3-1-2021

Manufacturing Workers Have a Higher Incidence of Carpal Tunnel Syndrome

Eric B. Battista

Nikhil Yedulla

Dylan S. Koolmees

Zachary A. Montgomery

Karthik Ravi

See next page for additional authors

Authors

Eric B. Battista, Nikhil Yedulla, Dylan S. Koolmees, Zachary A. Montgomery, Karthik Ravi, and Charles S. Day

Manufacturing Workers Have a Higher Incidence of Carpal Tunnel Syndrome

Eric B. Battista, BS, Nikhil R. Yedulla, BS, Dylan S. Koolmees, BS, Zachary A. Montgomery, BS, Karthik Ravi, and Charles S. Day, MD, MBA

Objective: It is unclear whether clerical or labor-type work is more associated with risk for developing work-related carpal tunnel syndrome (WrCTS). **Methods:** National employment, demographic, and injury data were examined from the Bureau of Labor Statistics databases for the years 2003 to 2018. Injuries for clerical and labor industries were compared using linear regression, two-group *t* test, and one-way analysis of variance (ANOVA) analysis. **Results:** WrCTS injuries are decreasing over time ($B = -1002.62$, $P < 0.001$). The labor industry demonstrated a significantly higher incidence of WrCTS when compared with the clerical industries ($P < 0.001$). Within labor industries, the manufacturing industry had the highest incidence of WrCTS over time ($P < 0.001$). **Conclusions:** Our study showed WrCTS injuries have declined over time. Additionally, our findings may suggest that the labor industry has a stronger association with WrCTS than the clerical industry.

Keywords: carpal tunnel injury, carpal tunnel syndrome, clerical worker injury, labor worker injury, manufacturing worker injury, occupational injury, work-related hand injury, work-related injuries, overuse injury

Carpal tunnel syndrome (CTS) is one of the most common entrapment neuropathies, affecting roughly 1% to 5% of the general population.[1–3] There is significant debate regarding the types of occupations most at risk for CTS.[4,5] In particular, work-related carpal tunnel syndrome (WrCTS) has been linked to occupational computer use; however, there has been conflicting information presented in several studies.[2,6,7] Several other studies have investigated individual risk factors for WrCTS associated with various computer and non-computer based occupations.[8–11] These risk factors include biomechanical mechanisms such as impact hand force, hand activity levels, forceful exertion, frequency and duration of exertion, vibration, and postural deviation.[8,9,11] Similarly, general population studies, including workers from many different industries, have examined the effects work has on the risk for WrCTS injury.[12–16] These studies have associated several different occupations, work activity requirements, and physical factors such as sex and body mass index (BMI) with increased incidence of or risk for WrCTS. Despite an abundance of studies, there is still ambiguity regarding the relationship between occupation and risk for WrCTS.

From the Henry Ford Health System, Detroit, Michigan (Dr Day); Wayne State University School of Medicine, Ann Arbor, MI (Mr Battista, Mr Yedulla, Mr Koolmees, Mr Montgomery, Dr Day); University of Michigan (Mr Ravi), Detroit, Michigan.

No funding was provided for the completion of this project. This project was completed at the Henry Ford Health System.

Conflict of Interest: None declared.

This project was exempt from IRB review as it was determined by to not fit the definition of Human Subjects Research.

Clinical significance Statement: Our findings offer clinically valuable insight into the recent trends in work-related carpal tunnel syndrome injuries with regards to industry. Specifically, our findings suggest labor-workers have a higher incidence of carpal tunnel syndrome injuries when compared to clerical-workers.

Address correspondence to: Charles S. Day, MD, MBA, Henry Ford Hospital, 2799 W Grand Blvd K12, Detroit, MI 48202 (cday9@hfhs.org).

DOI: 10.1097/JOM.0000000000002122

Since the creation of the Occupational Safety and Health Administration (OSHA) in 1970, which established occupational safety guidelines for the workplace, there has been a reduction in work-related injuries by roughly 60%.[17] However, changes regarding WrCTS injuries over time remain unclear.[14,15,18,19] The purpose of this study is to investigate: (1) the prevalence of WrCTS relative to other upper-extremity work-related injuries, (2) the rate of WrCTS injuries on a national level by comparing the broader clerical (computer use) and labor (biomechanical mechanisms) industries, and (3) the rates of WrCTS in the sub-sector categories of the clerical and labor industries, respectively. We hypothesize the following: (a) WrCTS incidence is highest in clerical industries compared with labor industries, and (b) WrCTS occurrence and incidence has been decreasing for both labor and clerical industries over time.

METHODS

The Bureau of Labor Statistics (BLS), a division of the United States Department of Labor, develops and provides nationally, publicly available databases containing labor and economic statistics. Employment, injury, and demographic data were collected from the respective BLS databases for the years 2003 to 2018. National labor force data provided by the BLS's ''Current Population Survey'' was collected for the same time frame. The BLS uses OSHA injury data which defines nonfatal work-related injuries as injuries or illnesses resulting from events or exposures occurring in the workplace. Specifically, injuries that meet any of the following criteria are included in the OSHA/BLS injury data: (a) any work-related injury or illness that results in loss of consciousness, days away from work, restricted work, or transfer to another job, (b) any work-related injury or illness requiring medical treatment beyond first aid, and (c) any work-related diagnosed case of cancer, chronic irreversible diseases, fractured or cracked bones/ teeth, and punctured eardrums.[20] Furthermore, all work-related injury diagnosed by a physician or other health care provider are mandated to be reported to OSHA by the employer.[20] CTS injury data prior to 2003 was insufficient for our study due to differences in injury data categorization presented by the BLS databases. Total work-related injuries, work-related upper extremity injuries, and overall CTS injuries from work were examined from the BLS databases for the purpose of this study.

In order to distinguish between labor and clerical industries, we defined the ''Labor'' industries as manufacturing and construction industries; and ''Clerical'' industries as information, professional/ business services, and finance/insurance industries. The BLS's ''Industries at a Glance'' defines each industry as the following: (a) manufacturing sector comprises establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products; (b) construction sector comprises establishments primarily engaged in the construction of buildings or engineering projects; (c) information sector comprises establishments engaged in the following processes: producing and distributing information and cultural products, providing the means to transmit or distribute these products as well as data or communications, and processing data; (d) Professional/Business Services contains professional, scientific,

TABLE 1. Selected Types of Upper Extremity Injuries by Number of Occurrences Per Year From 2003 to 2018

Year	Total Overall Injuries	Total Upper-Extremity Injuries	Sprains, Strains, Tears	Fractures	Cuts, Lacerations	Bruise, Contusions	Carpal Tunnel Syndrome
2018	900,380	286,810	83,050	32,620	56,860	16,240	5,050
2017	882,730	286,150	83,440	34,450	55,270	16,560	5,470
2016	892,270	283,900	83,690	32,200	55,140	16,440	5,390
2015	902,160	294,420	88,600	33,540	57,520	17,200	4,920
2014	916,440	288,240	85,290	33,500	53,260	16,250	6,800
2013	917,090	286,320	81,910	32,210	52,180	16,090	6,440
2012	918,720	289,940	84,230	30,990	54,400	18,010	7,590
2011	918,140	288,790	80,310	31,420	53,780	16,910	8,620
2010	933,200	209,600	35,000	26,960	52,760	14,560	8,490
2009	964,990	220,730	37,250	28,640	56,980	13,890	9,150
2008	1,078,140	244,150	36,680	35,320	64,030	16,460	10,080
2007	1,158,870	269,240	40,740	35,010	67,470	20,030	11,940
2006	1,183,500	274,180	42,350	36,320	83,090	19,400	13,010
2005	1,234,680	284,750	43,410	37,010	86,010	18,750	16,460
2004	1,259,320	290,460	45,610	35,820	81,590	22,810	18,710
2003	1,315,920	298,530	48,300	35,260	79,540	24,740	22,140

Data were extrapolated from the Bureau of Labor Statistics nonfatal injury database: resource Table R31.[7]

technical, management, and administrative support services; (e) Finance/Insurance sector comprises establishments primarily engaged in financial transactions (transactions involving the creation, liquidation, or change in ownership of financial assets) and/or in facilitating financial transactions.[21] Employment data for the industries mentioned above were included for comparison. WrCTS occurrences and incidence rates were then stratified by industry and then into clerical and labor categories.

Statistical Analysis

The primary outcome of interest in this study was the WrCTS injury occurrence and incidence rates in the specified industries. Mean injury occurrence and/or incidence rates were compared for upper-extremity injury types and between clerical and labor industries and sub-industries using univariate two-group *t* tests or Wilcoxon rank-sum test in comparisons involving two categories. A one-way analysis of variance (ANOVA) or Kruskal–Wallis test was performed to compare differences amongst the different industries when more than two categories are involved. For ANOVA or Kruskal–Wallis tests that are significant, multiple comparisons were performed using a Benjamini–Hochberg adjustment for adjusted *P*-values. Simple linear regression was performed for all analysis containing only a single variable and year. Slope (B) was also used to analyze injury changes per year over time. All analyses were verified by an institution affiliated statistician and performed using SAS 9.4 software (SAS Institute Inc., Cary, NC). A *P*-value <0.05 was considered statistically significant.

RESULTS

In 2003, the total population in the United States for the ages of 16 and over was 221,168,000, and the total eligible labor force comprised 146,510,000 individuals with 137,736,000 employed (94%) and 8,774,000 unemployed (6%).[22] Employed male and female workers comprised approximately 53% and 47%, respectively. As of 2018, the total population was 257,791,000.[23] Additionally, the total eligible labor force consisted of 162,075,000 individuals, including 155,761,000 people who were employed (96%) and 6,314,000 who were unemployed (4%). Employed male and female workers comprised approximately 53% and 47% of the labor force, respectively, suggesting the percentage of male and female workers in the labor force has stayed relatively constant during the 15-year period.

In 2003 there were 1,315,920 total injuries, 298,530 UE injuries (22%), and 22,140 CTS injuries (1.7% of total injuries, 7.4% of UE injuries). In comparison, in 2018, there were 900,380 total reported non-fatal injuries involving days away from work, of which 286,810 were upper-extremity (UE) injuries (31.8%) and 5050 were work-related carpal tunnel syndrome (0.5% of total injuries, 1.8% of UE injuries) (WrCTS) injuries (Table 1). From 2003 to 2018, total injuries ($B=-29{,}534.51$, $P<0.001$) and WrCTS injures ($B=-1002.62$, $P<0.001$) showed a significant decrease in injuries over time. UE injuries did not significantly change over time ($B=840.66$, $P=0.577$). WrCTS accounts for a relatively small proportion of the total UE work-related injuries. Table 1 provides the number of occurrences for common types on upper-extremity injuries per year from 2003 to 2018.[24] CTS injuries are significantly less common annually than the other injuries listed in Table 1 ($P<0.01$). Of the injuries selected, sprains, strains, and tears was the only category to increase in the number of occurrences over time ($B=3818.56$, $P<0.001$). The largest reduction in annual injuries was cuts and lacerations with an estimated decrease of over 2000 injuries annually and a 30.3% decrease from 2003 to 2018 ($B=2084.46$, $P<0.001$). Carpal tunnel syndrome was the second largest reduction with a reduction of roughly 1000 injuries annually and a 77.2% decrease from 2003 to 2018 ($B=-1002.62$, $P<0.001$).

Clerical industries had the highest total employment numbers and demonstrated a growth by 4.9 million workers from 2003 to 2018 (Fig. 1). In comparison, labor industries had significantly lower employment ($P<0.001$) for the entire time period and decreased by 1.9 million workers. Despite the lower overall number of workers, the WrCTS occurrence is significantly higher in the labor industry ($P<0.001$) (Fig. 2). During this time span, annual WrCTS injuries declined for both the clerical industry ($R=-0.82$) and labor industry ($R=-0.91$), with a steeper decline observed for the latter ($B=-387.69$) in comparison to the former ($B=-146.44$) upon regression analysis. WrCTS incidence rates per 10,000 varied from roughly four (in 2003) to just over one (in 2018) for labor industries and from 1.4 (in 2003) to roughly 0.2 (in 2018) for clerical industries.

Within the labor industry sector, which consists of the manufacturing and construction industries, manufacturing showed a significantly higher WrCTS occurrence over the time frame ($P<0.001$). However, manufacturing had a larger decrease in

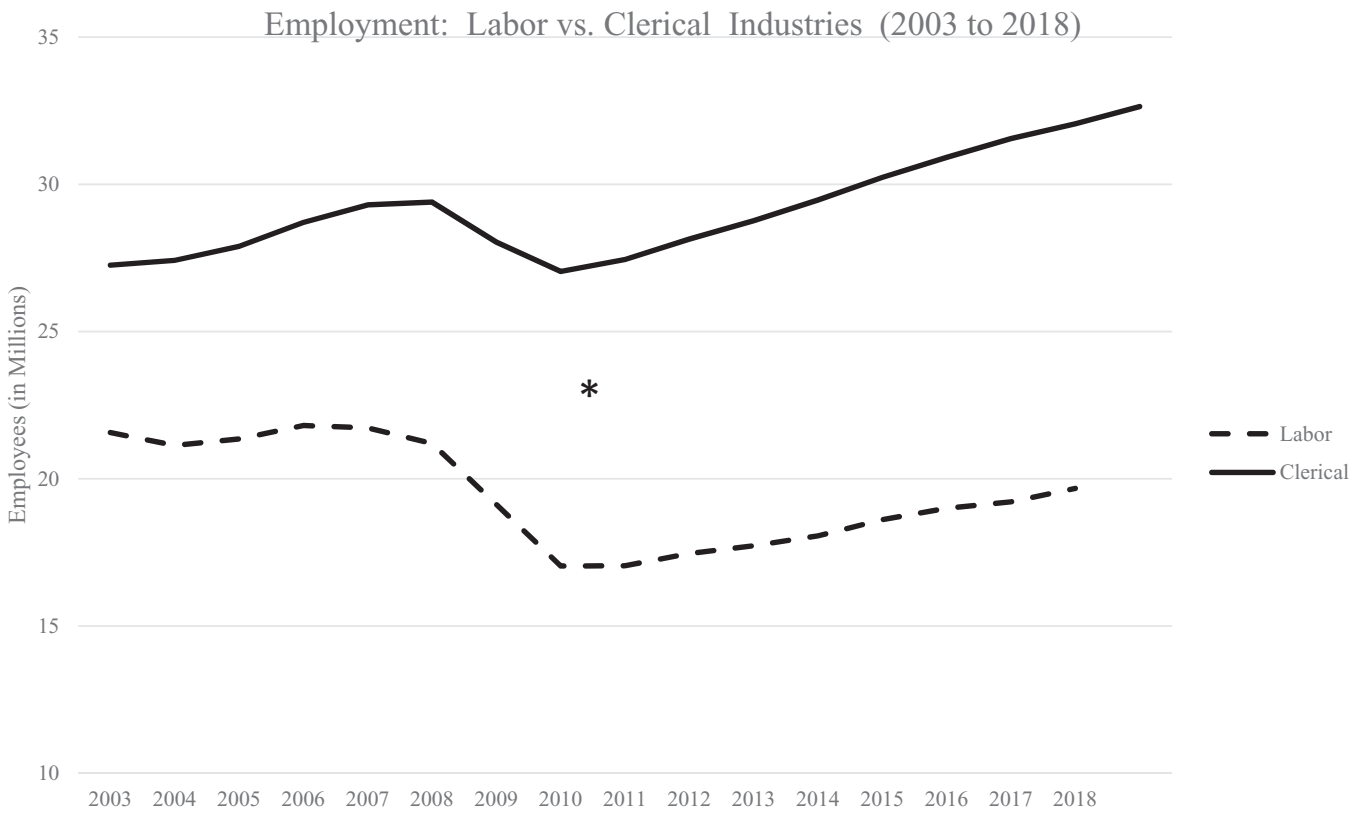

FIGURE 1. Total employment for clerical and labor industries from 2003 to 2018. Clerical work industries had significantly higher employment than manual labor industries ($P < 0.001$).

WrCTS injuries over the time frame ($R = -0.90$, $B = -330.74$) when compared with construction ($R = -0.85$, $B = -56.96$) (Fig. 3).

Within the clerical industry, which consists of the information, professional/business services, and finance/insurance sector industries, the finance/insurance industry was found to have the largest decrease in WrCTS occurrence over time ($R = -0.78$, $B = -75.96$), followed by the professional/ business services industry ($R = -0.57$, $B = -37.38$) and then the information industry ($R = -0.93$, $B = -33.10$) (Fig. 4). The information industry showed significantly lower CTS occurrences than both the finance/insurance and professional/business services industries ($P < 0.001$). No significant differences in WrCTS occurrence were observed between the finance/insurance industry and the professional/business services industry.

DISCUSSION

Significant debate exists regarding the role of workplace occupations in the development of WrCTS.[4,5] Though studies have linked WrCTS to both computer-based work activities and labor-based activities, there is still uncertainty regarding how occupation and risk for WrCTS relate to each other.[2,6–10,12–16] The purpose of this paper was to further examine this relationship by analyzing national employment and worker injury data from the United States Bureau of Labor Statistics.

Based on our data, the United States labor force characteristics remained relatively constant from 2003 to 2018 with similar breakdowns in employment percentage and worker distribution based on sex. WrCTS injuries comprise a relatively small proportion of upper-extremity injuries (1.8%). Additionally, annual occurrences of WrCTS have dropped significantly ($B = -1002.62$, $P < 0.001$) over time and comprise an even smaller percentage of work-related upper-extremity injuries than in 2003 (7.4% in 2003, 1.8% in 2018). When comparing the broader clerical and labor industries, labor workers demonstrated a significantly higher rate ($P < 0.001$) of WrCTS despite lower overall total employment. More specifically, the manufacturing sector industry had the highest average WrCTS incidence (two per 10,000) and average number of occurrences (4028) over the time period.

Other studies have also utilized national health databases to analyze rate of WrCTS. A project utilizing the National Health Insurance and National Employment Insurance databases of Korea also examined CTS in relation to work.[25] Around 100,000 men and roughly 200,000 women subjects diagnosed with CTS were included for the years 2008 to 2015. Over 200 job categories were organized into blue- and white-collar jobs as well as high- and low-risk for CTS depending on the amount of wrist use. Among the white-collar, high-risk CTS jobs were management, accounting, and finance. Furthermore, it was concluded that blue-collar work, analogous to our labor industries, had a greater impact on the wrist. In fact, the authors found rates of CTS 1.8 times higher in blue-collar workers compared with white-collar workers. This suggests some consistency with our analysis of the BLS national data that supports how labor industries are more likely than clerical work to be linked to CTS. In our study we found a slightly higher rate; in 2018, the rate of WrCTS was three times greater for labor industries (calculated using 2020 WrCTS cases in manual labor industries divided by 660 cases in the clerical industries). The definition of a blue-collar and white-collar job was at the discretion of the researchers in the Korean study, so it is difficult to determine the extent to which manufacturing or clerical industries of BLS match either of these respective categories.

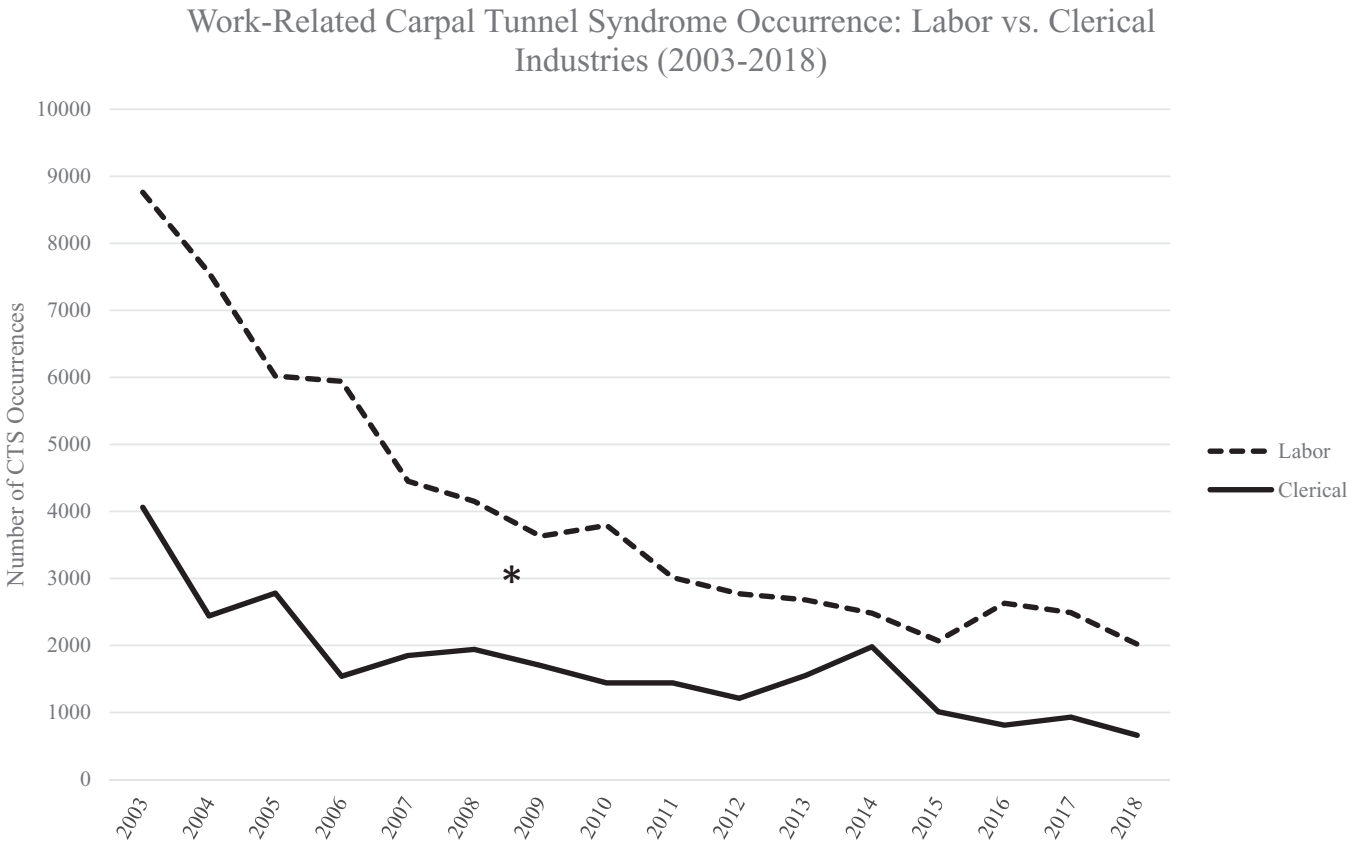

FIGURE 2. Work-related carpal tunnel syndrome (WrCTS) occurrence in clerical work and manual labor industries. Manual labor industries were shown to have a significantly higher incidence rate when compared with clerical industries ($P < 0.001$).

A second study examined the California Department of Health workers' compensation claims of CTS in California during 2007 to 2014.[14] Worker's compensation insurance companies report cases of CTS involving time lost from work beyond the day of injury or injuries that require more than first aid to the Department of Industrial Relations. In total, 139,000 cases were identified over this period. Overall, this study found an average of 6.7 cases per 10,000 full-time equivalent workers from 2007 to 2010 and 5.9 cases from 2011 to 2014. The authors report that there was an overall decrease in workers compensation claims related to CTS over time. The occupational categories associated with the highest rates of CTS were also examined. The top three were production (14.0 cases per 10,000), material moving (13.4), and office administrative support (13). Our study found decreasing rates of CTS cases over time from nearly four to less than one per 10,000 over a 15-year period of time, and rates between 1 and 1.4 per 10,000 workers from 2007 to 2014 when matching timeframes. This discrepancy in CTS incidence can be due to a variety of reasons, including differences in industries/occupations chosen in relation to those used in our BLS study the fact that the California study only includes full-time equivalent workers, in contrast to the BLS who does not restrict data to full time workers only. Nevertheless, in corroboration with the BLS findings of reduced CTS incidence over time, this California worker's compensation study shows a reduction in CTS incidence between the 2007 to 2010- and 2011 to 2014-time frames. Furthermore, our findings of higher CTS incidence in the manufacturing industry are consistent with peak findings occurring in the production occupation, which may be similar to the manufacturing sector as defined by the BLS.

A third report from the United Kingdom analyzed CTS injuries in a working population from 2006 to 2010 based on data from the General Registrar Office for Scotland.[16] Only subjects of working age (16 to 74 years) with a lone diagnosis of CTS, confirmed with nerve conduction studies, were included ($n = 884$ patients). The authors used the Standard Occupational Classification 2010 to organize patients based on occupation. Incidence rates were extrapolated per 100,000 people using confidence intervals. In particular, this UK report found an overall CTS incidence rate of 103 per 100,000 people (10.3 per 10,000). The skilled trades group, which encompasses similar occupations as our labor industry, had an incidence of 136 per 100,000 (13.6 per 10,000). Three occupation groups roughly fit our clerical industry definition and had the following incidence: (1) manager, directors, and senior officials (4.4 per 10,000), (2) administrative and secretarial occupations (8.2 per 10,000), and (3) sales and customer service technicians (9.6 per 10,000). In our study focused on BLS data, we found overall industry WrCTS incidence rates of roughly 1.0 per 10,000 people for the years 2006 to 2010. Furthermore, we found average WrCTS incidence rates of 2.2 per 10,000 and 0.6 per 10,000 for labor and clerical industries, respectively, for the same time period. While the incidence rates differ greatly between the two studies, both this UK study and our BLS study found higher incidence rates among labor-type work when compared with clerical-type work. However, it is important to acknowledge how our BLS study is difficult to directly compare with overall WrCTS incidence and occupation incidence presented in this UK study for several reasons. These limitations include but are not limited to: differences in the definition of CTS injuries, injury reporting inaccuracies that may exist present in the

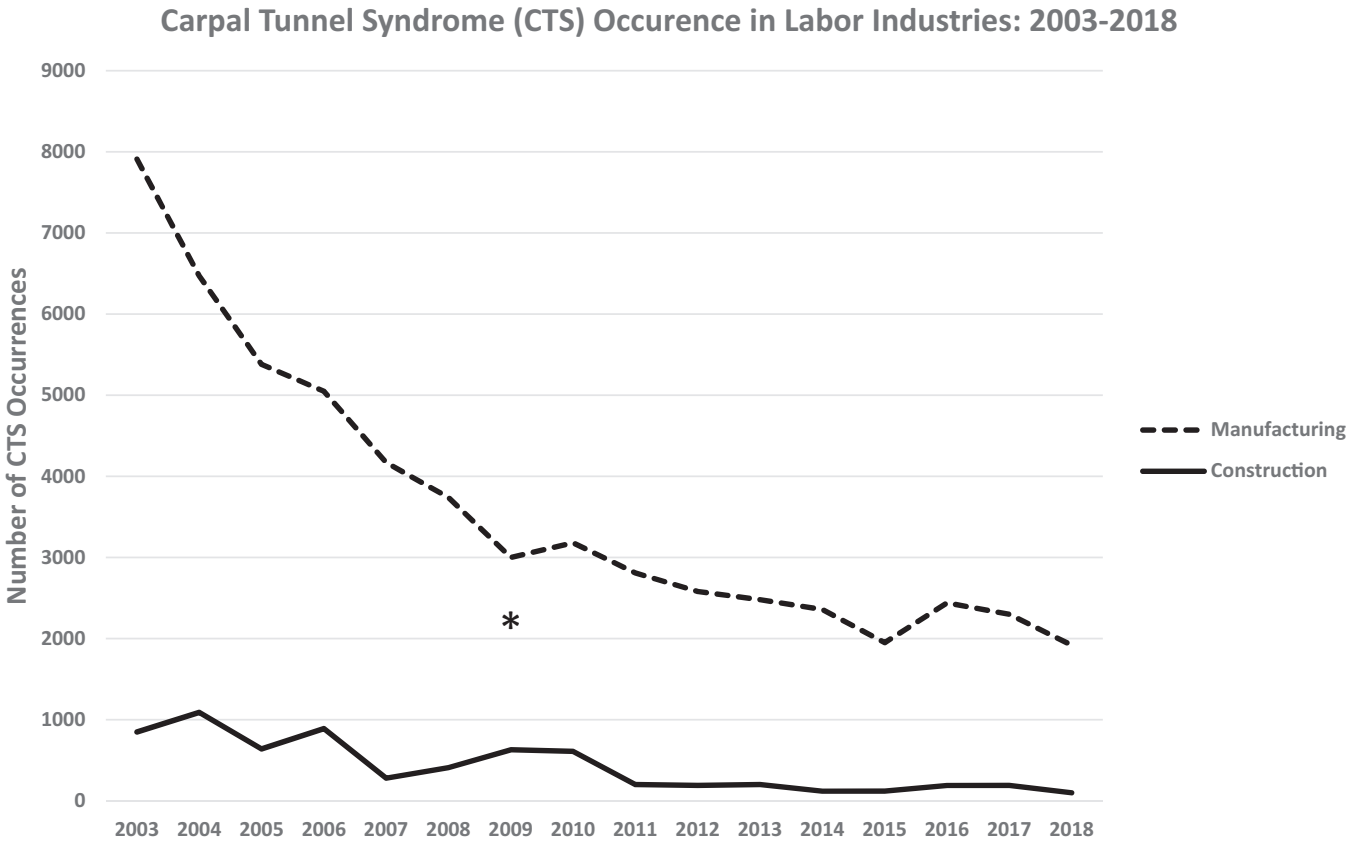

FIGURE 3. The manufacturing showed significantly higher occurrences of WrCTS than the construction industry ($P < 0.01$) when comparing the two labor-based industries.

BLS databases,[26–28] and differences in the industries/occupations included in the respective studies.

Limitations

This BLS database study has some limitations. First, the BLS database is not fully comprehensive regarding labor- and clerical-based industries because the job categorizations do not exactly define the specific job tasks that being performed on a day-to-day basis. For example, there are jobs in the labor industries whose tasks may be primarily clerical in nature and vice versa. However, we suspect the chosen industries provide an adequate representation of average labor and clerical workers for the purpose of our study. Second, this is a retrospective study which comes with data reporting inaccuracies. There may be inaccuracies in survey results and limitations in the data collection by the BLS database. There is potential for underreporting of injuries because the OSHA injury data used by the BLS is self-reported by employers.[28] Some studies suggest that the decline in overall rates of injuries may be due to a reduction in reportable cases instead of an actual reduction of injuries.[26,27] Additionally, reporting requirements are updated by OSHA relatively frequently, which may affect the consistency of WrCTS injury reporting. However, no direct change to WrCTS injury reporting was confirmed upon personal contact by author with a state level OSHA liason. Such differences in overall reporting likely do not affect labor and clerical industries differently, meaning that relative comparisons and trends between sectors in industries in our study still provide important insights. Furthermore, any data collection errors for this database are unlikely to be due to a specific bias in the way the data are being presented by the BLS, and OSHA conducts inspections to address underreporting of injuries by employers. Moreover, states with independently operating safety and health programs are required to have reporting guidelines that are at least as effective as those outlined by OSHA.[29,30] Lastly, the BLS/OSHA definition of WrCTS, which uses employer reported injury data and categorizations, has several limitations on which injuries are included. All diagnosed cases of WrCTS with days away from work must be reported, but some WrCTS may not involve days away from work and thus may represent underreporting.[20] These reporting limitations may underestimate overall WRCTS injuries and/or limit the ability to compare our data for WrCTS to other studies. Regardless, these potential disparities do not take away the relative trends and comparisons that are analyzed regarding BLS data in this study.

CONCLUSION

Over time WrCTS injuries have decreased. Labor industries showed the largest reduction in WrCTS but still had higher rates of WrCTS when compared with clerical industries over the time period of 2003 to 2018. This may suggest that labor type workplace activities and exposures place workers at a higher risk of WrCTS injury than in the clerical type workplace. Such trends may indicate how work-related actions of lifting, grip strength, and forceful wrist motion may in fact contribute more to WrCTS than computer use.[8,9,11] However, it is important to consider the limited ability to control for specific work-related activities and exposures regarding both labor and clerical industries and the respective occupations that comprise each of the industries. Importantly, WrCTS injuries across all private industries have declined over the time period, but it

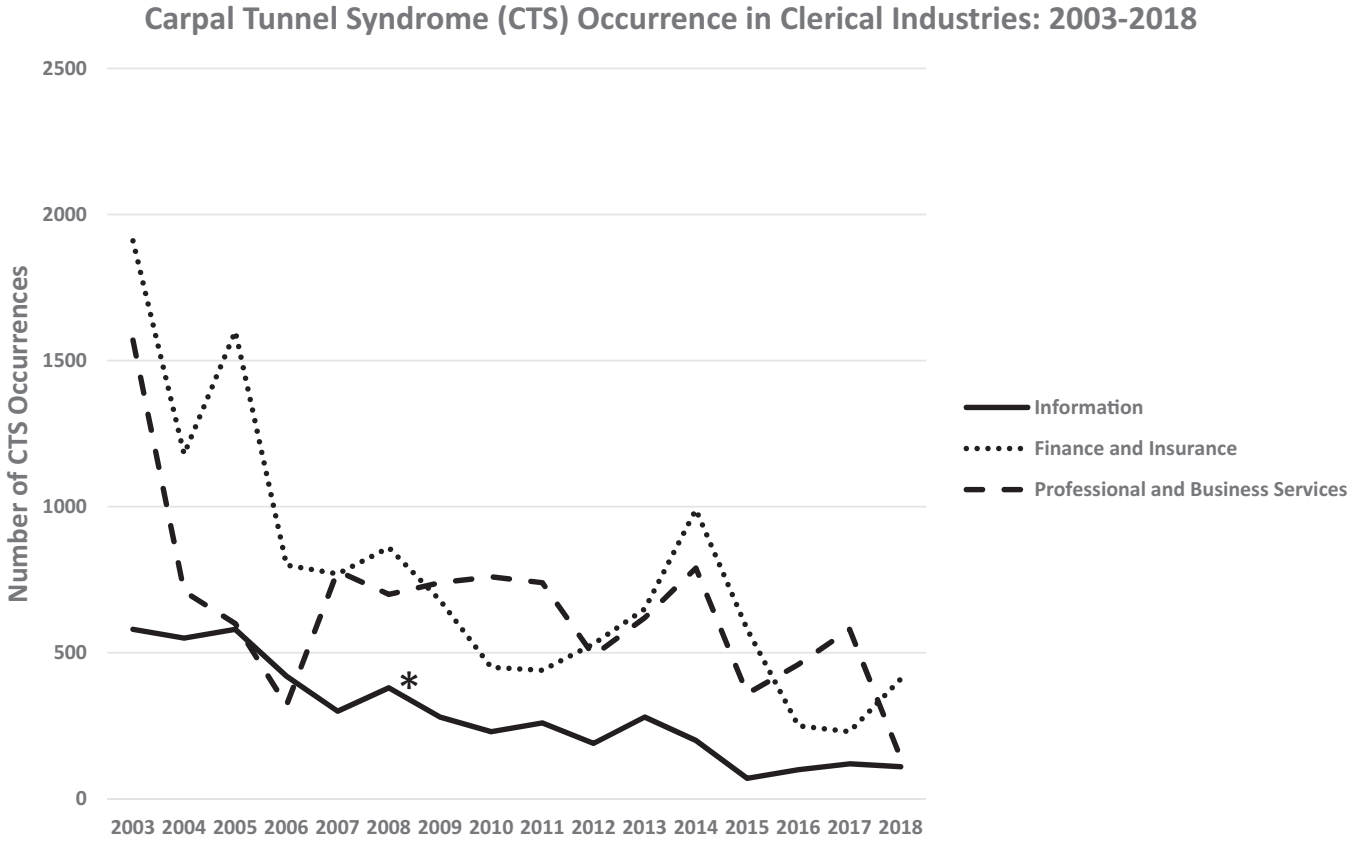

FIGURE 4. Work-related carpal tunnel occurrences (WrCTS) for the clerical work industries. The Information industry was found to have significantly lower WrCTS occurrences than the other clerical-based industries ($P < 0.001$). However, no significant difference was found between the Finance and Insurance and Professional and Business Services industries ($P = 0.58$).

is difficult to attribute this decrease to either improvement in worker safety and ergonomics or changes in reporting requirements. To gain further insights into this association, a large population study using age, sex, and body weight matched workers who are randomized to labor-type or computer-based activities over a long period of time assessing for CTS symptoms and carpal tunnel pressure would be needed.

ACKNOWLEDGMENTS

The authors would like to acknowledge the Bureau of Labor Statistics and the Occupational Safety and Health Administration for their assistance and data support needed for the completion of this project. We would also like to thank Alaa Hazime for her assistance with the coordination of this project.

REFERENCES

1. Atroshi I. Prevalence of carpal tunnel syndrome in a general population. *JAMA*. 1999;282:153–158.
2. Shiri R, Falah-Hassani K. Computer use and carpal tunnel syndrome: a meta-analysis. *J Neurol Sci*. 2015;349:15–19.
3. Shiri R, Heliövaara M, Moilanen L, et al. Associations of cardiovascular risk factors, carotid intima-media thickness and manifest atherosclerotic vascular disease with carpal tunnel syndrome. *BMC Musculoskelet Disord*. 2011;12:80.
4. Newington L, Harris EC, Walker-Bone K. Carpal tunnel syndrome and work. *Best Pract Res Clin Rheumatol*. 2015;29:440–453.
5. Thomsen JF, Gerr F, Atroshi I. Carpal tunnel syndrome and the use of computer mouse and keyboard: a systematic review. *BMC Musculoskelet Disord*. 2008;9:134.
6. Ali KM, Sathiyasekaran BWC. Computer professionals and carpal tunnel syndrome (CTS). *Int J Occup Saf Ergon*. 2006;12:319–325.
7. Eleftheriou A, Rachiotis G, Varitimidis SE, et al. Cumulative keyboard strokes: a possible risk factor for carpal tunnel syndrome. *J Occup Med Toxicol*. 2012;7:16.
8. Burt S, Deddens JA, Crombie K, et al. A prospective study of carpal tunnel syndrome: workplace and individual risk factors. *Occup Environ Med*. 2013;70:568–574.
9. Kozak A, Schedlbauer G, Wirth T, et al. Association between work-related biomechanical risk factors and the occurrence of carpal tunnel syndrome: an overview of systematic reviews and a meta-analysis of current research. *BMC Musculoskelet Disord*. 2015;16:231.
10. Thiese MS, Gerr F, Hegmann KT, et al. Effects of varying case definition on carpal tunnel syndrome prevalence estimates in a pooled cohort. *Arch Phys Med Rehabil*. 2014;95:2320–2326.
11. Dale AM, Gardner BT, Zeringue A, et al. Self-reported physical work exposures and incident carpal tunnel syndrome: self-reported exposures and CTS. *Am J Ind Med*. 2014;57:1246–1254.
12. Roquelaure Y, Ha C, Pelier-Cady M-C, et al. Work increases the incidence of carpal tunnel syndrome in the general population. *Muscle Nerve*. 2008;37:477–482.
13. Hulkkonen S, Shiri R, Auvinen J, et al. Risk factors of hospitalization for carpal tunnel syndrome among the general working population. *Scand J Work Environ Health*. 2020;46:43–49.
14. Jackson R, Beckman J, Frederick M, et al. Rates of carpal tunnel syndrome in a state workers' compensation information system, by industry and occupation — California, 2007-2014. *MMWR Morb Mortal Wkly Rep*. 2018;67:1094–1097.
15. Luckhaupt SE, Dahlhamer JM, Ward BW, et al. Prevalence and work-relatedness of carpal tunnel syndrome in the working population, United States, 2010 national health interview survey. *Am J Ind Med*. 2013;56:615–624.

16. Jenkins PJ, Srikantharajah D, Duckworth AD, et al. Carpal tunnel syndrome: the association with occupation at a population level. *J Hand Surg Eur Vol*. 2013;38:67–72.
17. Injury and Illness Prevention Programs - Frequently Asked Questions. Available at: https://www.osha.gov/dsg/InjuryIllnessPreventionPrograms-WhitePaper.html. Accessed June 24, 2020.
18. Gelfman R, Melton LJ, Yawn BP, et al. Long-term trends in carpal tunnel syndrome. *Neurology.* 2009;72:33–41.
19. Bongers FJM, Schellevis FG, van den Bosch WJHM, et al. Carpal tunnel syndrome in general practice (1987 and 2001): incidence and the role of occupational and non-occupational factors. *Br J Gen Pract J R Coll Gen Pract*. 2007;57:36–39.
20. OSHA Injury and Illness Recordkeeping and Reporting Requirements. Available at: https://www.osha.gov/recordkeeping/.
21. Industries at a Glance: Industry at a Glance Home. Available at: https://www.bls.gov/iag/. Accessed June 24, 2020.
22. 2003 Annual Averages - Household Data (CPS) - Tables from Employment and Earnings. Available at: https://www.bls.gov/cps/cps_aa2003.htm. Accessed June 24, 2020.
23. 2018 Annual Averages - Household Data - Tables from Employment and Earnings. Available at: https://www.bls.gov/cps/cps_aa2018.htm. Accessed June 24, 2020.
24. Case and Demographic Characteristics for Work-related Injuries and Illnesses Involving Days Away From Work. Available at: https://www.bls.gov/iif/oshcdnew.htm. Accessed June 24, 2020.
25. Lee I-H, Kim Y-K, Kang D-M, et al. Distribution of age, gender, and occupation among individuals with carpal tunnel syndrome based on the National Health Insurance data and National Employment Insurance data. *Ann Occup Environ Med*. 2019;31:e31.
26. Wuellner SE, Bonauto DK. Exploring the relationship between employer recordkeeping and underreporting in the BLS Survey of Occupational Injuries and Illnesses: employer Recordkeeping and SOII Underreporting. *Am J Ind Med*. 2014; 57:1133–1143.
27. Friedman LS, Forst L. The impact of OSHA recordkeeping regulation changes on occupational injury and illness trends in the US: a time-series analysis. *Occup Environ Med*. 2007;64:454–460.
28. Miller, G. Hidden Tragedy: Underreporting of Workplace Injuries and Illnesses. Available at: https://www.bls.gov/iif/laborcommreport061908.pdf. Accessed June 24, 2020.
29. State Plan Adoption of OSHA's Revised Reporting Requirements; 2018. Available at: https://www.osha.gov/recordkeeping2014/state_adoption_table.html. Accessed June 24, 2020.
30. OSHA's Recordkeeping Rule. Available at: https://www.osha.gov/recordkeeping2014/index.html. Accessed June 24, 2020.

