Is this table adjustable? ___ 61

____yes ____no

13.4b How long have you had your keyboard table? ____months or ____years ___ ___ 62 63

___ ___ 64 65

ID # ___ ___ ___ ___

13.5 Do you have a wrist rest or wrist pad?
____ yes ____ no ___ 66

13.5a How long have you had your wrist pad?
____ months or ____years ___ 67 ___ 68

___ 69 ___ 70

13.6 Please indicate the typical position you usually have your hands in when you are using:

[SHOW DIAGRAMS]

A computer keyboard ____Neutral ____Deviated ___ 71

A stenograph machine ____Neutral ____Deviated ___ 72

A typewriter ____Neutral ____Deviated ___ 73

ID # ___ ___ ___ ___

SYMPTOMS

Now I will ask you some questions about symptoms that you may have experienced in your hand or wrist area as shown in these diagrams.

[Show hand/wrist diagrams]

13. In the past month, have you had pain, aching, stiffness, burning, numbness or tingling in the area shown on this diagram? ___ 74

____yes **[If yes show diagram, ask worker to mark affected areas:]**

____no **[I no, skip to ques #19 for females, #20 for males]**

14. Which symptoms have you had, and what hands have they affected?

[Prompt for symptoms, read list of symptoms if necessary.]

	Neither	Right	Left	Both	
1.pain	___	___	___	___	
2. aching	___	___	___	___	___ 75
3.tingling	___	___	___	___	___ 76
4.numbness	___	___	___	___	___ 77
5.stiffness	___	___	___	___	___ 78
6.burning	___	___	___	___	___ 79
					___ 80

15. How long has it been since you first noticed these symptoms?
____ months or ____ years

___ ___
81 82

___ ___
83 84

111

16. How often have these symptoms occurred in the past year? **[READ OPTIONS]** ___ 85

____ 1. Less than once a month
____ 2. Once or twice a month
____ 3. About once a week
____ 4. Several time a week
____ 5. Everyday or nearly everyday

17. In the past year, how often have these symptoms caused you to wake up at night? **[READ OPTIONS]** ___ 86

____ 1. Never or less than once a month
____ 2. Once or twice a month
____ 3. About once a week
____ 4. Several time a week
____ 5. Everyday or nearly everyday

18. In the past year have these symptoms improved, gotten worse or stayed the same? ___ 87

____ improved
____ worse
____ same

MEDICAL/REPRODUCTIVE HISTORY

FEMALES ONLY: (ASK TO LOCAL 660 MEMBERS ONLY)

19. Have you been pregnant in the last three years? ___ 88

_____ yes ____ no (or don't know)

If yes - How many times? ____ times ___ ___ 89 90

What were the dates of these pregnancies?

1. ____/____ - ____/____
   Mon Yr Mon Yr
2. ____/____ - ____/____
   Mon Yr Mon Yr
3. ____/____ - ____/____
   Mon Yr Mon Yr

ID # ___ ___ ___ ___

PHYSICAL SIGNS

Now I would like to do some simple tests and measurements on your hand and wrist.

20. First of all I would like to measure the size of both wrists. I will do this by using this caliper. ___ ___

    ___ ___

    Right _____ Depth _____ Width

    Left _____ Depth _____ Width

21. (Tinel's test) I am going to slightly tap your wrist. Please tell me if you feel any tingling or funny sensations going down your fingers when I tap. This sensation will be similar to what you feel when you hit your funny bone. ___

    ___ Pos ____ Neg

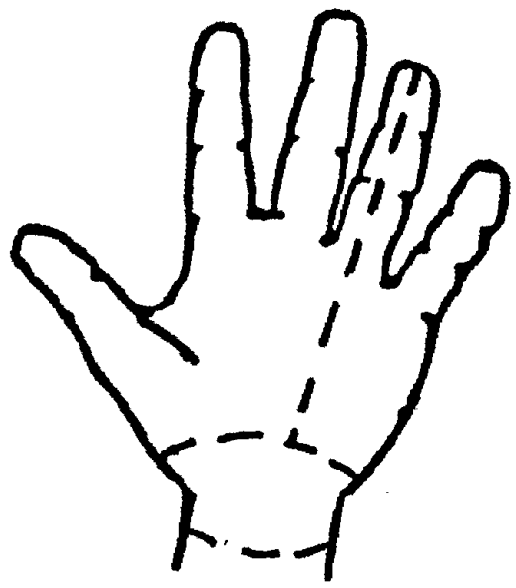
22. (Phalen's test) Now we will do the wrist flexion test. I would like you to put the back of your wrists together and bend them to a 90^0 angle and hold them at shoulder level **[DEMONSTRATE]**. I will ask you to hold your wrists in that position for one minute. Let me know if you feel any sensations in your hand or fingers during this test. **[IF THEY FEEL SENSATIONS BEFORE ONE MINUTE - STOP THE TEST]** ___

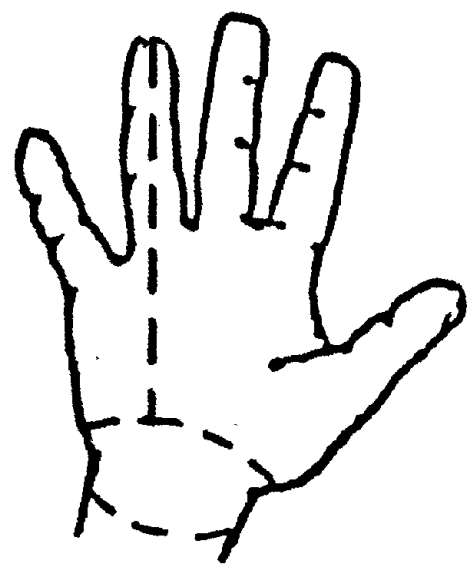
    ___ Pos ____ Neg

ID # _____

114

Left





Right

DATA SHEET FOR CARPAL TUNNEL RESEARCH STUDY

NAME Date:

HANDEDNESS Right Left Hand tested: Right Left

SENSORY LATENCIES

Place clip electrodes at mid point of proximal phalanx for digits II, IV, and V; and mark stimulation point at a distance of 14 cm for both median and ulnar nerves.

MEDIAN NERVE
Latency, wrist to digit II @ 14 cm. ____ mS. amplitude _____uV.
Latency, wrist to digit IV @ 14 cm. ____ mS. amplitude _____uV.
(Normal limits ..... < 3.7 mS. > 15 uV.)

ULNAR NERVE
Latency, wrist to digit IV @ 14 cm. ____ mS. amplitude _____mV.
Latency, wrist to digit V @ 14 cm. ____ mS. amplitude _____mV.
(Normal limits ..... < 3.7 mS. > 15 uV.)

MOTOR STUDIES

Median Nerve Set both distances @ 8 cm.
Latency, Wrist to APB _____ mS. amplitude _____ mV.
Latency, Wrist to 2nd lumbrical _____ mS. amplitude _____ mV.
(Normal limits ..... < 4.3 mS. > 4 mV.)
(Latency difference, APB - 2nd Lumbr < 0.4 mS.)

Ulnar Nerve, 8 cm.
Latency, Wrist to ADM _____ mS. amplitude _____ mV.
(Normal limits .....< 3.5 mS. > 6 mV.)

ORTHODROMIC STUDIES, May be omitted if above median sensory latencies are faster than 3.2 mS, and amplitude > 25 uV. Stimulate at palm, and record at wrist at 8 cm.

Median, palm to wrist @ 8 cm. ____ mS. amplitude _____uV.
Ulnar , palm to wrist @ 8 cm. ____ mS. amplitude _____uV.
(Normal limits ..... < 2.3 mS. > 25 uV.)
(Median - Ulnar difference < 0.3 mS.)

OTHER STUDIES:

Dorsal ulnar sensory cutaneous branch
(test if ulnar to digit V is >3.5 mS, or amplitude < 13 uV.
Latency, wrist to dorsal hand @ 8 cm. ____ mS. amplitude ____mV.
(Normal limits ..... < 2.0 mS. > 8 uV.)

Ulnar motor latency to FDI
(Do this if ulnar latency is more than 3.3 mS and ulnar compression at wrist is suspected.)

Latency, Wrist to FDI _____ mS. amplitude _____ mV.

Job Task Recording Sheet - Office Workers/Court Reporters

10 Do you work for LA County? ___Yes ___No **(IF YES ASK 10a, IF NO ASK 10b)**

10a. What department do you work for? _____

10b. What company do you work for? _____

ASK EVERYONE: 10c. When did you start working in **(Dept/Com)**? ___/___
When did stop working in **(Dept/Com)**? ___/___

11. What is your current job title and when did you start working in this job?
_____ ___/___

11a. What are you tasks and responsibilities for this job?

1. _____
2. _____
3. _____
4. _____

12. In you work as **(job title)**:

12a. How many hours per day are you working on the keyboard? ____ h/d

12b. When you are working on the keyboard are you entering data continuously or sporadically?
___ continuously ___ sporadically

[FOR COURT REPORTERS ONLY:]
12c. How many hours per day are you using a stenography machine?___h/d

[ASK EVERYONE]
12d. How many hours per day are you using an adding machine? ___h/d

12e. How many hours per day are you using a typewriter? ___h/d

12f. How many hours per day are you involved in office work such as: photocopying, filing or organizing paper work? ___h/d

12g. How many hours per day are you involved with phone work? ___h/d

12h. How many hours per day are you involved in supervisory work (e.g. supervising, scheduling, attending meetings, planning) ___h/d

12i. How many hours per day are you involved in moving/lifting/unloading materials? ____ h/d

Job Task Recording Sheet - Office Workers/Court Reporters - 2

IF LESS THAN TWO YEARS WORK HISTORY ASK:

13. Before working as (**OCCUPATION**) did you work for LA County? ___Yes ___No
(**IF YES ASK 13a, IF NO ASK 13b**)

13a. What department do you work for? _____

13b. What company do you work for? _____

ASK EVERYONE: 13c. When did you start working in (**Dept/Com**)? ___/___
When did stop working in (**Dept/Com**)? ___/___

14. What was your previous job title and when did you start working in this job?

_____ ___/___

14a. What were you tasks and responsibilities for this job?

1. _____
2. _____
3. _____
4. _____

15. In you work as (**job title**):

15a. How many hours per day were you working on the keyboard? ____ h/d

15b. When you were working on the keyboard are you entering data continuously or sporadically?
___ continuously ___ sporadically

[**FOR COURT REPORTERS ONLY:**]
15c. How many hours per day were you using a stenography machine?___h/d

[**ASK EVERYONE**]
15d. How many hours per day were you using an adding machine? ___h/d

15e. How many hours per day were you using a typewriter? ___h/d

15f. How many hours per day were you involved in office work such as: photocopying, filing or organizing paper work? ___h/d

15g. How many hours per day were you involved with phone work? ___h/d

15h. How many hours per day were you involved in supervisory work (e.g. supervising, scheduling, attending meetings, planning) ___h/d

15i. How many hours per day were you involved in moving/lifting/unloading materials? ____ h/d

Job Task Recording Sheet - Office Workers/Court Reporters - 3

IF LESS THAN TWO YEARS OF WORK HISTORY ASK:

16. Before working as (**OCCUPATION**) did you work for LA County? ___Yes ___No
(**IF YES ASK 13a, IF NO ASK 13b**)

16a. What department do you work for? _____

16b. What company do you work for? _____

ASK EVERYONE: 16c. When did you start working in (**Dept/Com**)? ___/___
When did stop working in (**Dept/Com**)? ___/___

17. What was your previous job title and when did you start working in this job?

_____ ___/___

17a. What were you tasks and responsibilities for this job?

1. _____

2. _____

3. _____

4. _____

18. In you work as (**job title**):

18a. How many hours per day were you working on the keyboard? ____ h/d

18b. When you were working on the keyboard are you entering data continuously or sporadically?
___ continuously ___ sporadically

[**FOR COURT REPORTERS ONLY:**]
18c. How many hours per day were you using a stenography machine?___h/d

[**ASK EVERYONE**]
18d. How many hours per day were you using an adding machine? ___h/d

18e. How many hours per day were you using a typewriter? ___h/d

18f. How many hours per day were you involved in office work such as: photocopying, filing or organizing paper work? ___h/d

18g. How many hours per day were you involved with phone work? ___h/d

18h. How many hours per day were you involved in supervisory work (e.g. supervising, scheduling, attending meetings, planning) ___h/d

18i. How many hours per day were you involved in moving/lifting/unloading materials? ____ h/d

ID# _ _ _ _

Job Task Recording Sheet - Sprinkler Fitters -1

10. Who is your current or most recent employer? (name of company) _____

10a. When did you start working with (**employer**)? __/__ 10b And when did you stop working with (**employer**)? __/__

11. What type of job were you working on?

(e.g. - new construction, core work, testing/ inspection, tenant improvement, retrofit, fabrication)

Job type/location_____

11a. When did you start (**and finish**) this job? __/__ - __/__
Mo Yr Mo Yr

11b. What are the job tasks you have to perform for this job?

1._____

2._____

3._____

4._____

12. In your (**job type**),

12a. How many hours per day are you actually fitting pipe? ____ hours/day
12b. How many hours per day are you cutting pipe? ____ hours/day
12c. How many hours per day are you moving/lifting/unloading materials? ____ hours/day

12d. How frequently do you use rivet or "hilty" guns? __ < 5 t/d __ 5-10 t/d __ 11-20 t/d __ 20-29 t/d __ 30+ t/d
12e. How frequently do you use power drills, saws or wrenches? __ < 5 t/d __ 5-10 t/d __ 11-20 t/d __ 20-29 t/d __ 30+ t/d
12f. What type and diameter of pipe do you usually work with on this job? _____ Type ____diameter

12g. What type of wrench do you usually use, aluminum or steel? ____ aluminum ____ steel

12h. How many hours per day are you involved in activities that don't require physical work such as inspections, reviewing blueprints, supervision, scheduling etc? ___ hours/day

12i. In a typical week, how may days are your working under a tight deadline forcing you to work hard or work overtime? ____ days/week (**mark 98 for less than 1/week**)

Job Task Recording Sheet - Sprinkler Fitters - 2

13. Have you worked on any other job types with (**most recent employer**) in the last 2 years? __No (**Go to Q14**) __Yes (**Go to Q15**)

14. (**IF LESS THAN 2 YEARS ASK:**) Before working with (**employer Q10**), who did you work for?_____
    14a. When did you start working with (**employer**)? __/__ 14b And when did you stop working for (**employer**)?__/__ (**Go to Q15**)

15. Before working in the (**job type Q11**), what type job were you working on? (**IF DIFFERENT EMPLOYER ASK:**)
    While working with (**employer Q14**), what type of job were you working on?
    (e.g. new construction, core work, testing/ inspection, tenant improvement, retrofit, fabrication)
    job type/location_____

15a. When did you start and finish this job? __/__ - __/__
Mo Yr Mo Yr

15b. What are the job tasks you have to perform for this job?
1._____
2._____
3._____
4._____

16. In your (**name job type**),
    16a. How many hours per day are you actually fitting pipe? ____ hours/day
    16b. How many hours per day are you cutting pipe? ____ hours/day
    16c. How many hours per day are you moving/lifting/unloading materials? ____ hours/day

    16d. How frequently do you use rivet or "hilty" guns? __ < 5 t/d __ 5-10 t/d __11-20 t/d __ 20-29 t/d __ 30+ t/d
    16e. How frequently do you use power drills, saws or wrenches? __ < 5 t/d __ 5-10 t/d __11-20 t/d __ 20-29 t/d __ 30+ t/d
    16f. What type of and diameter of pipe do you usually work with on this job? _____ Type ____diameter
    16g. What type of wrench do you usually use, aluminum or steel? ____ aluminum ____ steel

    16h. How many hours per day are you involved in activities that don't require physical work such as inspections, reviewing blueprints, supervision, scheduling etc? ____ hours/day

    16i. In a typical week, how may days are your working under a tight deadline forcing you to work hard or work overtime? ____ days/week (**mark 98 for less than 1/week**)

120

Job Task Recording Sheet - Sprinkler Fitters - 3

17. Have you worked on any other job types with (**employer Q10 or Q14**) in the last 2 years? __No (**Go to Q18**) __Yes (**Go to Q19**)
18. (**IF LESS THAN 2 YEARS ASK:**) Before working with (**employer Q14**), who did you work for?_____
    18a. When did you start working with (**employer**)?__/__ 18b And when did you stop working with (**employer**) to __/__(**Go to Q19**)

19. Before working in the (**job type Q15**), what type job were you working on? (**IF DIFFERENT EMPLOYER ASK:**)
    While working with (**employer Q18**), what type of job were you working on?
    (**e.g. new construction, core work, testing/ inspection, tenant improvement, retrofit, fabrication**)
    job type/location_____

19a. When did you start and finish this job? __/__ - __/__
Mo Yr Mo Yr

19b. What are the job tasks you have to perform for this job?

1._____
2._____
3._____
4._____

20. In your (**job type**),
    20a. How many hours per day are you actually fitting pipe? ___ hours/day
    20b. How many hours per day are you cutting pipe? ___ hours/day
    20c. How many hours per day are you moving/lifting/unloading materials? ___ hours/day

    20d. How frequently do you use rivet or "hilty" guns? __ < 5 t/d __ 5-10 t/d __11-20 t/d __ 20-29t/d __30+ t/d
    20e. How frequently do you use power drills, saws, or wrenches? __ < 5 t/d __ 5-10 t/d __11-20 t/d __ 20-29t/d __30+ t/d__
    20f. What type of and diameter of pipe do you usually work with on this job? _____ Type ___diameter

    20g. What type of wrench do you usually use, aluminum or steel? ___ aluminum ___ steel

    20h. How many hours per day are you involved in activities that don't require physical work such as inspections, reviewing blueprints, supervision, scheduling etc? ___ hours/day

    20i. In a typical week, how may days are your working under a tight deadline forcing you to work hard or work overtime? ___ days/week (**mark 98 for less than 1/week**)

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Job Task Recording Sheet - Sprinkler Fitters - 4

21. Have you worked on any other job types with (**employer Q10,14 or 18**) in the last 2 years? __No (**Go to Q18**) __Yes (**Go to Q19**)

22. (**IF LESS THAN 2 YEARS ASK:**) Before working with (**employer Q14**), who did you work for?_____
22a. When did you start working with (**employer**)? __/__ 22b. And when did you stop working with (employer)?__/__**Go to Q23**)

23. Before working in the (**job type Q19**), what type job were you working on? (**IF DIFFERENT EMPLOYER ASK:**)
While working with (**employer Q22**), what type of job were you working on?
(e.g. new construction, core work, testing/ inspection, tenant improvement, retrofit, fabrication)
job type/location_____

23b. What are the job tasks you have to perform for this job?
1._____
2._____
3._____
4._____

23a. When did you start and finish this job? __/__ - __/__
Mo Yr Mo Yr

24. In your (**job type**),

24a. How many hours per day are you actually fitting pipe? ____ hours/day
24b. How many hours per day are you cutting pipe? ____ hours/day
24c. How many hours per day are you moving/lifting/unloading materials? ____ hours/day

24d. How frequently do you use rivet or "hilty" guns? __ < 5 t/d __ 5-10 t/d __11-20 t/d __ 20-29t/d __30+ t/d
24e. How frequently do you use power drills, saws, or wrenches? __ < 5 t/d __ 5-10 t/d __11-20 t/d __ 20-29t/d __30+ t/d
24f. What type of and diameter of pipe do you usually work with on this job? _____ Type ____diameter

24g. What type of wrench do you usually use, aluminum or steel? ____ aluminum ____ steel

24h. How many hours per day are you involved in activities that don't require physical work such as inspections, reviewing blueprints, supervision, scheduling etc? ____ hours/day

24i. In a typical week, how may days are your working under a tight deadline forcing you to work hard or work overtime? ____ days/week (**mark 98 for less than 1/week**)

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ID# _ _ _ _

Job Task Recording Sheet - Carpenters-1

10. Who is your current or most recent employer? (name of company) _____

10a. When did you start working with **(employer)**? __/__ 10b. And when did you stop working with **(employer)**? __/__

11. What type of job were you working on?

(e.g. - highway const, office bldy, residential, cabinet making/finishing work etc)

Job type/location_____

11a. When did you start (and finish) this job? __/__-__/__
Mo Yr Mo Yr

11b. What are the job tasks you have to perform for this job?

1._____

2._____

3._____

4._____

12. In your **(job type)**,

12a. How many hours per day are you using hand-held power saws? ____ hours/day

12b. How many hours per day are you using hand-held power drills? ____ hours/day

12c. How many hours per day are you using a hammer? ____ hours/day

12d. How many hours per day are you moving/lifting/unloading materials? ____ hours/day

12e. What type of hammer do you usually use? ___steel handle ___fiberglass ___wood ___ other

12f. How many hours are you involved in activities that don't require physical work such as inspections, reviewing blueprints, supervision, scheduling etc.? ____ hours/day

12g. In a typical week, how may days are your working under a tight deadline forcing you to work hard or work overtime? ____ days/week **(mark 98 for less than 1/week)**

Job Task Recording Sheet - Carpenters - 2

13. Have you worked on any other job types with (**most recent employer**) in the last 2 years? __No (**Go to Q14**) __Yes (**Go to Q15**)

14. (**IF LESS THAN 2 YEARS**) Before working with (**employer Q10**), who did you work for?_____
    14a. When did you start working with (**employer**)? __/__ 14b. And when did you stop working with (**employer**)? __/__(**Go to Q15**)

15. Before working in the (**job type Q11**), what type job were you working on? (**IF DIFFERENT EMPLOYER ASK:**)
    While working with (**employer Q14**), what type of job were you working on?
    (**e.g. highway const, office bldg, residential cabinet making/finishing work etc.**)
    job type/location_____

    15b. What are the job tasks you have to perform for this job?
    1._____
    2._____
    3._____
    4._____

    15a. When did you start and finish this job? __/__ - __/__
    Mo Yr Mo Yr

16. In your (**job type**),
    16a. How many hours per day are you using hand-held power saws? ____ hours/day

    16b. How many hours per day are you using hand-held power drills? ____ hours/day

    16c. How many hours per day are you using a hammer? ____ hours/day

    16d. How many hours per day are you moving/lifting/unloading materials? ____ hours/day

    16e. What type of hammer do you usually use? ___steel handle ___fiberglass ___wood ___other

    16f. How many hours are you involved in activities that don't require physical work such as inspections, reviewing blueprints, supervision, scheduling etc.? ____ hours/day

    16g. In a typical week, how may days are your working under a tight deadline forcing you to work hard or work overtime? ____ days/week (**mark 98 for less than 1/week**)

Job Task Recording Sheet - Carpenters - 3

17. Have you worked on any other job types with (**employer Q10 or Q14**) in the last 2 years? __No (**Go to Q18**) __Yes (**Go to Q19**)
18. (**IF LESS THAN 2 YEARS ASK:**) Before working with (**employer Q14**), who did you work for?_____
    18a. When did you start working with (**employer**)?__/__ 18b. And when did you stop working with (**employer**)?__/__ (**Go to Q19**)

19. Before working in the (**job type Q15**), what type job were you working on? (**IF DIFFERENT EMPLOYER ASK:**)
    While working with (**employer Q18**), what type of job were you working on?
    (**e.g. highway const, office bldg, residential cabinet making/finisting etc.**)
    job type/location _____

    19b. What are the job tasks you have to perform for this job?
    1._____
    2._____
    3._____
    4._____

    19a. When did you start and finish this job? __/__ - __/__
    Mo Yr Mo Yr

20. In your (**job type**),
    20a. How many hours per day are you using hand-held power saws? ____ hours/day

    20b. How many hours per day are you using hand-held power drills? ____ hours/day

    20c. How many hours per day are you using a hammer? ____ hours/day

    20d. How many hours per day are you moving/lifting/unloading materials? ____ hours/day

    20e. What type of hammer do you usually use? ___steel handle ___fiberglass ___wood ___other

    20f. How many hours are you involved in activities that dont require physical work such as inspections, reviewing blueprints, supervision, scheduling etc.? ____ hours/week

    20g. In a typical week, how may days are your working under a tight deadline forcing you to work hard or work overtime? ____ days/week (**mark 98 for less than 1/week**)

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Job Task Recording Sheet - Carpenters - 4

21. Have you worked on any other job types with (**employer Q10,14 or 18**) in the last 2 years? __No (**Go to Q18**) __Yes (**Go to Q19**)

22. (**IF LESS THAN 2 YEARS:**) Before working with (**employer Q14**), who did you work for?_____
22a. When did you start working with (**employer**)?__/__ 22b. And when did you stop working with (employer)?__/__(**Go to Q23**)

23. Before working in the (**job type Q19**), what type job were you working on? (**IF DIFFERENT EMPLOYER ASK:**)
While working with (**employer Q22**), what type of job were you working on?
(e.g. highway const, office bldg, residential, cabinetmaking/finish work, etc,.)
job type/location_____

23b. What are the job tasks you have to perform for this job?
1._____
2._____
3._____
4._____

23a. When did you start and finish this job? __/__ - __/__
Mo Yr Mo Yr

24. In your (**job type**),

24a. How many hours per day are you using hand-held power saws? ____ hours/day

24b. How many hours per day are you using hand-held power drills? ____ hours/day

24c. How many hours per day are you using a hammer? ____ hours/day

24d. How many hours per day are you moving/lifting/unloading materials? ____ hours/day

24e. What type of hammer do you usually use? ___Steel handle ___fiberglass ___wood ___other

24f. How many hours are you involved in activities that don't requier physical work such as inspections, reviewing blueprints, supervision, scheduling etc.? ____ hours/day

24g. In a typical week, how may days are your working under a tight deadline forcing you to work hard or work overtime? ____ days/week (**mark 98 for less than 1/week**)

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