NIH Public Access
Author Manuscript
Arch Phys Med Rehabil. Author manuscript; available in PMC 2014 July 01.

Published in final edited form as:
Arch Phys Med Rehabil. 2013 July ; 94(7): 1293–1299. doi:10.1016/j.apmr.2013.01.028.

Natural history and predictors of long-term pain and function among workers with hand symptoms

Alexis Descatha, MD[1,2], **Ann Marie Dale, PhD**[1], **Alfred Franzblau, MD**[3], and **Bradley Evanoff, MD**[1]

[1]Division of General Medical Sciences, Washington University School of Medicine, St. Louis, MO, USA*

[2]Université de Versailles St-Quentin-Inserm, UMRS 1018, Centre for Research in Epidemiology and Population Health, Population-Based Epidemiological Cohorts" Research Platform, Occupational health Unit, Garches, France

[3]Department of Environmental Health Sciences, University of Michigan School of Public Health, Ann Arbor, MI, USA

Abstract

Objective—To evaluate predictors of hand symptoms and functional impairment after three years of follow-up among workers with different types of hand symptoms including carpal tunnel syndrome (CTS). Functional status and job limitations were also analyzed as key secondary objectives.

Design—Cohort design of 3-years duration

Setting—Working population-based study

Participants—1107 newly employed workers without a pre-existing diagnosis of CTS. Subjects were categorized into four groups at baseline examination: no hand symptoms, any hand symptoms but not CTS (recurring symptoms in hands, wrist or fingers without neuropathic symptoms), any hand symptoms of CTS (neuropathic symptoms in the fingers and normal nerve conduction study), or confirmed CTS (CTS symptoms and abnormal nerve conduction study). Among workers with hand pain at baseline, subject and job characteristics were assessed as prognostic factors for outcomes, using bivariate and multivariate regression models.

Interventions—Not applicable

Main outcome measure—The primary outcome assessed by questionnaire at 3 years was "severe hand pain" in the past 30 days.

© 2013 The American Congress of Rehabilitation Medicine. Published by Elsevier Inc. All rights reserved.

Corresponding Author: Ann Marie Dale, Division of General Medical Sciences, Campus Box 8005, Washington University School of Medicine, 660 S. Euclid Ave, St. Louis, MO, USA 63110. adale@dom.wustl.edu; Phone number: 314-454-8470; Fax number: 314-454-5113.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Financial Disclosure: We certify that we have affiliations with or financial involvement (eg, employment, consultancies, honoraria, stock ownership or options, expert testimony, grants and patents received or pending, royalties) with an organization or entity with a financial interest in, or financial conflict with, the subject matter or materials discussed in the manuscript AND all such affiliations and involvements are disclosed on the title page of the manuscript. Nerve conduction testing supplies were provided by NEUROMetrix, Inc.

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Results—At baseline, 155 workers (17.5% of 888 followed workers) reported hand symptoms, 21 had confirmed CTS. Presence of hand pain at baseline was a strong predictor of future hand pain and job impairment. Subjects with confirmed CTS at baseline were more likely to report severe hand pain, (adjusted prevalence ratios 1.98 [1.11 – 3.52]) and functional status impairment (adjusted prevalence ratios 3.37 [1.01 – 11.29]) than workers with other hand pain. Among subjects meeting our case definition for CTS at baseline, only 4 (19.1%) reported seeing a physician in the 3 year period.

Conclusions—Hand symptoms persisted among many workers after 3 year follow-up, especially among those with CTS, yet few symptomatic workers had seen a physician.

Keywords

hand; pain; Carpal Tunnel Syndrome; functional status; work

Hand musculoskeletal disorders, which include peripheral nerve entrapments and tendon disorders, as well as non-specific musculoskeletal regional pain disorders,[1, 2] have become one of the most significant and costly health problems in working populations.[3, 4] Carpal tunnel syndrome (CTS) is a major cause of hand symptoms among the working population world-wide, and is notable for its high costs related to medical treatment and work disability.[5-8] The efficacy of surgical decompression of the carpal tunnel in relieving symptoms of CTS has been well documented,[9] and some patients who avoid surgery improve spontaneously.[10-12] However, the natural history of CTS is poorly understood, particularly among patients with CTS who are not evaluated in clinical settings.[12, 13]

In working populations, many workers with hand symptoms do not receive surgery or other medical treatment. A study of 418 active workers in 12 worksites reported the persistence of hand symptoms after one year.[14] Among the 62 workers with hand pain at baseline (45 with CTS defined by symptoms and nerve conduction abnormality, 17 with other disorders), 45.2% had persistent symptoms, and persistence of pain was predicted by initial diagnosis of CTS.[14]

We hypothesized that active workers meeting a case definition of CTS would have worse outcomes after three years of follow-up than workers with other categories of hand pain. To study this question, we examined a cohort of workers at the time of hire and at three year follow-up, and evaluated the baseline characteristics that predicted future hand pain, functional or job limitations among workers with initial hand symptoms. We also describe prevalence of the outcomes at follow-up between subjects with hand symptoms and those without symptoms at baseline.

METHODS

Population

This study presents data collected as part of the Predictors of Carpal Tunnel Syndrome (PrediCTS) Study, an ongoing prospective study. The PrediCTS cohort includes 1107 newly hired workers recruited from participating companies between July 2004 and October 2006. Subjects were recruited from industries with both high and low hand-intensive jobs, including construction trades, healthcare, manufacturing, and biotechnology. Eligible workers were at least 18 years of age, and were starting a new full-time job (at least 30 hours per week) or recently became benefits eligible.[15] Workers were excluded if they had a previous diagnosis of CTS or peripheral neuropathy or were pregnant at baseline.[15] The Washington University School of Medicine Institutional Review Board approved this study, and all subjects provided written informed consent prior to participation.

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Data collection and measures

At the time of enrollment, subjects completed the baseline testing protocol which included a bilateral nerve conduction test of the median and ulnar nerves at the wrist, a brief physical examination of the upper extremities, and a self-administered questionnaire. Baseline test results were mailed to all subjects; those with symptoms and nerve conduction abnormalities suggestive of CTS were encouraged to see a physician. Follow-up questionnaires were collected at 6, 18, and 36 months after baseline. The follow-up questionnaires were either mailed to subjects or distributed at apprenticeship training classes or the worksite. Subjects who failed to return questionnaires were asked to complete the survey by telephone. Study subjects were compensated for their participation in the baseline testing protocol and each follow up questionnaire.

Baseline and follow-up questionnaires included items on personal characteristics, upper-extremity symptoms, medical care for hand/wrist disorders, and functional status.[16] The questionnaires also assessed physical work exposures, changes in work productivity and duties, and psychosocial measures such as job satisfaction and coworker/supervisor support.

Symptoms of the hand and wrist were assessed using the following initial question: “In the past YEAR, have you had RECURRING (repeated) symptoms in your HANDS, WRISTS, or FINGERS more than 3 times or lasting more than ONE week?” If yes, subjects answered questions about the location of symptoms (fingers, hands, wrists), the nature of the symptoms (i.e. Burning/Pain, Tightness/Stiffness, Soreness/Cramping/Aching, and Numbness/Tingling), completed a hand diagram[17, 18], and reported on symptom intensity in the last 30-days and the presence of nocturnal symptoms.

Our case definition of CTS required a combination of symptoms and abnormal median nerve conduction.[19, 20] Symptoms were classified as “classic” or “probable” using modified scoring of the hand diagram described by Katz et al.[17, 18] Abnormal median nerve conduction was defined as sensory latency >3.5 ms (14 cm) OR motor latency >4.5 ms OR median-ulnar sensory latency difference (MUDS) of > 0.5 ms (14 cm).[21]

Subjects were categorized according to baseline data into four mutually exclusive groups: symptoms of CTS (neuropathic symptoms in the median innervated fingers) without nerve conduction abnormalities, or confirmed CTS (symptoms of CTS and abnormal nerve conduction study) or other recurring symptoms in the wrist, hands, or fingers, or no symptoms in the wrist, hands, or fingers.

Outcomes

The primary outcome at 3 years was “severe hand pain,” defined as hand pain within the past 30 days with a rating of 5 or higher on a scale of 0 (no discomfort) to10 (worst discomfort imaginable). Using the same scale, “no pain” was defined as a rating of 0 and “moderate pain” was defined as a rating of 1 to 4.

Secondary outcomes included changes in functional status or job limitations due to hand/wrist pain.[22] The Levine Functional Status Scale was used for assessing functional status limitations;[16] this scale is based on subjects’ self-rated ability to perform regular work duties or activities of daily living, rated on a scale from 1 (no difficulty) to 5 (cannot perform activity at all). In order to determine overall functional status scores at baseline and 36 months the average of the eight items was used. The mean differences of functional status scores between baseline and follow-up were divided by the standard deviation of the difference to calculate effect size.[23] Subjects with an effect size of 0.8 or greater were considered positive for functional status limitations.[16] Job limitation was created as a dichotomous composite outcome that included all workers who reported a limitation

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

attributed to hand symptoms in one or more of the following areas: 1) limited ability to work, 2) decreased productivity, 3) lost time from work, 4) placed on job restrictions, and a 5) change in job or employer.[24]

Analyses

Baseline subject categorization and independent variables (gender, age, level of education, severe hand pain at baseline) were assessed as prognostic factors for the outcome. Self-reported occupational exposures were taken from the 6 month questionnaire, as many workers had not yet started their new jobs at the time of the baseline examination. Based on literature review and preliminary analyses, one physical exposure factor and one psychosocial exposure factor were chosen for analysis: workers who reported tasks where they used a twisting, rotating, or screwing motion of the forearm four or more hours per day, and social support scale measurement less than or equal to 22 (indicating the lowest quartile of level of social support.[25] Subjects were also asked if they had seen a physician for the treatment of hand pain, and if they had received surgery or a steroid injection or used a wrist brace or other treatment for CTS at any time during the study period.

We analyzed predictors of the three study outcomes: severe hand pain, functional status limitation, and job limitation at 3-year of follow-up, using bivariate and multivariate Cox regression models to calculate Prevalence Ratios of these outcomes among subjects with different risk factors. Statistical Analysis Software (SAS v9.1, SAS institute Inc, Cary, NC, USA) was used for all analyses. This paper was reviewed using the STROBE checklist to insure completeness of presentation and contents for observational studies.[26]

RESULTS

At 3 years, follow-up data were available on 888 workers of 1107 workers (80.2%, see Figure 1), with a mean age at baseline of 30.3 years (range 18-66 years,); 567 (63.9%) workers were men. No statistically significant baseline differences in symptoms or prevalence of CTS diagnosis was seen at baseline between subjects who were followed and those lost to follow-up. Loss to follow-up was more common among workers with high school diploma or less education at baseline (n=151, 69.0% of those lost to follow-up vs. n=426, 48.0% in the group followed up at 3 years, $P<0.05$), and among workers who reported lower social support on the six month questionnaire (n=35, 29.2% lost to follow-up, vs. n=147, 18.5% available at follow-up, $P<0.05$). No other differences in variables of interest were found between those followed at three years and those lost to follow-up.

At baseline, 155 workers (17.5% of the total cohort, figure 1) had hand symptoms: 21 met criteria for CTS, 52 had neuropathic symptoms in the median nerve distribution without nerve conduction abnormalities, and 82 had other symptoms in the hand, fingers, or wrist (Table 1). The population studied was young and mostly male; less than half had education beyond high school; 16% reported a low social support and 24% reported workplace exposure to repeated forearm motion over four hours/day on the six month questionnaire.

Workers with hand symptoms at baseline were more likely to show limitations and continued hand pain at a later time point, 51 (32.1%) of workers who were symptomatic at baseline reported “severe hand pain” at follow-up, compared to 111 (15.9%) of workers without hand pain at baseline (prevalence ratio 2.17 [1.64-2.88]). Workers with hand symptoms at baseline were also more likely to report job limitations at follow-up than those without hand symptoms (n=34, 21.9 % versus n=72, 9.8%, prevalence ratio =2.23 [1.54-3.23]).The prevalence of functional status limitations at follow-up was not significantly different between those with hand symptoms at baseline versus those with no symptoms (n=18, 11.6 % versus n=59, 8.1%, prevalence ratio =1.44 [0.88-2.38]).

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

At follow-up, 18 of the 155 workers with hand symptoms at baseline demonstrated functional status limitations by Levine's score (11.6%) and 34 reported job limitations (21.9%, Table 2). In the three-year period, 29 reported limited ability to work, six reported decreased productivity, two reported lost time from work, two reported having been placed on job restrictions due to hand symptoms, and one changed employers due to symptoms. Severe hand pain at baseline was closely associated with both functional status and job limitations at follow-up: 83.3% of the 18 subjects who reported functional limitations on the Levine scale reported severe hand pain vs. 26.3% who did not report functional limitation (prevalence ratio = 3.17 [2.24 – 4.49]); 64.7% of the 34 subjects who reported job limitation reported severe hand pain vs. 24.0% who reported no job limitation (prevalence ratio= 2.70 [1.80 – 4.04]).

Only 32 of 155 symptomatic subjects (20.7%) reported seeing a physician in the three year period. Among the 21 subjects with CTS, 4 (19.1%) reported seeing a physician in the period. Self-reported treatment was low with two subjects receiving hand surgery and five receiving steroid injections. Treatment was not included in the statistical models due to the small number receiving treatment. Among the two subjects who received CTS surgery, one had severe pain and functional limitation at 3 year follow-up; among the five subjects who received steroid injection, only one had no pain or functional limitation.

Meeting a case definition of electrodiagnostically confirmed CTS at baseline was the greatest predictor of future hand pain among these workers (Table 3): adjusted prevalence ratio was 2.0 for having a severe hand pain vs. no pain. Meeting a case definition of electrodiagnostically confirmed CTS at baseline was also associated with functional status limitation on the Levine scale (Table 4), with an adjusted prevalence ratio of 3.4 for having a limitation. Female gender also predicted functional status limitation. Low educational level was the only variable associated with our measurement of job limitation.

DISCUSSION

In our study, the natural history of hand symptoms among industrial workers showed the persistence of hand symptoms, with a high prevalence of continued hand pain after three years of follow-up. Only a small proportion of symptomatic workers sought medical care or received treatment. Meeting a case definition of electrodiagnostically confirmed CTS at baseline was associated with hand pain and functional limitation among these industrial workers at 3 years, though it did not predict our measure of job limitation.

The persistence of hand pain was high among persons meeting our case definition for CTS, even though effective treatments for CTS are available.[9] In working populations where risk factors are common, this result has been also described by others: Silverstein et al. reported the persistence of hand pain in almost half of their worker population at one-year of follow-up.[14] The proportion of the persistence of symptoms was higher in the study by Silverstein and colleagues compared to the current study, but their workers were older (40.6 years vs. 29.5), probably with overall higher physical exposures, and had a higher proportion of CTS at baseline (10.8% vs. 2.4%, with similar criteria). Nathan et al. found a persistence of hand symptoms, with a five years follow-up of a working population, between 22% for pain to 56% for numbness.[27] Spies-Dorgelo et al. reported similar persistent hand pain: more the half of their CTS patients coming from general practitioners reported residual symptoms.[28] Our study showed that workers meeting an epidemiologic case definition of CTS (with positive nerve conduction study) were at higher risk of future hand pain and limitations in functional status than workers with hand pain not meeting our CTS definition.

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

In addition to meeting CTS case definition, other factors were associated with pain and functional outcomes including gender for functional status limitation, and low educational level for job limitation. Work exposure factors were less strongly associated with outcomes than expected and only significant in bivariate analyses and in some models on pain outcomes.[14, 29, 30] Our exposure data were limited to self-reported exposure at one point in time, and by a relatively small number of subjects.

Study Limitations

Our study had a number of limitations that may have affected the results. The study population was predominately young male workers who rarely sought medical care. The relatively small overall number of CTS cases is typical of an active working population. Thus, the presented results cannot be directly applied to other populations such as retired workers or patients seeking care for hand symptoms. Another limitation concerns the use of self-reported variables. For the work physical exposure, we used only one variable, which has been previously validated.[2, 31] and previously used in the PrediCTS study.[24] However, this study does not account for potential variation in exposure during the study period, nor for the effects of other physical exposures. Self-reported physician visits and treatment may also be subject to inaccuracies, though invasive treatments such as surgery or wrist injections are likely to be recalled. We could not include treatment status in our statistical models due to the small number of subjects reporting treatment.

Other diagnoses of hand pain, such as tendonitis or osteoarthritis, were not specifically studied. We focused on CTS because of its frequency and importance in working populations and because we had a strong case definition based both on symptoms and electrophysiological measurements on each worker.[29, 32] Models were built using variables that covered major known prognostic factors in clinical and occupational studies, although the factors were limited to the data available and did not include a measure for depression nor the duration of hand pain. [14, 28, 33-35] However, considering the objective definition used for carpal tunnel criteria diagnosis.[19, 20] the probability of those variables affecting the case definition is low.

The main outcome was based on severe pain with a threshold of five or more on a ten-point scale. This outcome seemed valuable because pain is a major symptom in medical practice,[36] and severe pain is usually associated with function and other outcomes.[37] Our results showed a strong prospective relationship between pain and functional variables. Our job limitation composite outcome was not as closely associated with CTS as the Levine functional status scale. This variable was composed of several outcomes including changes in work productivity, change in job, and job limitations; these outcomes are complex and likely affected by many factors other than hand function.

Conclusions

Our study found that a CTS case definition including symptoms and nerve conduction abnormalities predicted persistent hand pain and future functional status limitations in a large working population. Relatively few workers with pain sought or obtained medical evaluation for their hand symptoms during the three-year study period. While the natural history of clinically confirmed CTS has been previously described, the prognosis of symptomatic workers without confirmed CTS deserves further study, as these workers seem to be at increased risk of future pain and functional limitation. Future efforts to prevent functional limitation due to hand symptoms should also take into account the relatively high prevalence of symptomatic workers who do not receive medical evaluation and treatment. Surveillance must also include asymptomatic workers as many cases in our study arose among this group.

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Acknowledgments

We would like to thank Nina Smock and Dan Ryan for their help in the tables and the dataset.

Grants:

1. Centers for Disease Control/National Institute of Occupational Safety and Health (R01 OH008017-01)

2. National Center for Research Resources (NCRR), a component of the National Institutes of Health (NIH), and NIH Roadmap for Medical Research (UL1 RR024992)

ABBREVIATIONS

CTS	Carpal Tunnel Syndrome
PrediCTS	Predictors of Carpal Tunnel Syndrome study

REFERENCES

1. Hagberg, M.; Silverstein, B.; Wells, R., et al. Work related musculoskeletal disorders (WMSDs). Taylor and Francis; Bristol: 1995. A reference book for prevention
2. Sluiter JK, Rest KM, Frings-Dresen MH. Criteria document for evaluating the work-relatedness of upper-extremity musculoskeletal disorders. Scand J Work Environ Health. 2001; 27(Suppl 1):1–102. [PubMed: 11401243]
3. Bernard, BPe. Musculoskeletal disorders and workplace factors: a critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back. 1997.
4. Punnett L, Wegman DH. Work-related musculoskeletal disorders: the epidemiologic evidence and the debate. J Electromyogr Kinesiol. 2004; 14(1):13–23. [PubMed: 14759746]
5. Atroshi I, Gummesson C, Johnsson R, Ornstein E, Ranstam J, Rosen I. Prevalence of carpal tunnel syndrome in a general population. JAMA. 1999; 282(2):153–8. [PubMed: 10411196]
6. van Tulder M, Malmivaara A, Koes B. Repetitive strain injury. Lancet. 2007; 369(9575):1815–22. [PubMed: 17531890]
7. Roquelaure Y, Ha C, Leclerc A, Touranchet A, Sauteron M, Melchior M, et al. Epidemiologic surveillance of upper-extremity musculoskeletal disorders in the working population. Arthritis Rheum. 2006; 55(5):765–78. [PubMed: 17013824]
8. Daniell WE, Fulton-Kehoe D, Chiou LA, Franklin GM. Work-related carpal tunnel syndrome in Washington State workers' compensation: temporal trends, clinical practices, and disability. Am J Ind Med. 2005; 48(4):259–69. [PubMed: 16142733]
9. Keith MW, Masear V, Amadio PC, Andary M, Barth RW, Graham B, et al. Treatment of carpal tunnel syndrome. J Am Acad Orthop Surg. 2009; 17(6):397–405. [PubMed: 19474449]
10. Padua L, Padua R, Aprile I, Pasqualetti P, Tonali P, Italian CTSSG. Multiperspective follow-up of untreated carpal tunnel syndrome – A multicenter study. Neurology. 2001; 56(11):1459–66. [PubMed: 11402101]
11. Resende LA, Tahara A, Fonseca RG, Sardenberg T. The natural history of carpal tunnel syndrome. A study of 20 hands evaluated 4 to 9 years after initial diagnosis. Electromyography and clinical neurophysiology. 2003; 43(5):301–4. [PubMed: 12964258]
12. Pensy RA, Burke FD, Bradley MJ, Dubin NH, Wilgis EFS. A 6-year outcome of patients who cancelled carpal tunnel surgery. Journal of Hand Surgery-European Volume. 2011; 36E(8):642–7.
13. Graham B. Nonsurgical treatment of carpal tunnel syndrome. J Hand Surg Am. 2009; 34(3):531–4. [PubMed: 19258153]
14. Silverstein BA, Fan ZJ, Bonauto DK, Bao S, Smith CK, Howard N, et al. The natural course of carpal tunnel syndrome in a working population. Scandinavian Journal of Work Environment & Health. 2010; 36(5):384–93.

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

15. Armstrong T, Dale A, Franzblau A, Evanoff B. Risk factors for carpal tunnel syndrome and median neuropathy in a working population. J Occup Environ Med. 2008; 50(12):1355–64. [PubMed: 19092490]
16. Levine DW, Simmons BP, Koris MJ, Daltroy LH, Hohl GG, Fossel AH, et al. A self-administered questionnaire for the assessment of severity of symptoms and functional status in carpal tunnel syndrome. J Bone Joint Surg Am. 1993; 75(11):1585–92. [PubMed: 8245050]
17. Katz JN, Stirrat CR, Larson MG, Fossel AH, Eaton HM, Liang MH. A self-administered hand symptom diagram for the diagnosis and epidemiologic study of carpal tunnel syndrome. J Rheumatol. 1990; 17(11):1495–8. [PubMed: 2273490]
18. Dale A, Strickland J, Symanzik J, Franzblau A, Evanoff B. Reliability of hand diagrams for the epidemiologic case definition of carpal tunnel syndrome. J Occup Rehabil. 2008; 18(3):233–48. [PubMed: 18521726]
19. Rempel D, Evanoff B, Amadio PC, de Krom M, Franklin G, Franzblau A, et al. Consensus criteria for the classification of carpal tunnel syndrome in epidemiologic studies. Am J Public Health. 1998; 88(10):1447–51. [PubMed: 9772842]
20. Descatha A, Dale AM, Franzblau A, Coomes J, Evanoff B. Comparison of research case definitions for carpal tunnel syndrome. Scand J Work Environ Health. 2011; 37(4):298–306. [PubMed: 21301789]
21. Dale AM, Descatha A, Coomes J, Franzblau A, Evanoff B. Physical examination has a low yield in screening for carpal tunnel syndrome. Am J Ind Med. 2011; 54(1):1–9. [PubMed: 21154516]
22. Badley EM. Enhancing the conceptual clarity of the activity and participation components of the International Classification of Functioning, Disability, and Health. Soc Sci Med. 2008; 66(11): 2335–45. [PubMed: 18314239]
23. Cohen, J. Statistical power analysis for the behavioral sciences. 2nd ed.. Lawrence Earlbaum Associates; Hillsdale, NJ: 1988.
24. Gardner BT, Dale AM, Vandillen L, Franzblau A, Evanoff BA. Predictors of upper extremity symptoms and functional impairment among workers employed for 6 months in a new job. Am J Ind Med. 2008; 51(12):932–40. [PubMed: 18651568]
25. Karasek R, Brisson C, Kawakami N, Houtman I, Bongers P, Amick B. The Job Content Questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. J Occup Health Psychol. 1998; 3(4):322–55. [PubMed: 9805280]
26. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP, et al. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. BMJ. 2007; 335(7624):806–8. [PubMed: 17947786]
27. Nathan PA, Keniston RC, Myers LD, Meadows KD, Lockwood RS. Natural history of median nerve sensory conduction in industry: relationship to symptoms and carpal tunnel syndrome in 558 hands over 11 years. Muscle Nerve. 1998; 21(6):711–21. [PubMed: 9585324]
28. Spies-Dorgelo MN, van der Windt DA, Prins AP, Dziedzic KS, van der Horst HE. Clinical course and prognosis of hand and wrist problems in primary care. Arthritis Rheum. 2008; 59(9):1349–57. [PubMed: 18759252]
29. Roquelaure Y, Ha C, Rouillon C, Fouquet N, Leclerc A, Descatha A, et al. Risk Factors for Upper-Extremity Musculoskeletal Disorders in the Working Population. Arthritis & Rheumatism-Arthritis Care & Research. 2009; 61(10):1425–34. [PubMed: 19790112]
30. Blanc PD, Faucett J, Kennedy JJ, Cisternas M, Yelin E. Self-reported carpal tunnel syndrome: predictors of work disability from the National Health Interview Survey Occupational Health Supplement. Am J Ind Med. 1996; 30(3):362–8. [PubMed: 8876807]
31. Stock SR, Fernandes R, Delisle A, Vezina N. Reproducibility and validity of workers' self-reports of physical work demands. Scand J Work Environ Health. 2005; 31(6):409–37. [PubMed: 16425584]
32. Leclerc A, Landre MF, Chastang JF, Niedhammer I, Roquelaure Y. Upper-limb disorders in repetitive work. Scand J Work Environ Health. 2001; 27(4):268–78. [PubMed: 11560341]
33. Katz JN, Losina E, Amick BC 3rd, Fossel AH, Bessette L, Keller RB. Predictors of outcomes of carpal tunnel release. Arthritis Rheum. 2001; 44(5):1184–93. [PubMed: 11352253]

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

34. Tay LB, Urkude R, Verma KK. Clinical profile, electrodiagnosis and outcome in patients with carpal tunnel syndrome: a Singapore perspective. Singapore Med J. 2006; 47(12):1049–52. [PubMed: 17139401]

35. Nunez F, Vranceanu A-M, Ring D. Determinants of Pain in Patients with Carpal Tunnel Syndrome. Clinical Orthopaedics and Related Research. 2010; 468(12):3328–32. [PubMed: 20811788]

36. Jackson JL, Kroenke K. The effect of unmet expectations among adults presenting with physical symptoms. Ann Intern Med. 2001; 134(9 Pt 2):889–97. [PubMed: 11346325]

37. McGeary DD, Mayer TG, Gatchel RJ. High pain ratings predict treatment failure in chronic occupational musculoskeletal disorders. J Bone Joint Surg Am. 2006; 88(2):317–25. [PubMed: 16452743]

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

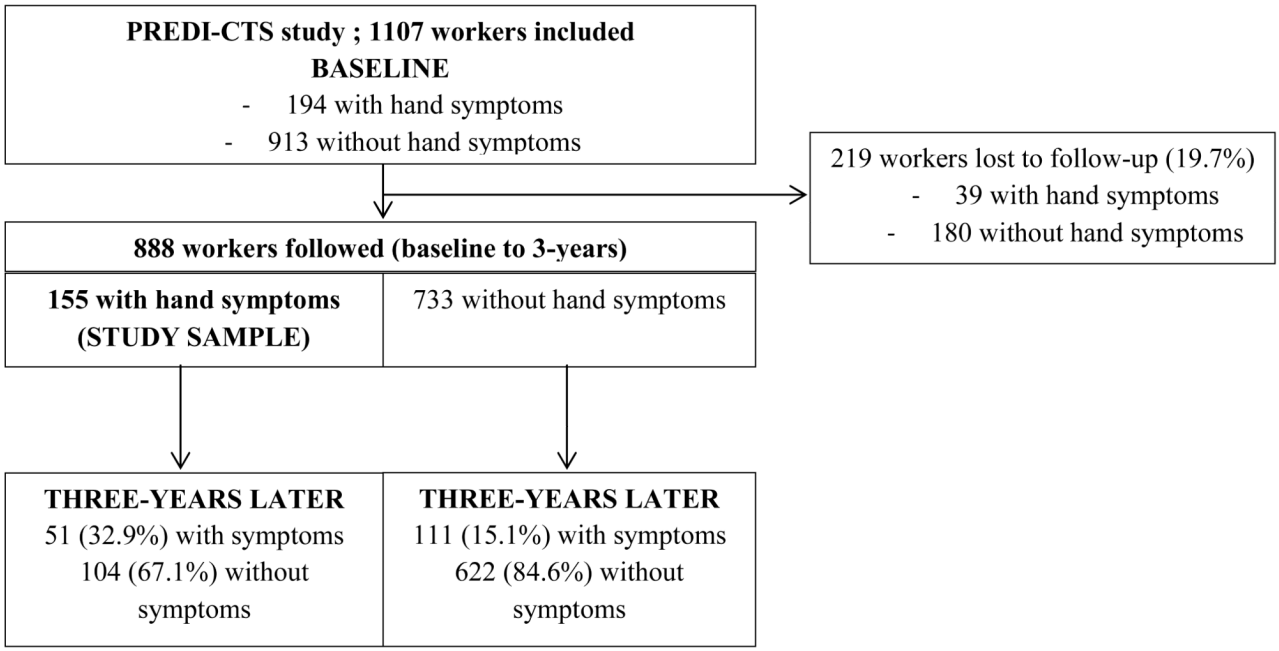

Figure 1.
Flow diagram

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

Table 1
Description of the selected factors among the workers with and without hand symptoms

Variable	Workers without hand symptoms N,%		Workers with hand symptoms n, %	
	N%	Mean (SD)		Mean (SD)
Age at baseline		*30.43 (10.62)*		*29.51 (9.16)*
Gender				
Male	451, 61.5		116, 74.8	
Female	282, 38.5		39, 25.2	
Baseline categories of hand pain				
Confirmed CTS	0		21, 13.6	
Symptoms of CTS, NCS−	0		52, 33.6	
Other Hand Symptoms	0		82, 52.9	
Education level at baseline				
Greater than high school	391,53.3		71, 45.8	
High school or less	342, 46.7		84, 54.2	
Lack of social support *±				
No	527, 71.9%		121, 84.0	
Yes	124, 16.9%		23, 16.0	
Repetitive forearm motion 4 or more hours/day *				
No	581, 79.3%		118, 76.1	
Yes	152, 20.7%		37, 23.9	
Severe hand pain at baseline				
No	733, 100%		84, 54.2	
Yes	0, 0%		71, 45.8	
TOTAL	**733**		**155**	

CTS = carpal tunnel syndrome, NCS− = negative for nerve conduction study

* reported at 6 months in new job

± missing data for 11 subjects

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Table 2

Distribution of hand disorders at baseline, and outcomes of pain and limitation at follow-up among the 155 workers with hand pain

	Other Hand Symptoms	Symptoms of CTS, NCS−	Confirmed CTS
	n, %	n, %	n, %
Baseline Pain *(n =155/888;17.5%)*	82, 9.2	52, 5.9	21, 2.4
Symptom outcome at 36 months			
No hand pain *(n =75;48.4%)*	45, 54.9	25, 48.1	5, 23.8
Moderate pain *(n=29;18.7%)*	15, 18.3	11, 21.1	3, 14.3
Severe hand pain *(n =51;32.9%)*	22, 26.8	16, 30.8	13, 61.9
Functional status limitation on Levine scale *(n =18;11.6%)*	6, 7.3	7, 13.5	5, 23.8
Job limitation *(n =34;21.9%)*	19, 23.0	9, 17.3	6, 28.6

CTS = carpal tunnel syndrome, NCS− = negative for nerve conduction study

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

Table 3

Prognostic factors associated with the pain at 3 year follow-up among workers with hand pain at baseline

	Moderate Hand pain vs. no pain			Severe Hand pain vs. no pain		
	n, %**	PR (crude)	PR (adjusted*)	n, %**	PR (crude)	PR (adjusted*)
Age, mean years (SD)	*29.1 (7.97)*	1.00 (0.97 - 1.04)	1.00 (0.97 - 1.04)	*30.8 (10.57)*	1.01 (0.99 – 1.03)	1.01 (0.99 - 1.03)
Gender						
Male	24, 20.7	1	1	36, 31.0	1	1
Female	5, 12.8	0.70 (0.30 - 1.62)	0.77 (0.31 - 1.90)	15, 38.5	1.13 (0.71 - 1.78)	1.07 (0.69 - 1.66)
Baseline categories of hand pain						
Other hand symptoms	15, 18.3	1	1	22, 26.8	1	1
Symptoms of CTS, NCS−	11, 21.2	1.15 (0.61 - 2.17)	1.58 (0.82 - 3.01)	16, 30.8	0.95 (0.60 - 1.50)	1.00 (0.57 - 1.76)
Confirmed CTS	3, 14.3	1.39 (0.53 - 3.59)	1.94 (0.72 - 5.21)	13, 61.9	**2.05 (1.40 - 3.01)**	**1.98 (1.16 - 3.38)**
Education level						
Greater than high school	14, 48.3	1	1	16, 31.4	1	1
High school or less	15, 51.7	1.20 (0.65 - 2.23)	1.30 (0.64 - 2.62)	35, 68.6	**1.81 (1.12 - 2.91)**	1.54 (0.94 - 2.52)
Lack of social support						
No	26, 21.5	1	1	35, 28.9	1	1
Yes	1, 4.4	0.30 (0.05 - 2.00)	0.29 (0.04 - 2.07)	12, 52.2	1.48 (0.93 - 2.35)	1.40 (0.89 - 2.19)
Repetitive forearm motion						
No	25, 21.2	1	1	33, 28.0	1	1
Yes	4, 10.8	0.72 (0.28 - 1.82)	0.66 (0.24 - 1.81)	18, 48.7	**1.54 (1.02 - 2.33)**	1.08 (0.66 - 1.77)
Severe hand pain at baseline						
No	18, 21.4	1	1	23, 27.4	1	1

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

	Moderate Hand pain vs. no pain			Severe Hand pain vs. no pain		
	n, %**	PR (crude)	PR (adjusted*)	n, %**	PR (crude)	PR (adjusted*)
Yes	11, 15.5	0.87 (0.46 - 1.65)	0.73 (0.38 - 1.41)	28, 39.4	1.34 (0.87 - 2.05)	1.22 (0.79 - 1.88)
TOTAL	**29, 18.7**			**51, 32.90**		

PR= Prevalence ratio with (95% Confidence Interval), CTS = carpal tunnel syndrome, NCS− = negative for nerve conduction study

*adjustment was made by including all of the variables listed

**proportion of cases out of total with hand symptoms at baseline (N)

NIH-PA Author Manuscript NIH-PA Author Manuscript NIH-PA Author Manuscript

Arch Phys Med Rehabil. Author manuscript; available in PMC 2014 July 01.

Table 4

Prognostic factors associated with functional impairment between baseline and 3 year follow-up among workers with hand pain at baseline

	Functional status impairment on Levine scale			Job impairment using job scale		
	n, %	**PR (crude)**	**PR (adjusted*)**	**n, %**	**PR (crude)**	**PR (adjusted*)**
Age, mean years (SD)	*34.61 (10.91)*	**1.05 (1.01 - 1.09)**	1.04 (0.998 - 1.08)	*29.26 (10.39)*	1.00 (0.96 - 1.03)	1.04 (0.99 - 1.08)
Gender						
Male	9, 7.8	1	1	26, 22.4	1	1
Female	9, 23.1	**2.97 (1.27 - 6.96)**	**2.51 (1.07 - 5.92)**	8, 20.5	0.92 (0.45 - 1.85)	0.96 (0.45 - 2.03)
Baseline categories of hand pain						
Other hand symptoms	6, 7.3	1	1	19, 23.2	1	1
Symptoms of CTS, NCS−	7, 13.5	1.26 (0.52 - 3.06)	2.21 (0.69 - 7.09)	9, 17.3	0.71 (0.36 - 1.42)	0.71 (0.32 - 1.58)
Confirmed CTS	5, 23.8	2.45 (0.98 - 6.18)	**3.37 (1.01 - 11.29)**	6, 28.6	1.37 (0.65 - 2.90)	1.11 (0.45 - 2.79)
Education level						
Greater than high school	5, 27.8	1	1	8, 23.5	1	1
High school or less	13,72.2	2.20 (0.82 - 5.87)	2.09 (0.77 - 5.70)	26, 76.5	**2.75 (1.33 - 5.68)**	**2.70 (1.25 - 5.87)**
Lack of social support						
No	10, 8.3	1	1	27, 22.3	1	1
Yes	4, 17.4	2.10 (0.72 - 6.14)	2.07 (0.64 - 6.71)	5, 21.8	0.97 (0.42 - 2.27)	0.85 (0.39 - 1.89)
Repetitive forearm motion						
No	11, 9.3	1	1	23, 19.5	1	1
Yes	7, 18.9	2.03 (0.85 - 4.86)	0.89 (0.30 - 2.58)	11, 29.7	1.53 (0.83 - 2.83)	1.11 (0.52 - 2.37)
Severe hand pain at baseline						
No	10, 11.9	1	1	18, 21.4	1	1

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

	Functional status impairment on Levine scale			Job impairment using job scale		
	n, %	PR (crude)	PR (adjusted*)	n, %	PR (crude)	PR (adjusted*)
Yes	8, 11.3	0.95 (0.40 - 2.27)	0.38 (0.13 - 1.08)	16, 22.5	1.05 (0.58 - 1.91)	0.89 (0.45 - 1.75)

PR= Prevalence ratio with (95% Confidence Interval), CTS = carpal tunnel syndrome, NCS− = negative for nerve conduction study

*adjustment was made by including all of the variables listed