Accepted: 29 April 2017
DOI: 10.1002/ajim.22736

RESEARCH ARTICLE

WILEY AMERICAN JOURNAL OF INDUSTRIAL MEDICINE

Dupuytren's contracture and handwork: A case-control study

Alfred Haines MD, MSc, FRCPC, CCFP[1,2] | Carolyn Levis MD, MSc, FRCS(C)[3] | Charles H. Goldsmith PhD[1,4,5] | Manraj Kaur MSc, PT[3,4] | Eric Duku PhD[6] | Richard Wells PhD[7,8] | Stephen D. Walter ARCS (London), PhD[1,9] | Cheryl Rook RN, CRSP, DOHS, Dip. Env. Health[10] | Susan Stock MD, MSc, FRCPC[11] | Gary Liss MD, MS, FRCPC[12,13] | Jessica Murphy MSc[3,4] | Achilleas Thoma MD, MSc, FRCS, FACS[1,3,4]

[1] Department of Clinical Epidemiology and Biostatistics, McMaster University, Hamilton, ON, Canada
[2] Department of Family Medicine, McMaster University, Hamilton, ON, Canada
[3] Department of Surgery, McMaster University, Hamilton, ON, Canada
[4] Surgical Outcomes Research Centre (SOURCE), McMaster University, Hamilton, ON, Canada
[5] Simon Fraser University, Faculty of Health Sciences, Burnaby, BC, Canada
[6] Offord Centre for Child Studies, Hamilton Health Sciences (Chedoke Site), Hamilton, ON, Canada
[7] Department of Kinesiology, Faculty of Applied Health Sciences, University of Waterloo, Waterloo, ON, Canada
[8] Institute for Work and Health, Toronto, ON, Canada
[9] Department of Mathematics and Statistics, McMaster University, Hamilton, ON, Canada
[10] Occupational Health Clinic for Ontario Workers Inc., Toronto, ON, Canada
[11] Department of Social and Preventive Medicine, University of Montreal, Research Centre (CR-CHUM), Montreal, QC, Canada
[12] Gage Occupational and Environmental Health Unit, University of Toronto, Toronto, ON, Canada
[13] Ontario Ministry of Labour, Toronto, ON, Canada

Correspondence
Achilleas Thoma, Department of Clinical Epidemiology and Biostatistics, McMaster University, Suite 101, 206 James Street South, Hamilton, ON L8P 3A9, Canada.
Email: athoma@mcmaster.ca

Funding information
Ontario's Workplace Safety & Insurance Board (WSIB): The Solutions for Workplace Change competitive research grants program,
Grant number: DUPUYTREN'S CONTRACTURE AND OCCUPATION: A PROPO

Objective: The objective of this study was to examine the association between Dupuytren's contracture (DC), repetitive handwork (RHW), heavy handwork (HHW), and/or vibration exposure.

Methods: Frequency and intensity of the three types of handwork were collected and compared between DC patients and controls. Hours of work were weighted by average "frequency," for RHW, and average "intensity," for HHW and use of vibrating tool. Logistic regression was used to evaluate risk of developing DC associated with the above-mentioned factors.

Results: Data from 129 cases (74 clinical, 106 controls) was analyzed. Family history, male gender and age (decades) were associated with increased risk of DC. Results indicate that the risk becomes substantial after about 30 years of steady RHW. Independent effects of intensity-weighted HHW and vibrating exposure were not established.

Conclusions: Frequency-weighted RHW increases DC risk. Additionally, a strong association between DC, male gender and heredity was found.

This research was performed at St. Joseph's HealthCare, Hamilton, ON, Canada and McMaster University, Hamilton, ON, Canada.

KEYWORDS
Dupuytren's contracture, frequency-weighted, heavy handwork, repetitive handwork, vibration exposure

1 | BACKGROUND

Guillaume Dupuytren, a French anatomist and military surgeon, is best known for Dupuytren's contracture (DC),[1] while the condition has been described for centuries. DC is a disease of the palmar fascia resulting in thickening and contracture of fibrous bands on the surface of the hands and fingers. The principal clinical deformity is a slowly progressive, irreversible, and disabling flexion of the fingers.[2] The flexion results in curling of fingers toward the palm, predominantly affecting ring, and little fingers. This shortening is termed a contracture. About 5% of Caucasian populations have evidence of DC.[3] In its later stages, DC produces restriction of activities of daily living and reduces the patients' quality of life, frequently requiring surgical intervention, and collagenase injections. Disease recurrence is common.

The epidemiology of DC indicates that it is more prevalent in males than females, and the prevalence increases with age.[4] Genetic susceptibility is a well-recognized etiological factor; there is an increased risk of DC with positive family history.[5] In 2004, Geoghegan et al[6] conducted a case-control study using prospective data collection from DC patients. Diabetes was a risk factor for DC, with the highest risk among patients with insulin dependent diabetes; epilepsy and anti-epileptic medication were not found to be related to DC. Godtfredsen et al[7] conducted a prospective cohort study addressing the relationship between alcohol and tobacco use, and DC. They found that these determinants increased the odds ratios (OR) for having DC in a dose-dependent manner. There are case reports and series of DC that occurred after single hand injuries such as penetrating wounds, crush injuries, or fractures. No analytical epidemiologic investigations have been conducted to study the association of DC with single injury.

In 2011, Descatha et al[8] conducted a meta-analysis of the literature to assess the association between manual work exposure and DC. Four databases (PubMed, Embase, Web of science, Base de Données de Santé Publique) were searched using the key words: "Dupuytren's contracture," "work," and "occupational disease." The selection of articles was performed to include the association between manual work, either heavy manual labor and/or exposure to vibrations, and DC. Exposure was assessed, including job title, self-reported exposure, and measurements (for vibration exposure). High quality methodological criteria (HQMC) were applied to the retrieved studies. Scores of 13 or higher on the HQMC were considered high quality. Six studies [4,7,9–12] met the HQMC; five found a dose-response relationship. The meta-odds ratios (meta-OR) analysis integrates the quantitative findings from studies. For the 6 HQMC studies, the meta-OR for manual work was 2.0 (95%CI 1.5-2.7); the meta-OR for vibration exposure was 2.1 (1.6-2.9). The results support the association between DC, and vibration exposure and manual work. In Descatha's meta-analysis, Lucas et al only studied both factors, manual work and vibration exposure, regarding DC association.

Descatha et al[13] conducted a cross-sectional study of 2161 men, examining DC and its relationship with heavy manual work with and without significant use of vibrating tools, adjusted on age and diabetes. Heavy manual work without vibration exposure was associated with the DC (adjusted OR 3.9; 95%CI 1.3-11.5), as was use of vibrating tools (OR 5.1; 95%CI 2.1-12.2).

Descatha et al[14] investigated DC in a prospective cohort of 10 017 men; analyses were performed adjusted on age, diabetes, alcohol, and smoking. They considered two outcomes: "Dupuytren's disease without surgery and without limitations, and Dupuytren's disease with surgery or limitations." Over 15 years of "manipulating" a vibrating tool at work, (OR 2.0; CI 1.3-2.9) was associated with the "disabled" DC. Risk was not increased to DC without surgery. "Carrying loads," "climbing stairs," and "computer work" were not significantly associated.

Palmer et al[15] examined the relation between DC and occupational exposure to vibration and manual work in 4969 eligible men. Associations were assessed by Poisson regression (PR), according to occupational vibration in the past week above or below UK's Health and Safety Executives action threshold (2.8 ms^{-2}). Models were adjusted for age, smoking status, social class, lifting weights >56 lbs., digging/shoveling, and use of a computer keyboard for >4 h/day. The elevated risk for vibration exposure above the threshold was PR 2.9 (95%CI 1.4-6.0). Risks were increased with heavy lifting, and digging and shoveling.

In our study, the aspects of handwork addressed were repetitive handwork (RHW), heavy handwork (HHW), and vibrating power tools (VPT). RHW was defined as repeating a similar action with the hand or wrist more than twice per minute. HHW was defined as lifting, holding, pushing or pulling 5 or more kilograms. The use of VPT was defined as having a running (or "operating") vibrating tool in the hands.

2 | OBJECTIVE

We sought to examine the association between DC and the exposure of concurrently three handwork factors − RHW, HHW, and vibrating exposure, controlling for potential confounding factors. The secondary objective of this study was to examine the association between DC and single hand injury.

3 | METHODS

We selected cases with DC, and controls without DC, and gathered and analyzed information from both groups about their handwork exposures and other factors pertinent to the study objective.

4 | SUBJECTS

DC treatment and surgery are exclusively performed by plastic surgeons in Hamilton, Ontario, Canada. To achieve as complete ascertainment as possible of DC cases referred to plastic surgeons in Hamilton, we cooperated with all nine plastic surgeons. Hamilton is a tertiary centre with a population of 500 000 and catchment area of 1.5 million people.

Surgeons were asked to identify current patients with DC, diagnosed on the basis of either: flexion contractures (lack of full extension) of the metacarpophalangeal (MCP) or proximal interphalangeal (PIP) joints caused by palmar or digital cords not associated with scar contractures or congenital camptodactyly, or palmar or digital nodules or cords or skin tethering, without contracture at the MCP or PIP joint.

The diagnosing surgeons had no contact with the interviewers, who subsequently gathered the main exposure data.

In identifying controls, the aim was to select subjects resembling the general population from which DC cases arise, avoiding control subjects with unrepresentative rates of work-related musculoskeletal disorders, concerns, or exposures. Accordingly, controls were selected from two sources: patients ("clinical controls") with another condition presenting to the same plastic surgical practices as the cases, and general population controls ("community controls").

Patients with sebaceous cysts, who are commonly seen by plastic surgeons, were selected as clinical controls; there is no established link between this condition and RHW, HHW, and/or vibration exposure. Clinical control subjects with sebaceous cysts were ascertained from seven of the surgeons' offices: two of the nine participating surgeons did not see sebaceous cyst patients. Vernon's Directory, a publicly available directory known to have a nearly complete listing of residents, was used to randomly select persons residing in Hamilton as "community controls." The data were through over automated and manual processing steps to insure its accuracy and relevancy. City Directories in Ontario have been the only reliable source of residential, business, and demographic data (http://www.vernonspublishing.com/index.php/main/home.html).

Eligible subjects were between the ages of 16 and 80 years at the time the study began. In addition, subjects needed to be able to understand and respond to the interviewer's questions in English.

Information was gathered from subjects by self-administered questionnaire, followed by structured telephone interview.

4.1 | Questionnaire

The questionnaire content was developed based on inclusion of items potentially related to the risk of developing DC. These items were ascertained through consolidation of findings of a literature review and the expert opinion of the plastic surgeon investigators. Item phrasing was modeled, where possible, on other widely used questionnaires of established ease of use by general populations, for example, such as the Ontario Health Survey (www.ontariohealthstudy.ca). In the pretesting phase, items were identified and modified if they proved to be ambiguous, misleading or redundant, and the administration time and sequencing of items was evaluated.

The self-administered questionnaire included (see appendix 1 for questionnaire details):

1. Demographics.
2. Hand injury history.
   a. Have you ever had any hand or wrist injuries that sent you to a hospital or physician for urgent treatment?
   b. If yes, write down the injury and year(s) it occurred.
3. Full- and part-time paid jobs (duration of one year or more).
   a. Type of industry.
   b. Years worked.
4. Medical conditions.
   a. Such as diabetes, diagnosed by a doctor.
5. Age of onset of DC.
   a. Indicate your approximate age when the doctor told you.
6. Family history (first degree) of DC.
   a. Have any of your blood relatives (father, mother, brothers, sisters, children, grandparents, uncles, aunts, first cousins) ever been diagnosed with DC of the hand? See pictures in study brochure.
7. Smoking history.
8. CAGE questionnaire.
   a. Have you ever thought you should cut down on your drinking?
   b. Have you ever become annoyed when people criticize you about your drinking?
   c. Have you ever felt guilty about your drinking?
9. Have you ever felt you needed a drink first think in the morning? Alcohol consumption (Current drinks per week).

The four-item CAGE questionnaire has been shown to be an effective method of screening for alcoholism.[16] When two or more CAGE questions are answered affirmatively, the sensitivity, specificity, and positive predictive value are all greater than 75% in the inpatient setting. Poulin et al[17] have used the CAGE questionnaire successfully as an indicator of alcohol disorders in the general Canadian population.

4.2 | Interview for exposure assessment

The purpose of the structured interview following the questionnaire was to gather more detailed exposure information. Accurate data can be obtained using subject-matter experts were consulted to develop an interviewer-administered handwork exposure questionnaire based on strategies and constructs in work activities.[18–21]

Two annotated Borg[22] were developed to assist subjects in estimating "frequency" of RHW, and "intensity" of HHW and vibration. (appendix 2).

Subjects were asked to estimate the numbers of hours per day, week, and year, that they had spent doing RHW, HHW or using the main vibrating power tool involved in the job. This information was itemized for each full-time and part-time job each of participants held that lasted more than 1 year. In addition, for each of these jobs, subjects were asked to estimate the average "frequency" of RHW and the average "intensity" entailed with HHW or use of the main vibrating power tool. The interviewers were trained about the concepts associated with using subjective data to estimate cumulative ergonomic exposures. To minimize variation in an effort to recall information, interviewers were encouraged to be consistent in the procedures used to assess exposure in all subjects. Only at the end of the interview did the interviewers become explicitly aware of the respondent's case status.

4.3 | Field testing of the questionnaire and interview

Two of the authors (TH and CL) tested the questionnaire in 29 patients with and without musculoskeletal disorders. These patients had either: (i) exposure to heavy or RHW; (ii) used VPT for their current job; or (iii) had DC. The subjects were interviewed and re-interviewed by two interviewers, A and B, after a minimum interval of 2 weeks, using the questions on handwork exposures, to evaluate their test retest reliability.

Subjects were randomly allocated to the interview sequence as follows: AA, BB, AB, BA. Interviewers were blinded to the prior interview results. Eleven had current jobs with HHW, eight with RHW, and six with HHW and vibration. Four had DC.

Intra-class correlations (ICCs) for hours per day, days per week, and weeks per year, as well as average frequency or intensity were calculated, to estimate inter-subject reliability. For RHW, the ICCs varied from 0.50 to 0.89 for current job, and 0.55 to 0.88 for the previous job. Corresponding results for HHW were 0.77-0.96 for current job, and 0.64-0.92 for previous job; for use of main vibrating tool, they were 0.79-0.93 for current job, and 0.78-0.95 for previous job. These levels are considered to represent good repeatability.[23] These results indicated that our hand exposure questionnaire could yield reproducible information on these handwork variables for prior occupations.

4.4 | Data collection

The questionnaire was sent to cases, clinical controls, and community controls. The questionnaire was mailed with a self-addressed stamped envelope and a cover letter explaining the McMaster Department of Surgery Study. A brochure was included, giving an explanation and pictures of DC. Remuneration of $20 was offered for participation. Also included was an information package with the definitions of aspects of handwork and Borg-like annotated exposure scales, so that respondents could evaluate their exposures over the phone.

The phone interviews commenced as soon as questionnaires were mailed back. A total of four interviewers conducted telephone interviews that lasted 1.5-2 h, depending on the extent of subjects' exposures to handwork.

4.5 | Sample size calculation

Estimates of the sample size requirements were made using Epi Info.[24] We assumed a one-tailed alpha level of 2.5%, and 80% power. To detect a doubling of risk, it was determined that about 190 cases at 20% prevalence of manual occupations[25] would be needed, along with equivalent numbers of clinical controls and community controls. As we anticipated a participation rate of about 75% among cases, it was projected that 250 cases would need to be identified. Similarly, it was anticipated that 250 clinical controls would be required. It was planned to recruit 250 community controls, as well.

It became clear that, because of insufficient volume, this would not be feasible in the study's data collection timelines. The questionnaire was sent to 925 people from three categories: 258 cases, 267 clinical controls, and 400 community controls. A modified version of the Dillman method was used to enhance response rates.[26] Approximately 2 weeks after the questionnaire was mailed, a reminder letter was sent to all subjects. After 1 month, those who had not returned the questionnaire were contacted by telephone. Each subject was contact attempted up to five times by telephone before being classified as non-responding.

4.6 | Statistical analysis

For each job for each subject, total hours of work were determined that met the criteria for RHW, HHW, and use of main vibrating tool. These hours were totaled for all jobs for each subject, for each hand. In addition, the hours of work in each job were weighted by average frequency, for RHW, and by average intensity, for HHW and use of main vibrating tool. These weighted hours were summed across all jobs for each subject, for each hand. Further, these exposure variables were then truncated at the time of diagnosis of DC in cases. Pack-years (20 cigarettes per pack) of cigarette smoking were similarly adjusted. In addition, in cases, age was truncated at the age of diagnosis.

Cases and controls were compared in terms of exposure to handwork variables and injury, as well as age, gender, handedness, family history of DC, history of diabetes, CAGE score (two or more, or not), alcohol consumption (current drinks per week), and cigarette smoking (pack years). These relationships were studied using logistic regression, with main results presented in Table 3. Age was scaled by 10 to represent censored age in decades.

Unilateral DC was compared to bilateral DC by these variables, particularly the handwork variables, to determine whether it was warranted to combine unilateral and bilateral DC cases. The comparison was done using cross tabulation for the categorical variables and by comparing means for the continuous variables. In addition, the covariates were used in a logistic regression, with unilateral compared to bilateral DC as the dependent variable, to determine if unilateral and bilateral DC differed importantly in terms of these variables.

Clinical and community controls were compared similarly, using cross tabulation, comparison of means, and logistic regression with these covariates as predictors. In addition, right- and left-sided cases were compared similarly initially, to determine whether right- or left-sided injury history, or right- or left-sided estimates for hours and frequency / intensity weighted hours for repetitive and HHW, and use of main vibrating tool, were importantly associated with ipsilateral case status.

Multivariable logistic regression was used to evaluate the relative importance of the covariates, in terms of their association with case/control status.

As an effect of repetitive or HHW or of vibrating tool exposure could plausibly depend on the levels of other covariates, all interaction terms between these exposures and the other covariates, as well as among these exposures themselves, were added to a model. The interaction terms with the least statistical significance were then removed, one at a time, and the resulting models were repeatedly re-run, to determine whether such terms would remain, at a criterion level of 0.05.

The test of goodness of fit of the models was evaluated by the Hosmer and Lemeshow Test; a criterion of 0.05 was used to indicate adequacy of fit. All statistical analyses were performed using SPSS, version 18.0.

5 | RESULTS

Three hundred fifty-eight subjects returned their questionnaires. Inability to see or hear, poor comprehension of English, lack of time, or incorrect mailing address were the most common reasons provided for refusal to participate in the trial. Out of the 358 participants, 21 subjects were subsequently excluded when it was found they were outside the age eligibility criteria, or were a control subject with DC, or a community control subject with sebaceous cyst. One had already participated in the field study and one had died. In addition, 26 people declined further participation at that point, for reasons including lack of time or interest.

In total, 309 subjects completed both the questionnaire and the telephone interview. Of these, 129 were cases, 74 clinical controls, and 106 community controls. Overall response rates were 50%, 28%, and 18%, respectively.

When right- and left-sided injury was combined into a single injury variable, no association was found between the exposures and the ipsilateral case status ($P > 0.001$). Logistic regressions ran separately for left and right sided cases were performed with the side of the hand dominance as the dependent variable. These analyses showed that none of the left- or right-sided variables were associated with ipsilateral DC status. The analysis of right- and left-sided exposure variables showed similar results. For example, the Pearson correlations between censored total hours for right- and left-sided repetitive work, HHW, and use of main vibrating tool were 0.66, 0.88, and 0.83, respectively. Accordingly, in the subsequent main analyses, a single variable was used for right or left injury history, and right- and left-sided estimates for hours and frequency/intensity weighted hours were summed.

Tables 1 and 2 compare unilateral and bilateral DC subjects by the categorical and continuous factors. There is a higher percentage of males among bilateral DC. No statistically significant difference in other variables for unilateral compared with bilateral DC subjects were observed. We compared the clinical and community controls by the categorical and continuous factors in Tables 1 and 2; there are a higher percentage of males among community controls compared to clinical controls.

When these categorical and continuous factors were studied with logistic regressions using unilateral versus bilateral DC as the dependent variable, no exposure variables were found to be associated with unilateral compared to bilateral case status, with the exception of gender (analyses not shown). Accordingly, unilateral DC and bilateral DC were combined into a single DC variable for the rest of our analyses. When these categorical and continuous factors were studied with logistic regression using clinical versus community control status as the dependent variable, no other variable, and in particular, no exposure variables, were found to be associated with clinical versus community control status, with the exception of gender (male gender was associated with community control status) (analyses not shown). Accordingly, they were combined, as controls, in the next steps in the main analysis.

When the patients and controls were grouped together and analyzed in comparison to the cases, we found that family history of DC is much more common, and there was a higher percentage of males (Tables 1 and 2) among cases compared to controls. Censored age and current alcohol consumption were also found to be higher among cases.

These relationships were studied using logistic regression, with main results presented in Table 3. The censored total hours and hour intensity/hour frequency scaled by 10 000 represent censored total hours, and hour intensity/hour frequency in paid work for both hands combined; the hours are divided by 10 000 to represent a typical 10 work years of 40 h per week and 50 weeks/year.

Assessment of interactions between these exposures and covariates, and among these exposures themselves, did not identify strong evidence that their effects depended on the level of other factors. The Hosmer and Lemeshow test ($P = 0.20$) indicated that the model fit was adequate. Nagelkerke's R squared was 22%. The RHW value for one subject, a case, met the criterion for being "extreme" although it was not clinically implausible; exclusion of this subject resulted in only minor change in the coefficients for this model.

The results show that family history of DC is associated with high OR 13.3 (95%CI: 4.9-36.2), consistent with increased risk of DC. The OR for male gender is 4.6 (95%CI: 2.5-8.6). Age in decade is associated with an OR of 1.32 (1.07-1.63). Independent of the other factors, the equivalent of a year's exposure to frequency-weighted RHW (half a year per hand) is associated with an increase of 3.2% (OR = 0.97) per year. The exposure, per decade work years of 40 h per week and

TABLE 1 Frequency distribution of risk factors for Dupuytren's contracture

Risk factor	Unilateral or bilateral DC				Clinical or community			Case or control		
	Right DC *n* (%)	Left DC *n* (%)	Bilateral DC *n* (%)	*P*-value	Clinical *n* (%)	Community *n* (%)	*P*-value	Cases *n* (%)	Controls *n* (%)	*P*-value
Male	22 (59.5)	16 (76.2)	60 (84.5)	0.02	28 (36.8)	55 (52.9)	0.03	98 (76.0)	83 (46.1)	<0.01
Right handedness	34 (91.9)	19 (90.5)	63 (88.7)	0.87	66 (86.8)	87 (83.7)	0.55	116 (89.9)	153 (85.0)	0.20
Relative with DC	9 (24.3)	7 (33.3)	17 (23.9)	0.67	2 (2.6)	4 (3.9)	0.65	33 (25.6)	6 (3.3)	<0.01
Diabetes	2 (5.4)	0 (0)	10 (14.1)	0.09	4 (5.3)	5 (4.8)	0.89	12 (9.3)	9 (5.0)	0.14
High cage score	3 (8.1)	3 (14.3)	16 (22.5)	0.16	8 (10.5)	10 (9.6)	0.84	22 (17.1)	18 (10.0)	0.07
History of heavy handwork	25 (67.6)	17 (81.0)	57 (80.3)	0.29	50 (65.8)	79 (76.0)	0.13	99 (76.7)	129 (71.7)	0.32
History of repetitive handwork	32 (86.5)	18 (85.7)	62 (87.3)	0.98	68 (89.5)	94 (90.4)	0.84	112 (86.8)	162 (90.0)	0.38
History of vibrating tool use	9 (24.3)	9 (42.9)	26 (36.6)	0.29	19 (25.0)	39 (37.5)	0.08	44 (34.1)	58 (32.2)	0.73
History of left hand injury	4 (10.8)	5 (23.8)	14 (19.7)	0.38	17 (22.4)	20 (19.2)	0.61	23 (17.8)	37 (20.6)	0.55
History of right hand injury	7 (18.9)	5 (23.8)	15 (21.1)	0.91	17 (22.4)	25 (24.0)	0.79	27 (20.9)	42 (23.3)	0.62
History of one or more injuries on right or left hand	9 (24.3)	8 (38.1)	25 (35.2)	0.44	29 (38.2)	36 (34.6)	0.63	42 (32.6)	65 (36.1)	0.52

Values in bracket indicate percentage (%); DC, Dupuytren's contracture.

50 weeks, to frequency-weighted RHW was 1.016 (1.001-1.032). Independent effects of intensity-weighted HHW (0.99) and vibrating exposure (OR = 0.98) were not established. RHW has a risk of 1.03 compared to the non-significant protective effects of HHW (OR = 0.98) and vibrating tools (OR = 0.97). We did not observe any relationship between DC and hand injury that required urgent treatment.

6 | DISCUSSION

This population-based case-control study is the first study to our knowledge to document the relationship between repetitive manual work and risk of DC in a Canadian sample. This study does not definitively resolve the controversy regarding the relationship of manual work and hand injury to DC. However, it places on a firmer footing prior evidence indicating that work of a repetitive nature increases the risk. For instance, a 60-year-old female singer, whose hand are idle most of the time, and has no regular exertions has a predicted risk of DC if 23%. However, a 60-year-old female who started as a secretary at the age of 20, and continues for 40 years, who has rapid steady exertion of 40 h/week and 50 weeks/year has a predicted risk of DC is 45%. Nevertheless, evaluations of DC risk examining higher prevalence of different tools contrast with work with heavy manual work and significant use of vibrating tools [Palmer et al., 2014].[13,14]

Our study indicates that, as with age itself, many years of repetitive work generally need to elapse before DC manifests. In an urban centre, the effects of RHW exceed those of HHW and use of vibrating tools. No relationship between DC and hand injury that required urgent treatment was identified in this study. We note also that our study did not find important risks associated with smoking, alcohol consumption, the CAGE score, or diabetes.

Our study has limitations. Despite our rigorous efforts in recruiting and persistence in tracking non-responders, our response rate was low, especially among the control groups, raising the possibility of unrepresentative exposure estimates from them. On the other hand, most of the exposure estimates were similar between the control groups and also between them and the cases, which can give us some confidence in their representativeness.

Our strategy of selecting DC cases from patients who seek care from surgeons carries a risk of selection bias, in that those seeking care may be more likely to be in manual occupations. In proposing the study originally, we argued that to do a full population based study would be unfeasible. Clinically, it is not apparent that such a risk of selection bias is real, as we often have patients in manual work who continue on, for example, with carpal tunnel syndrome, because they cannot take time off or because of job security concerns. That is, such a selection bias could conceivably operate in the opposite direction. Our results suggest that such a risk has not been significant since, while our results suggest that RHW increases DC, after substantial exposure, DC does not appear to be associated with history of

TABLE 2 Means (standard deviations) of “censored” continuous risk factors

	Unilateral or bilateral DC				Clinical or community			Case or control		
Censored risk factor	Right DC (*n* = 37)	Left DC (*n* = 21)	Bilateral DC (*n* = 71)	*P*-value	Clinical control (*n* = 74)	Community control (*n* = 106)	*P*-value	Cases (*n* = 129)	Controls (*n* = 180)	*P*-value
Age	59.4 (11.1)	54.5 (12.9)	55.1 (11.6)	0.15	50.0 (16.5)	53.3 (15.2)	0.16	56.2 (11.7)	51.9 (15.8)	<0.01
Pack years of cigarettes	8.9 (12.5)	13.3 (17.6)	16.6 (17.0)	0.06	15.3 (18.4)	12.6 (20.1)	0.37	13.8 (16.1) (n = 123)	13.7 (19.4) (n = 173)	0.98
Current alcohol[a]	10.9 (14.6)	6.9 (9.4)	8.3 (10.0)	0.37	6.3 (9.6)	5.4 (8.0)	0.46	8.8 (11.4)	5.8 (8.7)	0.02
Total years HHW	12.7 (14.5)	13.8 (12.4)	13.4 (14.4)	0.96	10.0 (12.9)	15.2 (14.6)	0.02	13.3 (14.0)	13.0 (14.1)	0.85
Total years RHW	20.7 (13.9)	21.7 (13.3)	21.6 (17.2)	0.96	16.7 (13.4)	21.0 (14.9)	0.05	21.4 (15.6)	19.2 (14.4)	0.21
Total years VPT	4.7 (11.4)	8.1 (12.3)	4.8 (11.4)	0.48	3.2 (7.9)	5.4 (9.6)	0.11	5.3 (11.5)	4.4 (8.9)	0.46
Total hours HHW scaled by 10 000	21.7 (38.6)	25.1 (38.8)	27.3 (43.5)	0.80	17.6 (33.7)	23.2 (33.9)	0.27	26.4 (41.2)	20.8 (33.8)	0.31
Total hours RHW scaled by 10 000	37.9 (42.3)	34.8 (30.0)	39.8 (39.6)	0.87	29.9 (31.8)	35.6 (33.7)	0.25	38.4 (38.8)	33.2 (32.9)	0.21
Total hours VPT scaled by 10 000	4.8 (16.0)	8.3 (14.2)	4.0 (9.0)	0.38	4.1 (11.4)	5.7 (19.4)	0.52	4.9 (12.2)	5.0 (16.5)	0.96
Hour intensity HHW scaled by 10 000	99.5 (193.9)	124.5 (217.1)	120.4 (214.8)	0.86	81.0 (165.2)	117.0 (205.8)	0.21	115.1 (208.1)	101.8 (190.0)	0.57
Hour frequency RHW scaled by 10 000	166.4 (226.8)	167.8 (164.8)	197.0 (248.8)	0.77	129.6 (151.6)	166.2 (181.5)	0.15	183.6 (229.8) (*n* = 128)	150.7 (170.0)	0.17
Hour intensity VPT scaled by 10 000	15.5 (47.3)	34.3 (55.1)	20.4 (48.5)	0.37	13.8 (39.9)	28.6 (125.2)	0.32	21.3 (49.3 (*n* = 128)	22.3 (98.7)	0.90

HHW, heavy handwork; RHW, repetitive handwork; VPT, use of main vibration powered tool.

The censored total hours and hour intensity/hour frequency “scaled by 10 000” represent censored total hours and hour intensity/hour frequency in paid work for both hands combined; the hours are divided by 10 000 to represent a typical 10 work years of 40 h per week and 50 weeks/yr.

[a]Current alcohol is not censored.

TABLE 3 Logistic regression: Influence of categorical and continuous factors on Dupuytren's contracture

	P-value	Odds ratio (95%CI)
Male	<0.001	4.61 (2.48-8.57)
Right handedness	0.69	1.20 (0.50-2.84)
Relative with DC	<0.001	13.32 (4.90-36.24)
Diabetes	0.75	1.19 (0.42-3.40)
High cage score	0.19	0.57 (0.24-1.33)
Hand injury	0.97	0.99 (0.55-1.77)
Censored age in decades	0.01	1.32 (1.07-1.63)
Censored pack years of cigarettes[a]	0.09	0.99 (0.97-1.00)
Current alcohol	0.08	1.03 (1.00-1.05)
Censored hour intensity HHW scaled by 20 000	0.26	0.99 (0.973-1.007)
Censored hour frequency RHW scaled by 20 000[b]	0.04	1.016 (1.001-1.032)
Censored hour intensity VPT scaled by 20 000[b]	0.40	0.982 (0.942-1.024)
Constant	<0.001	0.055

HHW, heavy handwork; RHW, repetitive handwork; VPT, use of main vibration powered tool.
The censored hour intensity/hour frequency "scaled by 10 000" represent censored hour intensity/hour frequency in paid work for both hands combined; the hours are divided by 10 000 to represent a typical 10 work years of 40 h per week and 50 weeks/yr.
[a]13 missing.
[b]1 missing.

HHW or vibrating tool use. If our cases were overrepresented by people who were visiting surgeons for diagnosis and medical management so they could return to manual work, we should have seen similar risks for those exposures.

In addition, because the diagnosis of DC generally follows the onset of symptoms, the use of the year of diagnosis to estimate the endpoint of the exposure period could result in an overestimate of its length. The year of diagnosis, however, is a more precise estimate of time of condition onset than the year of symptom onset because the onset of DC is usually insidious. The cases would be hard pressed if asked to pin down a specific date for the onset of their symptoms. The diagnosis of DC, however, is a significant, discrete, and documented event. Again, however, there is a countervailing possibility: that the insidious onset of DC is associated with reduction in hours of manual work for some time before diagnosis. Workers who develop DC are not able to do certain aspects of work. Thus, it is possible that using the year or age of diagnosis as a cut-point for exposure could actually underestimate it.

Our study has had a number of strengths. Among these is that we had full recruitment in our study of plastic surgeons in our area; thus, we have had very good representation of people with DC who come to the attention of plastic surgeons. We also believe that our study group would not be different from other urban North American populations and hence, the results are generalizable. We have gone considerably further than previous studies in assessing prior handwork exposure in detail. We carefully assessed and confirmed the reliability of our exposure measures.

7 | CONCLUSION

This study supports that a low, but significant, increase in risk per year was found for age (1.32 [1.07-1.63]) and frequency-weighted RHW (1.016 [1.001-1.032]). This finding supplements the body of evidence that highlights the importance of primary prevention to reduce RHW exposure in the workplace.

AUTHORS' CONTRIBUTIONS

CL, TH, AT, SW, CG, GL, CR, SS—designing research question, writing protocol, and securing funding for the project. TD, CL, AT, SW, GL, CR, SS—recruitment for the study. CG, ED—statistical support, writing of the manuscript. AT, MK, JM, CG, TH—writing of the manuscript, revision of the manuscript, and submission.

ACKNOWLEDGMENTS

This study would not have been possible without the support of the following physicians and their staff: Drs. Bain, Campbell-Moscrop, Dal Cin, Heddle, Martin, Strumas, Hynes, Thoma, and Levis. We were very grateful to them. The support of WSIB RAC was greatly appreciated.

FUNDING

Funding support for this research was obtained from Ontario's Workplace Safety and Insurance Board (WSIB) under the Solutions for Workplace Change competitive research grants program.

ETHICS APPROVAL AND INFORMED CONSENT

Ethics approval for this study was obtained from McMaster Research Ethics Board, now known as Hamilton Integrated Research Ethics Board. Informed consent to participate was obtained from all participants in accordance with the principles of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS), and the International Conference on Harmonization: Good Clinical Practice (ICH GCP).

DISCLOSURE (AUTHOR)

The authors report no conflicts of interest.

DISCLOSURE BY AJIM EDITOR OF RECORD

Steven Markowitz declares that he has no conflict of interest in the review and publication decision regarding this article.

DISCLAIMER

None of the authors in this manuscript have any conflicts of interest to disclose.

REFERENCES

1. Dupuytren G. Permanent retraction of the fingers, produced by an affection of the palmar fascia. *Lancet ii* 1834;222–225.
2. Picardo NE, Khan WS. Advances in the understanding of the aetiology of Dupuytren's disease. *Surgeon*. 2012;10:151–158.
3. Thurston A. Review article: Dupuytren's disease. *J Bone Joint Surg*. 2003;469–477.
4. Gudmundsson KG, Arngrimsson R, Sigfusson N, Bjornsson A, Jonsson T. Epidemiology of Dupuytren's disease: clinical, serological, and social assessment. The Reykjavik Study. *J Clin Epidemiol*. 2000;53:291–296.
5. Ling RSM. The genetic factor in Dupuytren's disease. *J Bone and Joint Surg*. 1963;45B:709–718.
6. Geoghegan JM, Forbes J, Clark DI, Smith C, Hubbard R. Dupuytren's disease risk factors. *J Hand Surg*. 2004;29:423–426.
7. Godtfredsen NS, Lucht H, Prescott E, Sorensen TI, Gronbaek M. A prospective study linked both alcohol and tobacco to Dupuytren's disease. *J Clin Epidemiol*. 2004;57:858–863.
8. Descatha A, Jauggret P, Chastang JF, Roquelaure Y, Leclerc A. Should we consider Dupuytren's contracture as work-related? *BMC Musculoskelet Disord*. 2011;12:96.
9. Bennett B. Dupuytren's contracture in manual workers. *Br J Ind Med*. 1982;39:98–100.
10. Cocco PL, Frau P, Rapallo M, Casula D. Occupational exposure to vibrations and Dupuytren's disease a case-control study. *Med Lav*. 1987;78:386–392.
11. Bovenzi M, Cerri S, Merseburger A, et al. Hand-arm vibration syndrome and dose-response relation for vibration induced white finger among quarry drillers and stonecarvers. *Occup Env Med*. 1994;51:603–611.
12. Lucas G, Brichet A, Roquelaure Y, Leclerc A. Dupuytren's disease: personal factors and occupational exposure. *Am J Ind Med*. 2008;51:9–15.
13. Descatha A, Bodin J, Ha C, et al. Heavy manual work, exposure to vibration and Dupuytren's disease? Results of a surveillance program for musculoskeletal disorders. *Occup Environ Med*. 2012;69:296–299.
14. Descatha A, Carton M, Mediouni Z, et al. Association among work exposure, alcohol intake, smoking and Dupuytren's disease in a large cohort study (GAZEL). *BMJ Open*. 2014;4:e004212.
15. Palmer KT, D'Angelo S, Syddall H, Griffin MJ, Cooper C, Coggon D. Dupuytren's contracture and occupational exposure to hand-transmitted vibration. *Occup Environ Med*. 2014;71:241–245.
16. Bush B, Shaw S, Cleary P, Delbanco T, Aronson M. Screening for alcohol abuse using the CAGE questionnaire. *Am J Med*. 1987; 82:231–235.
17. Poulin C, Webster I, Single E. Alcohol disorders in Canada as indicated by the CAGE questionnaire. *Can Med Assoc J*. 1997;157:1529–1535.
18. Ainsworth B, Jacobs D, Leon A, Montoye H, Richardson M. Assessment of the accuracy of physical activity questionnaire occupational data. *J Med*. 1993;35:1017–1027.
19. Rossignol M, Patry L, Sacks S. Carpal tunnel syndrome: validation of an interview questionnaire on occupational exposure. *Am J Ind Med*. 1998;33:224–231.
20. Houtman ILD, Goudswaard A, Dhondt S, van der Grinten MP, Hildebrandt VH, van der Poel EGT. Dutch monitor on stress and physical load: risk factors, consequences, and preventive action. *Occup Environ Med*. 1998;5:73–83.
21. Pope DP, Silman AJ, Cherry NM, Pritchard C, Macfarlane GJ. Validity of a self-completed questionnaire measuring the physical demands of work. *Scan J Work Environ Health*. 1998;24:376–385.
22. Borg G. Psychophysical scaling with applications in physical work and the perception of exertion. *Scand J Work Environ Health*. 1990;16:55–58.
23. Shoukri M, Edge V. 1996. *Statistical methods for health sciences*. CRC press, Inc.
24. Dean AG, Dean JA, Coulombier D, et al. *Epi Info, version 6a − a word processing, database, and statistics program for epidemiology on microcomputers*. Atlanta: Centers for Disease Control and Prevention.
25. Hébert, F, IRSST (Québec). 1996. Les indicateurs de lésions en santé et sécurité du travail: Analyse par secteur d'activité économique en 1991 [Montréal]: Institut de recherche et santé et en sécurité du travail du Québec.
26. Dillman DA. The design and administration of mail surveys. *Annu Rev Sociol*. 1991;17:225–249.

How to cite this article: Haines A, Levis C, Goldsmith CH, et al. Dupuytren's contracture and handwork: A case-control study. *Am J Ind Med*. 2017;60:724–733. https://doi.org/10.1002/ajim.22736

APPENDIX 1

Self-administered questionnaire online.

APPENDIX 2

Scale A: Frequency, for repetitive handwork
0-hands idle most of the time, no regular exertions
1
2-consistent slow, conspicuous pauses, or very slow motions
3
4-steady exertion/motion, may have frequent pauses
5
6-steady exertion/motion, may have infrequent pauses
7
8-rapid steady exertion/motion, few, if any pauses
9
10-rapid steady exertion/motion, no pauses, difficulty keeping up

Scale B: Intensity, for heavy handwork and vibration
0-none
1-very weak
2-weak (light)
3-moderate
4
5-strong (heavy)
6
7-very strong
8
9
10-extreme