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Applying Machine Learning to Workers' Compensation Data to Identify Industry-Specific Ergonomic and Safety Prevention Priorities:

Ohio, 2001 to 2011

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Abstract

Objective—This study leveraged a state workers' compensation claims database and machine learning techniques to target prevention efforts by injury causation and industry.

Methods—Injury causation auto-coding methods were developed to code more than 1.2 million Ohio Bureau of Workers' Compensation claims for this study. Industry groups were ranked for soft-tissue musculoskeletal claims that may have been preventable with biomechanical ergonomic (ERGO) or slip/trip/fall (STF) interventions.

Results—On the basis of the average of claim count and rate ranks for more than 200 industry groups, Skilled Nursing Facilities (ERGO) and General Freight Trucking (STF) were the highest risk for lost-time claims (>7 days).

Conclusion—This study created a third, major causation-specific U.S. occupational injury surveillance system. These findings are being used to focus prevention resources on specific occupational injury types in specific industry groups, especially in Ohio. Other state bureaus or insurers may use similar methods.

BACKGROUND

Biomechanical ergonomic hazards (exposure to overuse/overexertion, forceful exertions, strenuous movements, prolonged static or awkward postures, repetitive movements, contact stress, and vibration) and slip/trip/fall (STF) hazards are the most commonly reported external causes of occupational injuries and illnesses involving days away from work (DAW) in the U.S. and Ohio.[1–3] For 2013, Liberty Mutual reported that certain ergonomic hazards [overexertion involving outside source ($15.08 billion), other exertions or bodily reactions ($4.15 billion), and repetitive motion ($1.82 billion)] and STFs [falls on same level ($10.17 billion), falls to lower level ($5.40 billion), and slip or trip without a fall ($2.35 billion)] accounted for 63%, ~ $39 billion, of the total direct costs of disabling workplace injuries (>5 missed workdays).[2]

According to the Bureau of Labor Statistics (BLS), in 2014, about half (U.S. = 53%, Ohio = 49%) of occupational injuries and illnesses associated with at least one DAW were soft

tissue musculoskeletal diagnoses (eg, sprains, strains, or tears; carpal tunnel syndrome; tendonitis; and soreness, pain) and more than 75% of these musculoskeletal diagnoses could have been prevented with biomechanical ergonomic interventions or STF interventions.[4] In 2014, the single most common BLS nature of injury category grouping in Ohio (41.9%) and the U.S. (36%) was "sprains, strains, or tears." In the U.S., 87% of sprains, strains, or tears were caused by biomechanical ergonomic hazards (62%) or STFs (25%).[5,6]

Practically speaking, existing U.S. occupational surveillance systems are best equipped for capturing injuries and illnesses with relatively short latency periods.[7–9] Therefore, although some soft tissue musculoskeletal outcomes are classified as illnesses (eg, carpal tunnel syndrome), this article will refer to all of them as "injuries" hereafter.

The BLS, the Occupational Safety and Health Administration (OSHA), and other occupational public health or enforcement organizations refer to a specific group of soft tissue musculoskeletal diagnoses *caused by* exposure to biomechanical ergonomic hazards as "work-related musculoskeletal disorders," (MSDs or WMSDs).[10–12] However, biomechanical ergonomic hazards sometimes cause fractures, contusions, or other injuries that are not soft-tissue musculoskeletal diagnoses. Likewise, work-related soft-tissue musculoskeletal *diagnoses* caused by other hazards (eg, STFs, struck by, struck against) are not WMSDs. Similar to the BLS, this study applied two required criteria to define WMSDs: 1) the diagnosis/nature of injury was one of several soft tissue musculoskeletal diagnoses, and 2) the external cause involved exposure to biomechanical ergonomic hazards.[7–9] To emphasize prevention and avoid confusion introduced by using a clinical-sounding phrase, WMSD, this article uses Ergonomic or ERGO as a synonym for BLS-defined ergonomic WMSDs hereafter.

OCCUPATIONAL HEALTH SURVEILLANCE BY EXTERNAL CAUSE

To prevent Ergonomic and STF injuries, allocate resources for prevention, and evaluate intervention effectiveness, the most useful occupational injury surveillance systems, such as the BLS Survey of Occupational Injuries and Illnesses (SOII)[13] and the Safety and Health Assessment and Research for Prevention Program of the Washington State Department of Labor and Industries (W-L&I), include both nature of injury and external cause. BLS SOII produces annual national estimates for nonfatal occupational injuries and detailed data by nature of injury, source, event/exposure, body part, and other variables related to length of disability and injured worker characteristics for cases with one or more DAW, according to North American Industry Classification System (NAICS) codes. However, due to small sample sizes, BLS SOII state-level estimates have limited usefulness for tracking Ergonomic and STF injuries by industry.

There is no single, comprehensive system that can estimate the total burden of occupational injuries. In the U.S., SOII and WC systems have been criticized by a number of studies for problems with under-reporting, failing to count occupational injuries *and* illnesses, or excluding some fatal or nonfatal cases (by design).[14–16] For decades, the U.S. National Occupational Research Agenda (NORA) has identified improved surveillance of Ergonomic cases and STFs as a high national priority.[17] As with many health issues, the burden of

occupational injuries and need for prevention activities vary geographically, impacting specific populations of workers unequally. Due to their proximity to the community and legal authority, U.S. State and local public health practitioners are best suited to lead community-specific efforts to prevent occupational injuries.[18] However, they need detailed, state-specific information to prioritize intervention efforts, allocate limited resources, and guide policy decisions in their communities. Private and public WC insurer databases are an underutilized information source that can be used for public health purposes.[19,20] Recently, more state WC bureaus have been sharing WC information from the first reports of injury with state departments of health. However, often main sources of external cause information are unstructured narrative fields that describe how the injury occurred.

In the U.S., WC data from Washington and the other three "exclusive" state-run systems (North Dakota, Ohio, and Wyoming) are particularly useful for occupational injury surveillance because they include detailed data on all insured employers and employees in those states. W-L&I has demonstrated how WC data from an exclusive, state-based insurer can be used to understand injury root causes, identify specific, higher-risk industry groups and occupations, and guide a variety of prevention activities.[14–16,21]

OHIO OCCUPATIONAL HEALTH SURVEILLANCE BY EXTERNAL CAUSE

Started in 2012, the Ohio SOII program surveys at least 4000 establishments annually.[22] State-level BLS SOII data come from surveys that obtain U.S. records from a weighted sample of employers who represent the industry mix at the State and national levels. However, due to the small sample size, the most detailed industry-level Ohio data reported by external cause or by nature was for NAICS sectors (two-digit NAICS), and BLS-defined ergonomic WMSD results were suppressed by industry. The Ohio Bureau of Workers' Compensation (OHBWC) data represent the population of small and medium size employers in Ohio because employers (with the exception of sole proprietorships or partnerships) with less than 500 employees receive WC insurance from OHBWC. Larger (500 + employees), private employers and some large, public employers have the option to self-insure. OHBWC insures approximately two-thirds of Ohio workers. This arrangement provided an opportunity to use large, existing administrative databases to track and guide the prevention of work injuries for small to medium-sized employers in Ohio.

For years, the OHBWC Division of Safety and Hygiene used WC claims' experience in terms of claim counts and costs to guide the work of 120 industrial hygienists, ergonomists, and safety consultants. At OHBWC, ergonomists focus on recommending interventions to prevent ergonomics-related injuries, whereas safety specialists focus on recommending safety interventions to prevent injuries caused by a traumatic, sudden, unanticipated event, or accident including injuries caused by STFs.

In 2010, OHBWC and the National Institute for Occupational Safety and Health (NIOSH) established a research partnership to conduct high-impact, collaborative, ergonomic, and safety research studies with a commitment to protect Ohio workers by reducing the frequency and severity of occupational injuries. One goal of the partnership was to create an occupational health surveillance system to identify ergonomic and STF prevention priorities

for specific industries and employers. However, limited resources were available to code more than 1 million claims in the OHBWC data warehouse by intervention category, using the two, existing, relevant fields (diagnosis codes and unstructured narratives describing what caused the injury). Previously, we piloted methods to auto-code external cause using three categories.[23] Results were promising and identified limitations to address before scaling-up the program to auto-code all claims. As the second, main surveillance publication from the OHBWC-NIOSH partnership, this article expands upon earlier work that presented detailed methods used to link OHBWC WC data with NAICS code and estimated FTE counts by employer.[24,25]

OBJECTIVES

For OHBWC claims during the years 2001 to 2011, this study had three main objectives: 1) improve and apply automated methods to code claims into three intervention categories (Ergonomic, STF, or Other), 2) create an occupational injury surveillance system to track WC claim counts and claim rates per FTE by intervention category and NAICS codes, and 3) identify industry groups or industries to prioritize for ergonomic, STF, or other safety prevention efforts (Supplemental Figure 1, http://links.lww.com/JOM/A369).

METHODS

In this article, “external cause” was used as a synonym for cause, event/exposure, risk factor, hazard, or external mechanism, which are used similarly in the literature. Also, although psychosocial or nonbiomechanical physical risk factors (eg, heat stress) do fall under the purview of ergonomics, this article focused on biomechanical ergonomic hazards, defined as excessive biomechanical stresses experienced during normal work activities, hereafter referred to as ergonomic.

Objective 1: Auto-coding WC Claims by Intervention Category

Up to 2007, OHBWC did not code external cause information for claims in its data warehouse. In 2007, OHBWC developed and started using an in-house external cause coding system for lost-time claims. In 2012, NIOSH researchers developed and piloted a fast, accurate machine-learning method to automatically code 1000 claims from one NORA industry sector to one of three mutually exclusive, exhaustive intervention categories: 1) ergonomic (ERGO), 2) STF, and 3) all other interventions combined (OTH).[23] In this article, the ERGO abbreviation is only used when referring to BLS-defined WMSDs caused by ergonomic hazards using the case definition for this study (described below). To achieve the first objective for this article, the first step was to improve the piloted auto-coder by manually coding 9855 additional claims, using almost identical manual coding methods (Appendix B, Supplemental Figure 1, http://links.lww.com/JOM/A369).

OHBWC Data Warehouse

For this study, the main data field in the OHBWC data warehouse with information that could be used to determine external cause was a brief, unstructured narrative (“accident narrative”) describing the injury causation on the first report of injury. Additional claim

records in the OHBWC data warehouse include International Classifications of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis codes for all medical diagnoses and one diagnosis code was designated as the Optimal Return-to-Work (RTW) diagnosis. OHBWC uses a proprietary algorithm to select an Optimal RTW ICD-9-CM code, which identifies the diagnosis most likely to keep the injured worker off work for the longest period of disability. A 57-category variable (compared with 50 used in the pilot study), diagnosis category, was assigned to each claim based on the Optimal RTW ICD-9-CM diagnosis code (Table 1).

Intervention Category Case Definitions

As described below, the 2012 Occupational Injury and Illness Classification System (OIICS) event/exposure classification rules (Section 2.4)[26] and BLS-defined WMSD case definition[10] were the basis for the ERGO, STF, and OTH intervention category case definitions used in this study. All claims were placed into one of the three intervention categories, based on the intervention approach most likely to prevent similar incidents. Most of our specific auto-coding methods are described thoroughly elsewhere.[23]

The ERGO intervention category only includes claims defined by these two criteria: 1) claims caused by overexertion or bodily reaction (ie, OIICS event/exposure codes beginning with a 7, such as: overexertion in lifting, repetitive use of tools, prolonged sitting while operating a motor vehicle), *except* single episodes due to climbing down, stepping down, loss of balance, or missteps (see Appendix C); AND 2) claims with an Optimal RTW diagnosis classified as a possible ERGO (Table 1). Some illustrative ERGO claim narrative examples included, “plowing and shoveling snow pulled muscle in lt. arm,” “23 years of service as a tire repair expert using both vibrational tools,” “Air guns and pounding on tires with my hands,” “bent over to pick-up material and my back went out,” and “counting dairy product in a cooler, pulling out and putting back in, repetitiously.”

The STF intervention category included claims with any diagnosis that were classified as OIICS event/exposures codes for “Falls, Slips, Trips” (codes beginning with a 4), with two minor exceptions (Appendix B). Example STF claims include narratives such as, “leaving work, slipped and fell on parking lot,” “walking through shop bay tripped over skid of springs smacked down on concrete,” “I was moving a car door with a fellow co-worker & lost my footing and stumbled & twisted so I didn’t drop the door & I have severe pain over my left hip & left leg.”

The OTH intervention category included all one-digit OIICS events/exposure Divisions excluded from the ERGO or STF case definitions—violence, transportation, fires and explosions, contact with objects or equipment, and exposure to harmful substances or environments. Also, when the claim narrative indicated overexertion or bodily reaction (Division 7) as the external cause, but the diagnosis category (eg., contusions, fractures) was excluded from the ERGO intervention category (Table 1), the claim was classified as OTH. For example, a foot fracture (excluded from ERGO) with the narrative, “I was pushing loads down a track. Something snapped in my left foot, I felt a pain” would be coded as an OTH claim. More illustrative OTH claim narrative examples include: “bag of frozen food fell on her foot,” “I was carrying a cat then it bit me on my right hand,” “tire blew hit the guardrail

and the truck turned over on its side and slid 75 ft.," "injured worker (sic) received a shock to the arm when he grabbed a live line."

Training and Testing the Auto-Coder

Most of our specific auto-coding methods and SAS code are described thoroughly elsewhere.[23] In short, the auto-coding program used a Bayesian machine learning technique to calculate the probability a given claim belongs to each intervention category by considering words from the unstructured accident narrative and words from the diagnosis category descriptions.[23,27,28] The probabilities were based on word frequencies associated with each intervention category in the training set.

Program modifications and additional manual coding for this study were completed to improve manual coding and auto-coding efficiency and accuracy across all NORA industry sectors and all diagnosis categories. For example, application of case definitions using rule-based techniques for auto-coding could reduce possible misclassifications by excluding diagnosis categories that were excluded from the ERGO case definition. Similar to manual coding, when the Optimal RTW diagnosis category [eg, contusions, fractures (Table 1)] was excluded from the ERGO case definition (<0.01% of claims), the ERGO probability was changed to zero and the claim was classified as OTH or STF based on the highest probability score. Upon investigation, three claims reclassified for this reason (of ~100 claims) had a secondary diagnosis that did fit the ERGO case definition.

To re-evaluate the auto-coder's performance with the larger training set, 8600 manually coded claims were used to train the auto-coder, and 1000 randomly selected claims were used to test the accuracy of the intervention categories predicted by the auto-coder against the manually coded, "gold standard," category values. The process of randomly splitting the 9600 claims into a training set of 8600 and a prediction set of 1000 claims was repeated 25 times and the overall percent agreement, and intervention category specific sensitivities and PPVs were averaged across the 25 iterations.

After testing was complete, the next step to achieve our first objective was to use the 9600 randomly selected, manually coded claims as the training set to auto-code more than 1.2 million other claims in the claims database. Finally, auto-coded intervention categories were overridden for manually coded claims with rare (Note a, Table 1) diagnosis categories or diagnosis categories that were under-represented in the training set and were too challenging for the auto-coder (Note c, Table 1). At an average manual coding rate of 2.2 claims/minute, it would have taken about 4.5 person-years to manually code 1.2 million claims. The revised computer program finished in less than 3 hours.

Objective 2: Create an Occupational Injury Surveillance System by Intervention Category

Data Linkage—Adding Employee Counts and NAICS Codes—Beginning in 2011, OHBWC used NAICS industry codes and number of quarterly employees obtained from the Ohio unemployment insurance (UI) agency to calculate claim rates by number of employees or estimated FTEs by industry codes.[29] To achieve our second objective, OHBWC linked records for OHBWC-insured, private employers from calendar years 2001 to 2011 to UI

records using Federal Employer Identification Numbers common to both databases to obtain each employer's NAICS industry code(s) and quarterly number of employees.[24,25] Although 15% of employers with multiple-locations had more than 1 NAICS code across locations (establishments), there was no way to join policy data by location. Therefore, for analyses by NAICS codes, we included 85% of multiple-location policies (representing 85% of claims) where at least 75% of employees were associated with the same six-digit NAICS code across all locations. Less than 1% of policies were excluded because more than one OHBWC policy matched to one UI master record.

NORA Industry Sectors—We assigned each employer to one of ten NORA industry sectors (NORA sectors) by year using each policy's NAICS code.[30] To simplify results for this article, four NORA sector titles were abbreviated: Agriculture, Forestry & Fishing (Agriculture); Healthcare and Social Assistance (Healthcare); Wholesale and Retail Trade (Trade); and Transportation, Warehousing, and Utilities (Transportation). Publicly owned employers (NAICS = 92212, 92214, or 9221) were absent from the Public Safety NORA sector in this study of privately owned employers, leaving Ambulance Services (NAICS = 62191) as the only industry code in the NORA sector.

Denominator Adjustment—Estimating FTEs by Industry Group—The BLS Labor Productivity and Costs (LPC) program data[31] provided information on number of employees and number of paid work hours in each NAICS industry group (four-digit level) on the national level. These LPC data were used to calculate a ratio of FTEs per employee (FTE defined as 2000 hours per year) in each NAICS industry group. Total FTEs in each NAICS industry group were estimated by multiplying UI employee count data for individual employers by the industry group's ratio of FTEs per employee.

Claim Rate Calculations—Before calculating rates, data were reduced by summing numbers of claims and numbers of estimated FTEs by year stratified by NORA sectors, NAICS code levels (for up to three classification levels— NAICS subsectors (three-digit), industry groups (four-digit), or industries (five-digit)],[32] and six categories of claim type by intervention category ($ERGO_{lost\text{-}time}$, $ERGO_{total}$, $STF_{lost\text{-}time}$, STF_{total}, $OTH_{lost\text{-}time}$, and OTH_{total}), where lost-time = eight or more DAW (Ohio waiting period is 7 days) and total = lost-time and medical-only claims with 0 to 7 DAW. In addition to yearly calculations, aggregate numbers of claims and estimated FTE-years were also calculated for the 11-year study period (2001 to 2011).

To calculate rates per 100 estimated FTE-years, numbers of claims were divided by the number of estimated FTE-years and multiplied by 100. Claims for 1.8% of policies that had an unknown number of employees were included in aggregate claim count results but excluded from rate calculations. More information about denominator calculations, NAICS determination, data reduction, and rate calculation methods was provided in the study by Wurzelbacher et al.[24]

Objective 3: Industry Comparisons and Prioritization

The third objective for this study was to calculate Prevention Index (PI)[33] ranks among industries according to NAICS subsectors (three-digit), industry groups (four-digit), and industries (five-digit)[32] within NORA sectors. The PI, popularized by W–L&I, was designed to prioritize groups (ie, subsectors, industry groups, or industries) according to their need for prevention or further research. The PI is a value equal to the average of each group's ranks for claim count and claim rate, in a descending order. The PI rank is the PI value ranked in an ascending order. In this study, sector, subsector, industry group, and industry PI ranks were stratified by claim type and intervention category.

To reduce instability of rate estimates due to low numbers of claims, we used inclusion criteria for the PI similar to those used by Anderson et al[34] but scaled to apply to the 11-year time span (2001 to 2011). We included NAICS groups with 1) policies in 7 or more years, 2) ≥ 100 FTEs for each year with policies, and 3) ≥ 55 WC claims during the 11-year study period. These criteria were applied to each NAICS code group that was ranked by PI for each of the six claim types by intervention category.

In addition, to create standard box-plots by NORA sector, claim type, and intervention category, we calculated the minimum, maximum, and quartile claim rates among industries (five-digit NAICS) within each NORA sector for 2001 to 2011 combined. Industries included in the box-plots met the same inclusion criteria described above for PI ranks.

Statistical Analyses—For this study, WC claim rates by NORA sector or NAICS groups were stratified by intervention category, claim type, and time period (yearly, 2001 to 2008, 2009 to 2011, or 2001 to 2011). Poisson regression models with repeated measures by policy number were used to estimate annual changes in rates over time by intervention category, claim type, and NORA sector. Yearly trends were calculated for two time periods separately due to the substantial change in rates between 2008 and 2009 (23% and 14% decreases in lost-time and total claim rates, respectively). All analyses were conducted using SAS version 9.3 (SAS Institute, Inc., Cary, NC).

Ethical Issues—This research was approved by the NIOSH Institutional Review Board. The requirement for informed consent was waived because the study involved the analysis of previously collected WC data. OHBWC shared claims and policy data with NIOSH where the only personally identifying information were claim number, date of birth, and rare instances where the first report of injury narrative that described what caused the claim included personal information.

RESULTS

Objective 1: Auto-coding WC Claims by Intervention Category

A SAS-based auto-coding program[23,35] predicted 90% of the claims correctly, compared with 93.8% agreement between manual coders after consensus coding. There was essentially no difference in sensitivity (89.6%, ERGO = 89.6%, STF = 89.1%, OTH = 89.0%); however, positive predictive values were more variable among the three intervention categories

(ERGO = 90.6%, 90.6%, STF = 81.5%, OTH = 93.9%). In total, 1,213,655 claims (99%) were auto-coded by intervention category.

Objective 2: Claim Counts and Rates by Intervention Category and Industry Classification

Aggregate, descriptive policy, and claims data for 2001 to 2011 are presented in Table 2 by intervention category, by NORA sector, and across all NORA sectors (See Supplemental Table 1, http://links.lww.com/JOM/A370 for numerator data stratified by claims that were or were not used for claim calculations). During 2001 to 2011, OHBWC insured at least 326,119 unique, private employers in Ohio, covering an estimated 25 million FTE-years. Among this population, 95% of estimated FTE-years came from the five largest NORA sectors: Services (39.5%), Manufacturing (17.2%), Trade (17%), Healthcare (13.2%), and Construction (8.3%).

Claim Counts—Claims among the five largest NORA sectors accounted for 91% of lost-time claims and 94% of total claims during those 11 years (Table 2). ERGO and STF intervention categories accounted for more than two-thirds of lost-time claims (69%) and about half (44%) of total claims (Table 2). Lost-time claims as a proportion of total claims did vary by intervention category: ERGO = 0.31, STF = 0.28, and OTH = 0.10. For the six combinations of claim type and intervention category ($ERGO_{lost\text{-}time}$, $ERGO_{total}$, $STF_{lost\text{-}time}$, STF_{total}, $OTH_{lost\text{-}time}$, and OTH_{total}), claim counts decreased substantially across the 11-year time period, with a slight leveling off or increase after 2008. Yearly counts by claim type and intervention category are available by NORA Sector in Tables 3 and 4.

The distribution of total claims by intervention categories within each diagnosis category is presented in Table 1 and lost-time, medical-only, and total claim counts are presented by intervention category in Table 5 for diagnosis categories that are either excluded from the ERGO case definition or included as possible ERGO claims based on diagnosis alone. Distribution of diagnosis categories varied by intervention category. The three most common diagnosis categories for ERGO were sprains/strains of the back or upper extremity and soft tissue/enthesopathy, whereas for STF, the most common categories were sprains/strains of the back or lower extremity and contusions (data not shown). All sprain/strain categories combined accounted for 33% of total claims. Half of all sprains/strains were classified as $ERGO_{total}$ and 35% as STF_{total} (data not shown). Some diagnosis categories were dominated by one intervention category (eg, 82% of lower extremity sprains/strains were associated with STF_{total}), while others were more evenly distributed [eg, neck sprains/strains were associated with $ERGO_{total}$ (32%), STF_{total} (24%), and OTH_{total} (44%)].

Claim Rates—Lost-time claim rates per 100 estimated FTE-years are presented by NORA sector and intervention category for 2001 to 2011 combined in Table 2; for 2001, 2008, and 2011 in Table 6; and by year in Table 7 and Fig. 1A to C for the five largest NORA sectors. For 2001 to 2011, the Public Safety NORA sector (ie, Ambulance Services) $ERGO_{lost\text{-}time}$ claim rates were 2.2 times higher than the rate for the next highest sector (Transportation) and 7.3 times higher than the rate for the lowest sector (Agriculture) (Table 2). These rate

differences for the Public Safety NORA sector were greater for $ERGO_{total}$ claims and were all attributable to private Ambulance Services (NAICS = 62191) employers.

On average, from 2008 to 2009, there were 23% and 14% decreases in lost-time and total claim rates, respectively. However, decreases varied substantially between NORA sectors, for small sectors, for ERGO claims, and for STF claims (Table 6). Between the five largest NORA sectors, the rates decreased the most in the ERGO category for Services (16% to 23%), in STF for Manufacturing (22% to 31%), in $OTH_{lost\text{-}time}$ for Services (22%), and OTH_{total} for Manufacturing (19%). Some increases in claim rates from 2008 to 2009 were observed in two small NORA sectors, Mining ($ERGO_{total}$ up 14%, STF_{total} up 8%) and Public Safety ($ERGO_{lost\text{-}time}$ up 5%, OTH_{total} up 3%).

Trend estimates for percent changes by year are presented in Table 6 for two time periods (2001 to 2008 and 2009 to 2011). From 2001 to 2008, the rate of claims declined at least 5% per year for all claim types and intervention categories. From 2001 to 2008, compared with the other nine NORA sectors, Construction had the greatest yearly decline in lost-time claim rates across all intervention categories (ERGO = 12.6%, STF = 8.0%, and OTH = 8.9%) (Table 6). Yearly rates declined the most for ERGO (lost-time = 10.4%, total = 8.2%), followed by OTH (lost-time = 6.8%, total = 6.6%), and STF (lost-time = 5.8%, total = 5.0%) intervention categories. From 2009 to 2011, rate declines were still observed for $ERGO_{total}$ and STF_{total} claims; however, $ERGO_{lost\text{-}time}$ and $STF_{lost\text{-}time}$ rates increased slightly. Trends varied by intervention category and NORA sector, although a similar pattern was observed for the five largest sectors, where lost-time rates increased from 2009 to 2010, but returned to levels below those of 2008 rates by 2011 (Fig. 1A to C).

Objective 3: Prevention Priorities

Prevention Index by Four-digit NAICS Codes—For lost-time claims, there were a total of 209 distinct industry groups that met the PI inclusion criteria; 163 (78%) met the criteria for all intervention categories and 29 (14%) met the criteria for two intervention categories. Per industry group, estimated FTE counts ranged from 4567 to 1.8 million, lost-time claim rates ranged from 0.03 to 1.47, and claim counts ranged from 55 to 107,846.

The top 25 PI ranked four-digit NAICS groups and the top 10 claim rate ranked groups are presented in Figs. 2 to 4 as bubble plots, with lost-time claim rates on one axis and lost-time claim counts on the other axis, and bubbles sized proportional to the number of estimated FTE-years per industry group (See Supplemental Tables 2–4, http://links.lww.com/JOM/A371, http://links.lww.com/JOM/A372, http://links.lww.com/JOM/A373 for NORA sectors, industry group descriptions, and values represented in Figs. 2 to 4, respectively). Forty-six industry groups across eight NORA sectors were represented in the top 25 for at least one intervention category. Three industry groups (3% of eligible industry groups) were highly ranked for all intervention categories: Foundation, Structure, and Building Exterior Contractors (NAICS = 2381), Employment Services (NAICS = 5613), and Waste Collection (NAICS = 5621). The highest ranked industry groups by intervention category were Skilled Nursing Facilities (NAICS = 6231) for the $ERGO_{lost\text{-}time}$ category, General Freight Trucking (NAICS = 4841) for $STF_{lost\text{-}time}$, and Foundries (NAICS = 3315) for $OTH_{lost\text{-}time}$. Compared with lost-time PI results by industry group, total claim PI ranks identified one

additional top 25 industry group, General Medical and Surgical Hospitals (NAICS = 6221), ranked 24th for $ERGO_{total}$ claims. Several other industry groups had high total claim rates (top quartile) but low PI ranks of at least 80. We focused this article, tables, and figures on lost-time claim results because lost-time claims are more severe and less vulnerable to under-reporting (See Supplemental Tables 5 and 6, http://links.lww.com/JOM/A374, http://links.lww.com/JOM/A375 to examine the data in more detail, where results are presented for all PI ranked groups by claim type at the three-digit NAICS level). Additional aggregate data by four- and five-digit NAICS codes will be available on the OHBWC website (https://www.bwc.ohio.gov/employer/forms/publications/nlbwc/SafeHygPubs1.asp?txtCID=675537372).

Other Prioritization Criteria—Box plots of the distribution of claim rates among five-digit NAICS industries within each of the six largest NORA sectors by intervention category and claim type are presented in Fig. 5A to F. The most variable distribution of industry rates in most sectors was observed for OTH_{total} and $OTH_{lost\text{-}time}$, which include a broad range of events/exposures. The Construction sector had the least variability (narrowest interquartile range) for ERGO claim rates, whereas Healthcare had the most variability. Comparing intervention category priorities within sectors based on variability, point estimates, and skewedness, etc lead to different conclusions by sector. For example, across all intervention categories, lost-time rates in the Services sector were relatively low, with similar IQRs (magnitude and width), but highly variable rate ranges, especially for ERGO claims. Among all OHBWC industries, one services industry, Dance Companies (NAICS = 71112), had the highest rates for $ERGO_{total}$ (23.66 claims per 100 estimated FTE-years) and STF_{total} (10.85 claims per 100 estimated FTE-years). However, the PI rank for their industry group, Performing Arts Companies (NAICS = 7111), was not high ($ERGO_{total}$ PI rank = 31 and STF_{total} PI rank= 43). Similarly, lost-time Transportation claim rates were relatively variable, with overlapping lost-time IQRs for all three intervention categories. One Transportation industry, School and Employee Bus Transportation (NAICS = 48541) had the second highest $STF_{lost\text{-}time}$ and ninth highest $OTH_{lost\text{-}time}$ claim rates overall. However, the Transportation sector OTH_{total} IQR was wider and did not overlap the $ERGO_{total}$ IQR. Whereas in the Manufacturing sector, $STF_{lost\text{-}time}$ IQR was lower and did not overlap with $ERGO_{lost\text{-}time}$ or $OTH_{lost\text{-}time}$, which both included more extreme outliers ($ERGO_{lost\text{-}time}$ max = 1.37, $STF_{lost\text{-}time}$ max = 0.84, and $OTH_{lost\text{-}time}$ max = 1.36 claims per 100 estimated FTE-years).

DISCUSSION

This article presents an example of using machine learning for epidemiologic surveillance of occupational injuries. We developed methods and presented results from a surveillance system that leverages the efficiency of machine learning techniques to automatically code intervention category for over 1 million WC claim records. Those data by intervention category have been combined with UI data to calculate WC claim counts and rates by intervention category, NAICS codes, and NORA sectors. Other investigators have also used occupational injury data from multiple linked sources to provide more comprehensive surveillance by industry or external cause.[2,36–39]

PI results for NAICS subsectors, industry groups, and industries were presented to guide prevention and research efforts in Ohio by identifying industry-specific priorities for preventing ergonomic hazards, and STF hazards. This is the first time that WC claim counts and rates per FTE by NAICS industry codes and intervention category have been published using OHBWC data. Only a few highly ranked industry groups for ERGO $_{\text{lost-time}}$, STF $_{\text{lost-time}}$, and OTH$_{\text{lost-time}}$ claims are included in the results presented in the main manuscript; however, aggregate online tabular data by intervention category, claim type, and subsector (three-digit NAICS) are available in supplementary online files (Supplemental Tables 5 and 6, http://links.lww.com/JOM/A374 and http://links.lww.com/JOM/A375). Additional aggregate data by four- and five-digit NAICS codes will be available on the OHBWC website (https://www.bwc.ohio.gov/employer/forms/publications/nlbwc/SafeHygPubs1.asp?txtCID=675537372).

Objective 1: Auto-coding WC Claims by Intervention Category

Over the last two decades, injury surveillance studies have successfully applied increasingly sophisticated machine learning techniques to code unstructured narrative text data found in administrative databases, such as WC insurance databases.[27,40–44] The number of records auto-coded in this study surpasses other studies that have used narrative data to code external cause of injury data using auto-coding or semi-automatic coding.[40,41] The simplicity of the intervention categories used for this study made it possible to use auto-coding almost exclusively on the OHBWC claims (>99%) with 90% accuracy.[23] Improvements to the auto-coder addressed several limitations of the pilot version.[23] However, the improvements had only slight impacts on overall accuracy (down 0.1%), sensitivity (down 0.7% to 1.7%), or PPV (ERGO up 1.6%, STF up 1.5%, OTH down 1.1%). Manually coding a sample of claims from each NORA sector created a way to measure and ensure coding performance across all sectors. Semi-automatic coding that combines auto-coding and manual coding is useful for coding more challenging narratives or for coding by more detailed categories, such as two-digit OIICS event/exposure codes. For several years, Liberty Mutual used semi-automatic coding on WC claims to identify the two-digit OIICS event/exposure code used to create their annual Workplace Safety Index.[42,45] BLS has tested autocoding methods on SOII data with promising results comparable to or better than manual coding accuracy.[46,47]

Analyses of 6 years of semi-automatically coded OHBWC lost-time claims by one and two-digit OIICS event/exposure categories and by industry codes are underway. BLS tested the newest version of the program against 1000 randomly selected SOII narratives with promising results.[35] SAS code and word probabilities used for auto-coding have been shared with other researchers and health departments with some success.[48–50] For example, Yamin et al[48] used the three intervention category auto-coding program on 4268 WC claims in the metal manufacturing sub-sector to identify OTH WC claims for manual review.

Objective 2: Occupational Injury Surveillance System by Intervention Category

In our previous publication,[24] industry-specific claim count and claim rate results were presented, but not by intervention category. Findings from this study support previous conclusions that state-based WC data can be useful to 1) complement BLS data, 2) build injury surveillance capacity, and 3) prioritize injury prevention strategies within states. State

differences in WC systems and industry mix limit between-state comparisons. The injury surveillance system using the OHBWC data shares the same basic features found in surveillance systems that include external cause from BLS SOII data and W-L&I (eg, claim rates by FTE, claims involving DAW, and reporting by NAICS codes). However, several systematic differences[24] preclude direct comparisons. For example, only private employers' insured by the OHBWC were included in this study, whereas W-L&I and BLS SOII included private, public, and some self-insured employer data. Also, these OHBWC results include both medical-only claims with 0 to 7 DAW and lost-time claims with more than 7 DAW. Results by external cause from BLS SOII and W-L&I account for injuries with one or more and four or more DAW, respectively. Two major strengths of this study were that the data are a population of employers, rather than a small sample (eg, 4000 for Ohio SOII), and the large number of employer policy-years (>1.9 million, representing >326,000 unique policies) were aggregated across 11 years, which provided adequate numbers of employers to report data across almost all combinations of NAICS codes used in Ohio. Despite these differences, we made limited comparisons between the 2011 OHBWC $ERGO_{lost\text{-}time}$ and $STF_{lost\text{-}time}$ results and US BLS SOII[4,51–53] (2011 and 2014), Ohio BLS SOII (2014), and W-L&I WC claims results (2002 to 2010).[51,54,55]

Claim Counts by Intervention Category—About two-thirds of OHBWC lost-time claims were assigned to the $ERGO_{lost\text{-}time}$ or $STF_{lost\text{-}time}$ intervention categories. One-third of total OHBWC claims were categorized as sprains/strains, of which 54% were caused by ergonomic hazards and 35% were caused by STFs. According to BLS, about the same proportion of sprains/strains, or tears also may have been prevented by ergonomic or STF interventions nationally. Overall, these proportions supported the a priori decision to focus on soft tissue musculoskeletal WC claims and were consistent with BLS results, despite differences among the systems.

Claim Rates by Intervention Category and Time Period—A similar pattern of decreasing WC claim counts and rates was observed in all three intervention categories, with consistent decreases from 2001 to 2008, a sharper decrease from 2008 to 2009, followed by an increase in 2010, and a return to rates 2008 or less by 2011. Similar trends in occupational injury counts and rates were reported in our previous publication[24] and have been reported by BLS, NCCI, and W-L&I.[51,56–59] Yearly declines for STF claim rates were more gradual than ERGO rates, which declined twice as fast per year from 2001 to 2008, and overall, ERGO rates decreased 19% more than STF rates from 2001 to 2011. The same trend was observed in BLS where, from 2003 to 2010, BLS-defined ergonomic WMSD rates showed a larger decrease than BLS STF rates.[60]

Temporary Workers—In WC insurance, industry classification rules assign a temporary workers' WC claim to the employer of record, the temporary agency. In contrast, OSHA recordables for temporary workers are recorded on the OSHA log for the establishment where the incident occurred, the host employer. Therefore, the SOII classifies these cases under the industry classification code for the host employer. OHBWC results for the Temporary Help Services industry (NAICS = 56132) and its parent industry group, Employment Services (NAICS = 5613), are a useful way to assess occupational injury risk

for this large group of vulnerable workers. In this study, Employment Services ranked in the top 25 PI for five of six combinations of claim type and intervention category (not OTH_{total}), mostly due to the influence of Temporary Help Services, a large group of almost one-half million FTE-years across 11 years. The Employment Services industry group was also in the W-L&I top 25 PI for several categories.[55] In contrast, BLS rate and count data for BLS-defined ergonomic WMSDs in Temporary Help Services were ranked low in 2011 and were not published for 2014, due to small sample sizes.[4,51,52,61]

Objective 3: Prioritizing Ergonomic and Safety Intervention Efforts by NAICS Codes

For this study, the main objective for providing prioritization data by NAICS codes was to identify and share results captured in the OHBWC system by intervention category with stakeholders to use for prevention purposes according to their needs. Presenting results for total OHBWC WC claims by combining medical-only (0 to 7 DAW) with lost-time (8 or more DAW) claims was one unique contribution of this study. This study emphasized the more severe, lost-time results in the main tables because the top quartile of PI-ranked industry groups was almost identical for total claims and lost-time PI results by intervention category. However, PI results for total claims provided some indication of risk by intervention category for smaller industry groups that did not fit our inclusion criteria for lost-time comparisons.

High PI-Ranked Industry Groups—For several industry groups, we observed relatively consistent high PI ranks across two or three intervention categories. Knowing that more than one intervention category was prioritized provides a compelling reason to devise prevention plans including outreach and training efforts along with engineering controls, according to the ranks of the industry groups and their associated intervention categories.

The three industry groups with the highest PI rank in one of the intervention categories were also in the top 10 for at least one other category: General Freight Trucking (NAICS = 4841) was ranked highest for STFs and ranked eighth and third for ERGO and OTH, respectively; Skilled Nursing Facilities (NAICS = 6231) was ranked highest for ERGO and fifth for STF; and Foundries was ranked highest for OTHs and third for ERGO. All three of these industry groups have also been identified as high risk in one or more categories by BLS and W-L&I.[4,52,55]

The PI weights claim counts and claim rates equally. This may be a reasonable weighting, but it is somewhat arbitrary, so it was useful to examine how industry group size (number of estimated FTE-years) influenced PI ranks. High PI ranks can be attributable to a high claim count rank only, a high claim rate only, or both. For example, Foundation, Structure, and Building Exterior Contractors (NAICS = 2381) was a large employer group (95th percentile by industry group size) in Ohio and its PI rank results were high in Ohio for lost-time and total claims in all intervention categories, due to high claim count ranks. Despite differences between W-L&I and BLS, Foundation, Structure, and Building Exterior Contractors were also ranked highly in both systems in 2011 and 2014.[4,51,52,54,55,61,62]

Plastics Product Manufacturing (NAICS = 3261) was another relatively large industry group in Ohio that ranked in the top 25 PI for ERGO and OTH intervention categories due to high

claim counts. Ohio is one of several Midwestern states with relatively large populations of workers in Plastics Product Manufacturing,[63] but elsewhere the relatively small industry group was not prioritized by W-L&I or BLS as a high-risk group for occupational injuries.

Waste Collection (NAICS = 5621 or 56211), a medium-sized industry group, was ranked highly for all three OHBWC intervention categories, mostly attributable to high rate ranks. Waste Collection also had high rates in Washington State and the U.S.[4,52,54,55]

Small Size, High-Risk—Three, small, high-risk NORA sectors (Agriculture, Mining, and Oil & Gas) were not well represented in this study of private employer WC claims. Police departments, fire departments, and other high-risk Public Safety industries were also excluded from this study. Public Safety includes one NAICS industry code with private employers—Ambulance Services (NAICS = 62191). Ambulance Services ERGO PI ranks and rates were high in OHBWC, BLS, and W-L&I, although the latter were much lower in comparison. More detailed analyses of Ambulance Services OHBWC claims have been completed and will provide more detailed insights to prevent injuries among these workers.

Because large groups can dominate PI rankings, some small industry groups with low PI ranks were identified as priorities after examining outliers in the boxplots of claim rates by industries within NORA sectors. For example, School and Employee Bus Transportation (NAICS = 4854 and 48541) was a very small industry group (eighth percentile of FTE-years) with the highest STF claim rates ranks in the Transportation sector and some of the highest STF and OTH rates overall. BLS and W-L&I did not rank the group highly. The reasons for these high rates in Ohio are unclear. Despite low PI ranks, very high claim rates for School and Employee Bus Transportation justify further investigation of the less than 700 STF claims, a relatively small project. If further investigation suggests that effective interventions already exist, then intervening among this group of less than 50 employers can be done quickly with impactful results.

PI Strengths and Limitations—The PI is a simple, one-dimensional, easily interpreted, ordinal prioritization method that ranks industry groups by the average of each group's ranks for claim count and claim rate. The simplicity of using and interpreting PI ranks for prioritizing prevention activities is the method's main strength and main limitation. PI equally weights the importance of claim rate and claim count ranks, but the burden of injuries in large industry groups with high claim counts clearly influences the ranked results. The results are easy to interpret and easy to compare to occupational injury surveillance reports from W-L&I or to manually calculated PI ranks using publicly available BLS SOII data. However, simplifying quantitative results across several dimensions does not take into account other reasons for prioritizing one group over another (eg, small, high rate industries). The boxplots presented in this study added depth to our analysis by providing a visual representation of the distribution and variability of rates within sectors at the five-digit NAICS level. We could identify small industries with high claim rates, which otherwise may be overlooked due to aggregating data by industry group. Within-sector risk by intervention category varies by sector, by intervention category, and by claim type. In the Transportation sector, the OTH category was higher priority than ERGO. More detailed analysis of causation within OTH would be needed to prioritize resources to understand the relative

importance of transportation incidents, for example, compared with other external causes. For this study, highly ranked PI industry groups and claim rates were presented visually using bubble plots. The bubble plots were used to examine how the magnitude of industry group size, claim rate, and claim counts influenced a group of “high risk” industry groups. Further research is needed to develop improved quantitative prioritization techniques that take into consideration other attributes and more sophisticated data visualization. This study has provided aggregate data online for each intervention category by subsector (three-digit NAICS) to allow readers to examine and organize the data to meet their objectives. Additional tabular data by four- and five-digit NAICS will be available on the OHBWC website. Employer- or claim-level data cannot be shared publicly, but OHBWC can use employer-level data internally to identify specific employers to target for ergonomic or safety consulting services by looking at policy-level variability within the same industry or manual classification category.

Lastly, PI calculations prioritize among cases captured within a given system. WC data can be used to prioritize resources for preventing incidents caused by exposure to ergonomic hazards or other safety hazards that cause WMSDs and traumatic injuries. Results presented in this analysis do not estimate the overall burden of occupational injury and illness. In summary, the PI is useful but has several limitations. Future research is needed to develop and test more nuanced, quantitative methods for prioritizing limited prevention resources. Tailored approaches for different NORA sectors or other worker populations would be beneficial, given the differences observed in this study.

Study Limitations

Employer size: Despite its strengths, this study is subject to several limitations. First, the study population excludes large, self-insured employers. This may introduce a source of differential error because self-insured employers are not evenly distributed across NORA sectors and industry groups. Limiting results to employers insured by the State’s Bureau of Worker’ Compensation may not accurately represent claim rates for all employers when a NAICS industry code includes many self-insured employers (eg, hospitals, large retail trade chains). In such cases, the results may under- or overestimate rates for specific NAICS industry codes. However, excluding large employers can help focus occupational safety and health surveillance on relatively smaller employers who experience a greater burden of occupational injuries than large employers.[64]

Under-reporting: All occupational injury surveillance systems are missing some injuries. In the literature, under-reporting rates for WC insurance data, BLS SOII, and OSHA logs are disproportionately higher for BLS-defined ergonomic WMSDs not due to a sudden injury when compared with other injury types.[39,65–68] Reported overlap between SOII records and WC claims in Washington, California, and Michigan range from 41% to 90%. Also, more severe, lost-time injuries are more likely to be reported.[14–16] There are several factors that could have influenced our results by industry classifications.[8,68–70] For example, it has been shown that union members; blue-collar occupations; hourly workers; and workers in Manufacturing, Transportation, and Trade sectors are more likely to report a BLS-defined ergonomic WMSD or injury WC claim. In addition, a few studies[37,69] have also examined

under-reporting by external cause for traumatic injuries.[15,65] In the present study, some under-reporting of injuries is more likely for medical-only claims, the ERGO intervention category, or within NORA sectors with lower WC reporting rates (eg, Agriculture, Construction, and Mining NORA sectors). We reported that yearly ERGO claim rates decreased faster than STF and OTH claim rates. However, during the peak of the recession in five of the largest NORA sectors, STF rates from 2008 to 2009 decreased more than ERGO rates among all claim type and intervention category combinations (excluding Healthcare STF_{total}). One purpose of this study was to make comparisons and set priorities within each NORA sector, or within one broad NAICS code (eg, three-digit subsectors). As one of the primary goals of this study was to identify higher risk companies by intervention type within sectors, differential reporting rates observed among intervention types or sectors would not affect achieving this goal.

Measures of Claim Severity: The OHBWC data warehouse is a proprietary, private, administrative database designed for claims management and does not precisely track DAW for medical-only claims. Methods to gather more detailed information on DAW have been explored but remain unresolved and this was a limitation of our study. Future work on disability type, injury diagnoses, expanded PI calculations, and claims costs should provide alternate measures for more targeted prioritization.

Three Intervention Categories: Our decision to use a set of three, simple intervention categories for this analysis is another limitation of this study. We can make few inferences about over half of the total claims in our study population coded as OTH. However, our a priori objective was to focus on interventions for soft tissue musculoskeletal outcomes caused by ergonomic hazards or STF hazards, and this simple categorization system allowed us to achieve that goal efficiently and with enough specificity to inform prevention efforts. This is especially true for industry comparisons among small employers with few WC claims. Future work will include analysis of lost-time claims by OIICS one- or two-digit event/exposure categories.

Intervention Category Misclassification: Possible differential misclassification of intervention category in this study as a result of using auto-coding rather than manual coding is unlikely. Small differences in percent accuracy compared with manually coded claims were not problematic because both methods were highly accurate. The positive predictive value for the ERGO intervention category was 9% higher than for the STF category. However, any resulting misclassification would be non-differential misclassification with respect to industry classification codes and would not be expected to create bias in rates by intervention category. Lower sensitivity and PPV for auto-coded results seem attributable to poor performance coding slips and trips without falls. In our recently published auto-coding results using the same Bayesian model, sensitivity and PPV for “slips/trips without a fall” were 37% and 41%, respectively, whereas sensitivity for “falls on the same level” and “falls to lower level” were ~73% and PPVs were more than 60%.

Recently, the BLS started to use semi-automatic coding to improve the efficiency of coding SOII data.[46,47] Auto-coding methods can be used by researchers and practitioners to relieve the manual burden of reading and classifying each claim narrative. Other researchers and

public health practitioners have had some success using our SAS auto-coding program and word probabilities from unstructured narrative text information from first reports of injury data.[48–50]

The decision to model the ERGO category on the BLS-defined ergonomic WMSD case definition using only the most severe diagnosis was more than adequate. Considering only the most severe diagnosis did not have any appreciable effect on the accuracy of auto-coding over 1 million claims, as only three claims may have been misclassified because secondary diagnoses were not included in our ERGO case definition.

Timeliness: As is standard in the WC industry and to maintain rigorous research standards, a lag of at least 2 years is used to allow WC data to "mature" before analysis for publication. In Ohio, injured workers have up to 2 years to file a claim, and changes to claim status (medical-only vs lost-time) can occur within that time frame. This study was less timely than BLS SOII reports; however, the consistency of PI trends across time by four-digit NAICS subsector leads us to believe that the highest priorities in 2011 are still high priorities today. Furthermore, despite many underlying differences compared with BLS, many of the same industry groups identified in this article were also ranked highly by BLS in 2014. Subsequent analyses from this study population will also include claim costs, which require approximately 2 to 3 years of development to begin to stabilize. However, this does not preclude OHBWC from using their most recent claims data internally as benchmarks for their clients.

CONCLUSION

This study focused on identifying ergonomic and STF intervention needs by NAICS codes using OHBWC WC data for 2001 to 2011. To accomplish this objective, first, our previously developed auto-coding pilot program was improved before application to this large, multisector database. Aggregate tabular data have been shared online to provide useful summary information to understand and prioritize prevention efforts. Consistent with injury data from other US data sources, the count and rate of WC claims has decreased significantly from 2001 to 2011; however, decreases in claim counts and rates varied by intervention category and industry group. For many high-risk OHBWC industry groups, results were consistent with national BLS data and WC data from the state of Washington. OHBWC results should be used primarily for planning occupational health prevention and research activities in Ohio. Each of these surveillance systems has their own strengths and weaknesses. Regardless, currently BLS, W-L&I, and now OHBWC are the only three, major U.S. occupational injury surveillance systems that present similar data. These results highlight the importance of classifying industry-specific claims into intervention categories to target prevention efforts. Due to variability between and within NORA sectors, three-, four-, and five-digit NAICS codes, the most appropriate prioritization techniques is likely to vary by worker population.

This article presented methodology and results from the second of several planned epidemiologic surveillance studies using multisector WC data from OHBWC. Other studies underway will provide more detailed analyses of intervention categories within NORA

sectors, within a specific industry group (eg, Ambulance Services, Temporary Help Services), by diagnosis, and by claim costs.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Appendix

A. Abbreviations

- Agriculture=Agriculture, Forestry & Fishing NORA sector
- BLS=Bureau of Labor Statistics
- DAW=days away from work
- ERGO=BLS-defined WMSDs caused by ergonomic hazards using the case definition for this study
- $[ERGO/STF/OTH]_{lost\text{-}time}$=lost-time claims for the given intervention category (>7 DAW)
- $[ERGO/STF/OTH]_{total}$=total claims for the given intervention category (medical-only and lost-time)
- FTE=full-time equivalent employee
- Healthcare=Healthcare and Social Assistance NORA sector
- ICD-9-CM=International Classifications of Diseases, Ninth Revision, Clinical Modification
- LPC = BLS Labor Productivity and Costs program
- NAICS = North American Industry Classification System
- NIOSH = National Institute for Occupational Safety and Health
- NORA = National Occupational Research Agenda
- OHBWC = Ohio Bureau of Workers' Compensation
- OIICS = BLS Occupational Injury and Illness Classification System
- OSHA = Occupational Safety and Health Administration

- OTH=all other interventions combined (NOT ERGO or STF)
- PI = Prevention Index
- RTW= return-to-work
- SOII = BLS Survey of Occupational Injuries and Illnesses
- STF = slip/trip/fall
- Trade = Wholesale and Retail Trade NORA sector
- Transportation = Transportation, Warehousing, and Utilities NORA sector
- UI = unemployment insurance
- WC = workers' compensation
- W-L&I = Washington State Department of Labor and Industries
- BLS-defined WMSD = work-related musculoskeletal disorders due to ergonomic hazards as defined by the BLS

B. Manually Coded Claims

For this study, the first step was to manually code more claims. Each claim was consensus coded by at least two manual coders in accordance with case definitions described previously for ERGO, STF, or OTH. Manual coders used the 57 Optimal RTW diagnosis codes and read the brief unstructured accident narratives to assign an intervention category to each claim.

Auto-coded intervention categories were overridden by manually coded intervention categories for 1% of claims (N = 11,755) as follows.

- Compared with the pilot study, 7200 additional randomly selected claims were used to train and test the auto-coder, for a total of 9600 (800 randomly selected claims per month—400 lost-time and 400 medical-only, across all years).
- Second, claims with rare (<200, N = 2155) or under-represented (<20 claims) diagnosis categories were manually coded because it is less likely that the Bayesian method would accurately predict intervention category for these diagnoses. For under-represented claims, 50 randomly selected examples from the 10 under-represented categories (N = 500, 50 per category) were manually coded and the results were used to update the prediction probability scores.
- When there was not enough information available for manual coders to assign an intervention category, the claim was considered unclassifiable and we retained that classification in the final analyses (N = 127, 0.01%).
- When coders disagreed on a final intervention category, the claim was excluded from the training set and an auto-coded value was used instead (N = 32, 0.03%).

- Notations in Table 1 identify diagnosis categories that were manually coded for intervention category due to rarity (a) or uncommon (b) diagnosis categories that were under-represented in the training set (<20 claims).

C. Case Definition Exceptions

The two exceptions to the BLS OIICS coding rules for STFs from Division 4 (slips, trips, and falls)[26] used in the NIOSH STF case definition were as follows:

1. Claims caused by events or exposures due to a *single episode* of overexertion/bodily reaction due to climbing down, stepping down, loss of balance, or missteps (classified as "Overexertion and Bodily Reaction" event/exposures codes) were classified as STFs for this study instead of ERGOs. The reasoning behind this modification to the BLS case definition was that this type of event pertains to the interaction of the foot with the supporting surface, and might be prevented in a similar manner as STF events (such as through modifications to surface composition and texture, contamination, footwear, or body mechanics). For example, a sprained ankle where the narrative was "stepped off of forklift and twisted right ankle" was classified as a STF. These rare incidents account for less than 1% of all claims and less than 4% of all STF claims.
2. Claims caused by stepping on an object that did not result in a puncture wound (a "Contact with Objects and Equipment" code) were coded as STFs instead of OTHs. We made this exception because interventions designed to reduce STF events, such as improved housekeeping and organization of materials, could also be used to prevent these injuries. BLS OIICS coding would typically place injuries caused by stepping on an object, not resulting in a puncture wound, as a "struck by object or equipment," event.

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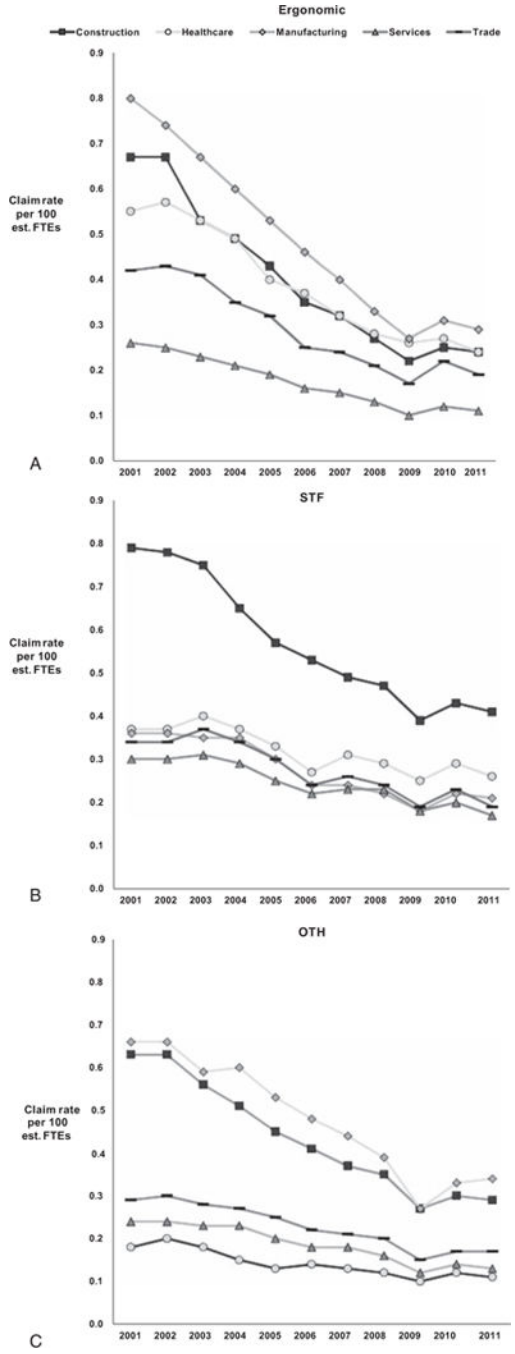

FIGURE 1.

(A–C) Yearly claim rates per 100 estimated FTEyears for the five largest NORA sectors by intervention category, for lost-time claims, 2001–2011: (A) ERGO, Ergonomic intervention category that includes BLS-defined work-related musculoskeletal disorders caused by ergonomic hazards; (B) STF, slip, trip, or fall intervention category; and (C) OTH, other intervention category. **Notes:** Rates current as of February 2017. Services sector, Services (except Public Safety); Trade sector, Wholesale Trade/Retail Trade; Healthcare sector, Healthcare and Social Assistance; lost-time claims, 8 or more days away from work.

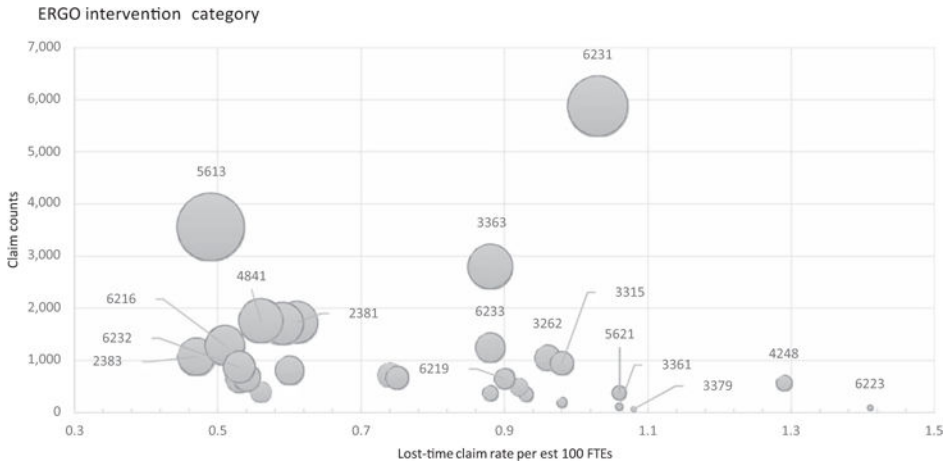

FIGURE 2.

High-priority NAICS industry groups (four-digit codes) for lost-time ERGO claims for the top 25 by Prevention Index rankings and top 10 by claim rates, 2001–2011. **Note:** Data current as of February 2017. Bubble size is based on the estimated number of FTE-years. Lost-time claims, 8 or more days away from work. ERGO, Ergonomic intervention category (includes BLS-defined work-related musculoskeletal disorders caused by ergonomic hazards).

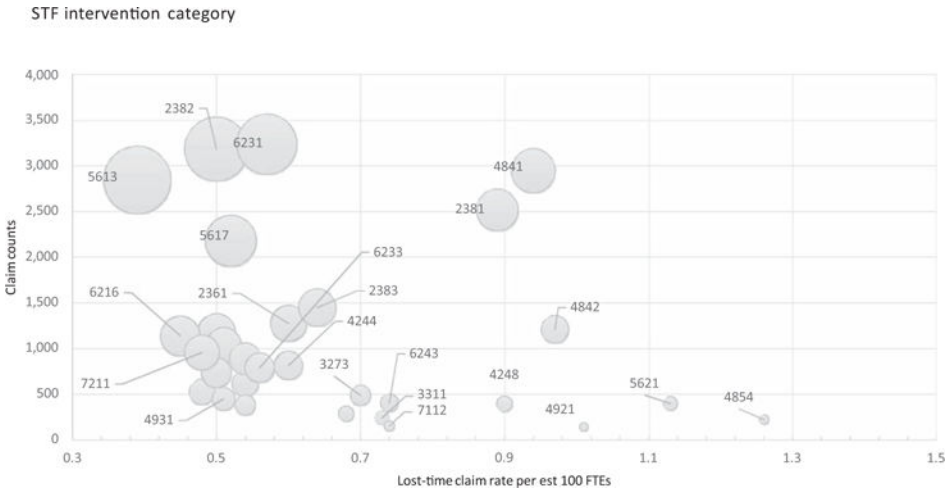

FIGURE 3.

High-priority NAICS industry groups (four-digit codes) for lost-time STF claims for the top 25 by Prevention Index rankings and top 10 by claim rates, 2001– 2011. **Note**: Data current as of February 2017. Bubble size is based on the estimated number of FTE-years. Lost-time claims, 8 or more days away from work. STF, Slip, trip, or fall intervention category.

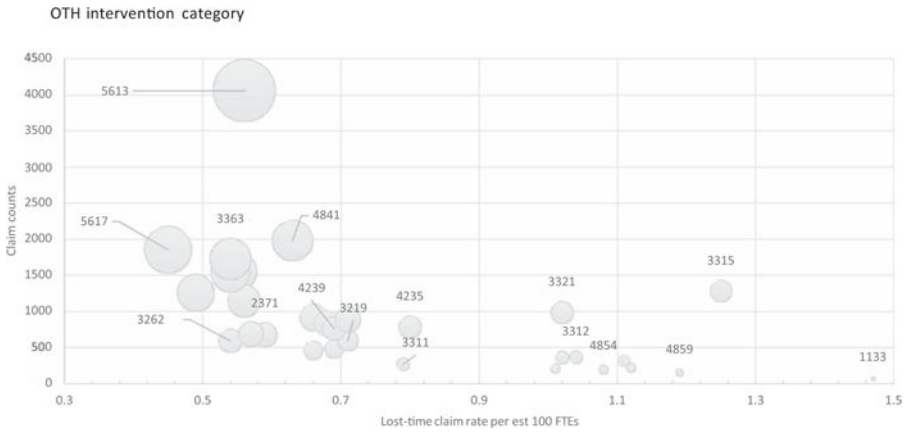

FIGURE 4.

High-priority NAICS industry groups (four-digit codes) for lost-time OTH claims for the top 25 by Prevention Index rankings and top 10 by claim rates, 2001–2011. **Note:** Data current as of February 2017. Bubble size is based on the estimated number of FTE-years. Lost-time claims, 8 or more days away from work. OTH, Other intervention category.

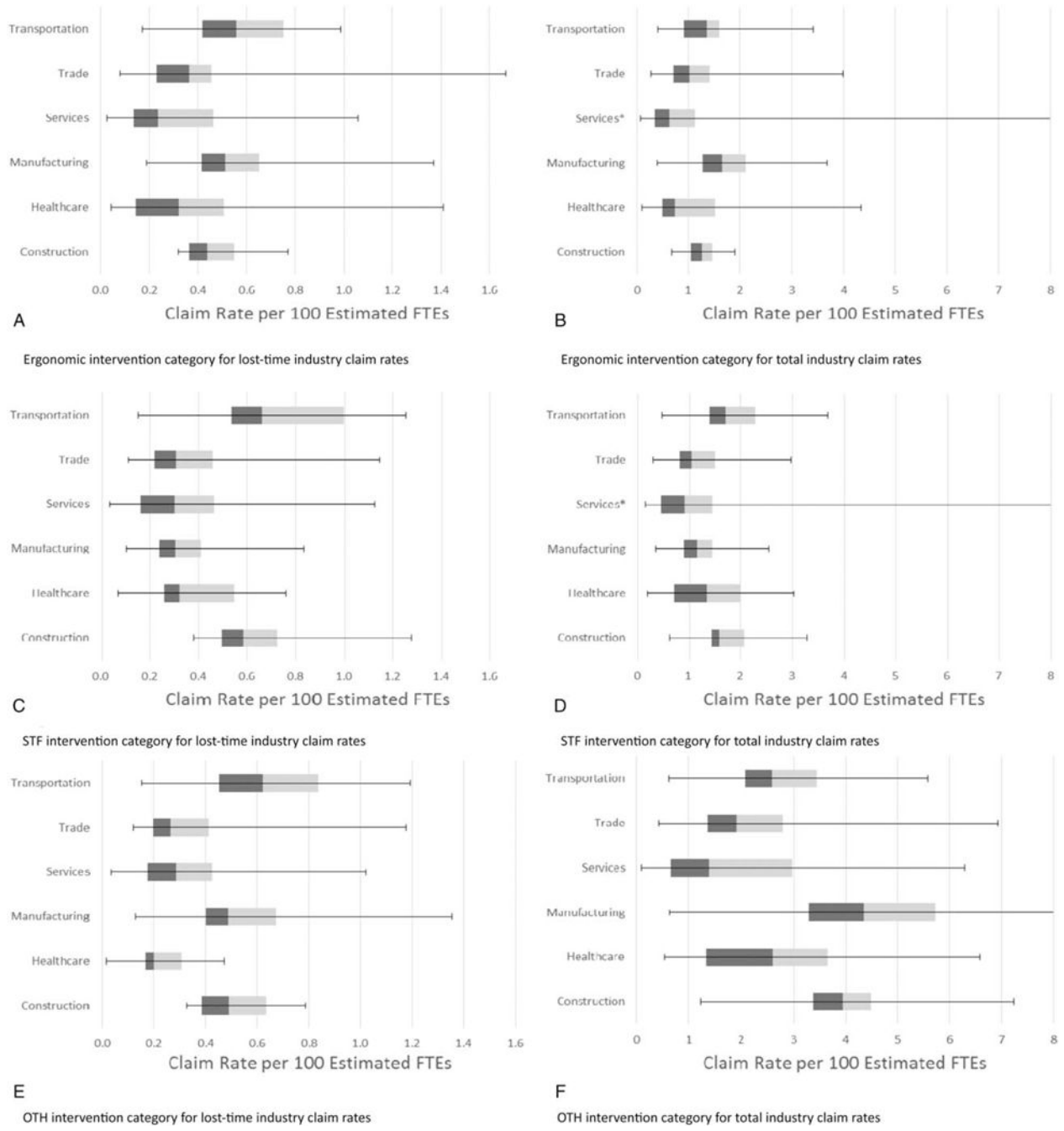

FIGURE 5.

(A–F) Box-plot charts* of the distribution of industry (five-digit NAICS) claim rates per 100 estimated FTE-years per NORA† sector for the five largest NORA sectors, aggregated for the time period 2001–2011, presented by intervention category and claim type: (A) $ERGO_{lost\text{-}time}$, (B) $ERGO_{total}$, (C) $STF_{lost\text{-}time}$, (D) STF_{total}, (E) $OTH_{lost\text{-}time}$, (F) OTH_{total}.

Notes: The Ergonomic intervention category includes BLS-defined work-related musculoskeletal disorders caused by ergonomic hazards. Data current as of February 2017. FTE, full-time equivalent employee (2000 hours/year); Healthcare sector, Healthcare and

Social Assistance; lost-time claims, 8 or more days away from work; NORA, National Occupational Research Agenda; OTH, all other; Services sector, Services (except Public Safety); STF, slip, trip or fall; Transportation sector, Transportation, Warehousing, Utilities; Trade sector, Wholesale Trade/Retail Trade. *Box plots lower whisker, minimum rate; bar, interquartile range where the dark shade, the 25th percentile to median and light shade, median to 75th percentile; upper whisker, maximum rate, except the Services Total claims maximum rates for ERGO (23.66) and STF (10.85), and the Manufacturing Total claims rate for OTH (15.0, for Ferrous Metal Foundries, NAICS = 33151) are not shown. Both extreme Services sector outliers were for Dance Companies, NAICS = 71112. †Among privately owned employers in Ohio with single and multiple locations.

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TABLE 1

Diagnosis Category (N = 57) by Intervention Category for Total OHBWC Workers' Compensation Claims, Private Employers* from 2001 to 2011

Diagnosis Category	Intervention Category† (Row Percentage)			Total Claims† (% of Grand Total)	ICD-9 Chapter	Diagnosis Codes (ICD-9-CM)	Notes
	ERGO	STF	OTH				
Possible WMSDs categories (possible ERGO)	52.9%	32.2%	15.0%	39.2%			
Sprains/strains - back	74.9%	18.8%	6.4%	11.5%	17	846, 847.1–847.9, 739.2–739.4, 724.1	
Sprains/strains - upper extremity	60.6%	23.0%	16.4%	8.6%	17	840–842, 739.7	*a*
Sprains/strains - lower extremity	13.2%	82.2%	4.5%	7.5%	17	843–845, 739.6	
Soft tissue/enthesopathy	71.2%	15.4%	13.4%	2.5%	13	726–729, 736.1	
Sprains/strains - neck	32.3%	23.5%	44.2%	2.0%	17	847.0, 723.1, 739.1	*a*
Diseases of the nervous system and sense organs	3.7%	2.6%	93.7%	1.7%	6	320–389, except 354.0	*b*
Disc disorders	66.4%	21.8%	11.8%	1.7%	13	722–723.0, 723.2–724.0, 724.2–724.9	
Dislocation	23.8%	67.5%	8.7%	1.1%	17	830–839	
Sprains/strains - other	90.2%	6.7%	3.0%	1.0%	17	848	*b*
Hernia of abdominal cavity	96.2%	3.2%	0.6%	0.6%	9	550–553	*a*
Carpal tunnel syndrome	95.6%	1.4%	3.1%	0.4%	6	354.0	*a*
Injury to nerves and spinal cord	3.2%	8.3%	88.4%	0.2%	17	950–957	
Knee derangement	21.9%	70.8%	7.3%	0.1%	13	717.0–717.9	*a*
Spinal osteoarthritis	50.2%	33.1%	16.7%	0.1%	13	721.0–721.91	*b*
Diseases of musculoskeletal and connective tissue NEC	32.2%	50.4%	17.4%	0.1%	13	710–716, 730–736.0, 736.2–739.0, 739.5, 739.8–739.9	
Symptoms signs and ill-defined conditions NEC	5.5%	8.0%	86.5%	0.0%	16	780–797, 799	*b,c*
Other joint disorders	50.7%	38.6%	10.6%	0.0%	13	718.0–719.9, 720.1–720.9	
Congenital spondylolisthesis	50.0%	36.6%	11.6%	0.0%	14	756.12	*a*
Categories that rule out WMSDs (Not ERGO)							
Open wounds	0.0%	1.7%	98.2%	23.5%	17	870–884, 890–894	
Contusion	0.0%	42.5%	57.5%	14.8%	17	920–924	*b*
Superficial injury	0.0%	4.7%	95.3%	4.3%	17	910–919	
Fracture - upper extremity	0.0%	31.1%	68.9%	3.3%	17	812–819	*a*
Burn	0.0%	1.0%	99.0%	3.1%	17	940–949	
Foreign body, eye	0.0%	0.0%	100.0%	3.0%	17	930	

Diagnosis Category	Intervention Category† (Row Percentage)			Total Claims† (% of Grand Total)	ICD-9 Chapter	Diagnosis Codes (ICD-9-CM)	Notes
	ERGO	STF	OTH				
Fracture - lower extremity	0.0%	74.8%	25.2%	1.9%	17	820–828	
Crushing Injury	0.0%	1.6%	98.4%	1.4%	17	925–929	
Poisoning and toxic effects	0.0%	0.0%	100.0%	0.8%	17	905–909, 960–989	*a*
Cellulitis or abscess	0.0%	9.1%	90.8%	0.8%	12	681–682	
Contact dermatitis and other eczema	0.0%	0.0%	100.0%	0.7%	12	692	*b*
Intracranial injury	0.0%	46.1%	53.9%	0.6%	17	850–854	*b*
Fracture - neck and trunk	0.0%	73.9%	26.0%	0.5%	17	805–809	*b*
Other and unspecified effects of external cause	0.0%	2.1%	97.9%	0.4%	17	990–995	
Amputation	0.0%	0.0%	100.0%	0.2%	17	885–887, 895–897	
Fracture - head	0.0%	29.0%	71.0%	0.2%	17	800–804	
Fracture - other, NEC	0.0%	65.0%	35.0%	<0.1%	17	810–811, 829	
Other diseases of the skin and subcutaneous tissue	0.0%	0.0%	100.0%	<0.1%	12	680, 683–691, 693–709	*a*
Diseases of the respiratory system	0.0%	15.3%	84.7%	<0.1%	8	460–499, 509–519	
Infectious and parasitic diseases	0.0%	0.0%	100.0%	<0.1%	1	001–139	
Diseases of the circulatory system	0.0%	52.6%	47.4%	<0.1%	7	390–409, 411–427, 429–459	*a*
Foreign body, not eye	0.0%	0.0%	100.0%	<0.1%	17	931–939	
Certain traumatic complications and unspecified injuries	0.0%	29.7%	70.3%	<0.1%	17	958–959	
Pneumoconiosis, resp. cond. due to external agents	0.0%	0.0%	100.0%	<0.1%	8	502–508	
Death, cause unknown	0.0%	6.1%	93.6%	<0.1%	16	798	
Diseases of the genitourinary system	0.0%	4.2%	94.2%	<0.1%	10	580–629	*b*
Internal injury of chest, abdomen, pelvis, and blood vessels	0.0%	17.8%	81.7%	<0.1%	17	860–869, 900–904	
Diseases of the digestive systems NEC	0.0%	9.8%	90.2%	<0.1%	9	520–549, 555–579	
Endocrine, nutritional and metabolic Diseases	0.0%	2.4%	97.6%	<0.01%	3	240–279	
Complications of surgical and medical care, NEC	0.0%	7.9%	89.5%	<0.01%	17	996–999	*a,b*
Mental disorders from brain damage	0.0%	40.7%	59.3%	<0.01%	5	310	
Neoplasms	0.0%	0.0%	100.0%	<0.01%	2	140–239	*a*
Other mental disorders	0.0%	10.9%	89.1%	<0.01%	5	290–309, 311–319	
Asbestosis	0.0%	0.0%	100.0%	<0.01%	8	501	*b*
Pregnancy-related conditions and adverse outcomes	0.0%	36.0%	64.0%	<0.01%	11	630–679, 760–779	*a*
Acute myocardial infarction/heart failure	0.0%	11.1%	88.9%	<0.01%	7	410, 428	

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Diagnosis Category	Intervention Category† (Row Percentage)			Total Claims† (% of Grand Total)	ICD-9 Chapter	Diagnosis Codes (ICD-9-CM)	Notes
	ERGO	STF	OTH				
Other congenital anomalies	0.0%	25.0%	75.0%	<0.01%	14	740–756.11, 756.13–759	
Diseases of the blood and blood-forming organs	0.0%	0.0%	100.0%	<0.01%	4	280–289	
Black lung‡		–	–		8	500	
Missing diagnosis	37.3%	29.0%	33.6%	0.8%		n/a	
Missing intervention category				<0.01%	n/a		
Grand total (column)	21.0%	23.1%	55.7%	100.0%			

Data current as of February 2017.

ERGO, Ergonomic intervention category (includes BLS-defined work-related musculoskeletal disorders caused by ergonomic hazards); NEC, not elsewhere classified; OTH, other; STF, slip, trip, or fall.

[a]Rare diagnosis categories that were manually coded for intervention category.

[b]Underrepresented diagnosis categories (<20 claims in training set).

[c]Based on frequency, the “Symptoms Signs and Ill-defined conditions NEC” category was underrepresented; after manually coding 50 claims, the auto-coder was still not successful so all claims from this category were manually coded.

*Among privately owned employers in Ohio with single and multiple locations.

†Total claims = medical-only and lost-time claims. Some rows do not add to 100% because 113 claims with missing or not otherwise classified intervention categories are only presented in the “Missing intervention category” row at the bottom, not by diagnosis.

‡Although there is a category for Black Lung (ICD-9-CM=500), these claims are not included in this study.

TABLE 2

NORA[a] Sector Results (Counts and Rates per 100 Estimated FTE-years) for 2001–2011 by Claim Type and Intervention Category

					Claim Type																	
					LT									Total								
					Intervention Category									Intervention Category								
					ERGO			STF			OTH			ERGO			STF			OTH		
			Est. FTE-years[c]		Claim Count			Claim Count			Claim Count			Claim Count			Claim Count			Claim Count		
NORA Sector	Total Policy Years	Unique Policies[b]	*N*	%	*N*	%	Rate	*N*	%	Rate	*N*	%	Rate	*N*	%	Rate	*N*	%	Rate	*N*	%	Rate
Services	885,946	155,248	9,594,469	39.5	16,842	21.9	0.17	23,594	30.9	0.24	18,251	26.8	0.19	53,434	21.5	0.55	88,999	32.6	0.92	190,869	28.7	1.97
Manufacturing	148,707	22,315	4,184,281	17.2	21,279	27.6	0.50	11,768	15.4	0.28	20,771	30.5	0.49	68,232	27.4	1.62	45,623	16.7	1.08	203,570	30.6	4.84
Trade	371,480	64,128	4,135,267	17.0	12,356	16.0	0.30	11,690	15.3	0.28	9,713	14.2	0.23	40,191	16.2	0.96	43,607	16.0	1.05	97,755	14.7	2.35
Healthcare	201,854	29,329	3,205,432	13.2	12,410	16.1	0.39	10,220	13.4	0.32	4,546	6.7	0.14	46,665	18.8	1.45	41,096	15.1	1.28	61,525	9.2	1.90
Construction	238,399	40,126	2,001,181	8.2	8,425	10.9	0.42	11,735	15.4	0.58	8,997	13.2	0.45	23,533	9.5	1.17	33,180	12.2	1.65	80,875	12.2	4.02
Transportation	57,044	10,759	862,649	3.6	4,574	5.9	0.53	6,306	8.3	0.72	4,618	6.8	0.53	11,789	4.7	1.36	16,340	6.0	1.88	21,753	3.3	2.50
Agriculture	10,838	1,801	144,024	0.6	237	0.3	0.16	415	0.5	0.29	477	0.7	0.33	1,123	0.5	0.78	1,697	0.6	1.17	4,281	0.6	2.96
Mining	2,186	375	52,456	0.2	219	0.3	0.42	310	0.4	0.59	330	0.5	0.63	659	0.3	1.26	998	0.4	1.90	2,190	0.3	4.17
Public Safety	1,158	213	52,358	0.2	613	0.8	1.17	257	0.3	0.49	225	0.3	0.43	2,901	1.2	5.54	1,066	0.4	2.04	1,861	0.3	3.55
Oil & Gas	3,736	586	31,666	0.1	95	0.1	0.30	141	0.2	0.45	259	0.4	0.82	263	0.1	0.83	416	0.2	1.31	1,117	0.2	3.52
All Sectors[d]	1,921,348	324,880	24,263,783	100	77,050	100.0	0.32	76,436	100.0	0.31	68,187	100.0	0.28	248,790	100.0	1.02	273,022	100.0	1.12	665,796	100.0	2.73
Unknown[e]	5,044	1,239	1,135,702		2,589		0.23	2,800		0.25	1,947		0.17	8,575		0.76	10,479		0.92	18,634		1.64
Total	1,926,392	326,119	25,399,485		79,639			79,236			70,134			257,368			283,501			684,430		

Data current as of February 2017.

Agriculture sector, Agriculture, Forestry, Fishing/Hunting; ERGO, Ergonomic intervention category that includes BLS-defined work-related musculoskeletal disorders caused by ergonomic hazards; FTE, full-time equivalent employee (2000 hours/year); Healthcare sector, Healthcare and Social Assistance; NEC, not elsewhere classified; NORA, National Occupational Research Agenda; LT, lost-time claims with 8 or more days away from work; OTH, other; Public Safety, Ambulance Services (NAICS = 62191), the only private industry in the sector. STF, slip, trip, or fall; Services sector, Services (except Public Safety); Total, medical-only and lost-time claims; Trade sector, Wholesale Trade/Retail Trade; Transportation sector, Transportation, Warehousing, Utilities.

[a]Among privately owned employers in Ohio with single and multiple locations.

[b]Unique policy counts are per sector; therefore, policies that belonged to >1 sectors during separate years are included for each sector's count.

[c]Estimated FTE year counts are totals for 2001–2011.

[d]Numerators for All Sectors rates exclude claims from policies with missing or unreliable employee count data for the corresponding policy-year. Refer to Supplemental Table S1 for claim counts used in rate calculations.

[e]For multi-location employers where the NAICS code selection method was less reliable or could not be determined.

TABLE 3

Number and Percentage of Workers' Compensation Lost-Time Claims (8 or More Days Away From Work) by Intervention Category and National Occupational Research Agenda (NORA) Sector for Private Employers Insured by the Ohio Bureau of Workers' Compensation—Ohio, 2001–2011

	Lost-Time Claims																					
	Year																					
	2001		2002		2003		2004		2005		2006		2007		2008		2009		2010		2011	
NORA Sector	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**
All NORA sectors*	28,577	100.0	27,857	100.0	26,299	100.0	24,769	100.0	21,944	100.0	19,434	100.0	18,563	100.0	16,378	100.0	11,776	100.0	13,425	100.0	12,717	100.0
Ergonomic intervention category†																						
All NORA sectors	10,989	100.0	10,607	100.0	9,525	100.0	8,666	100.0	7,626	100.0	6,725	100.0	5,958	100.0	4,986	100.0	3,740	100.0	4,238	100.0	3,990	100.0
Services	2,336	21.3	2,223	21.0	1,993	20.9	1,829	21.1	1,661	21.8	1,501	22.3	1,356	22.8	1,132	22.7	862	23.0	1,019	24.0	930	23.3
Manufacturing	3,409	31.0	3,000	28.3	2,655	27.9	2,442	28.2	2,134	28.0	1,885	28.0	1,604	26.9	1,289	25.9	870	23.3	1,003	23.7	988	24.8
Trade	1,793	16.3	1,762	16.6	1,641	17.2	1,396	16.1	1,232	16.2	980	14.6	889	14.9	773	15.5	565	15.1	710	16.8	615	15.4
Healthcare	1,461	13.3	1,574	14.8	1,527	16.0	1,440	16.6	1,197	15.7	1,107	16.5	976	16.4	852	17.1	769	20.6	783	18.5	724	18.1
Construction	1,345	12.2	1,324	12.5	1,039	10.9	983	11.3	865	11.3	705	10.5	620	10.4	498	10.0	339	9.1	356	8.4	351	8.8
Transportation	507	4.6	606	5.7	538	5.6	450	5.2	430	5.6	441	6.6	404	6.8	353	7.1	261	7.0	284	6.7	300	7.5
Agriculture	32	0.3	27	0.3	39	0.4	28	0.3	18	0.2	23	0.3	13	0.2	17	0.3	8	0.2	16	0.4	16	0.4
Mining	40	0.4	25	0.2	22	0.2	26	0.3	17	0.2	16	0.2	22	0.4	15	0.3	12	0.3	14	0.3	10	0.3
Public safety	57	0.5	60	0.6	61	0.6	62	0.7	60	0.8	55	0.8	65	1.1	47	0.9	51	1.4	46	1.1	49	1.2
Oil and gas	9	0.1	6	0.1	10	0.1	10	0.1	12	0.2	12	0.2	9	0.2	10	0.2	3	0.1	7	0.2	7	0.2
Slip, trip, or fall intervention category																						
All NORA sectors	8,976	100.0	8,828	100.0	9,025	100.0	8,447	100.0	7,487	100.0	6,396	100.0	6,687	100.0	6,175	100.0	4,570	100.0	5,154	100.0	4,691	100.0
Services	2,721	30.3	2,596	29.4	2,753	30.5	2,580	30.5	2,225	29.7	1,978	30.9	2,105	31.5	2,018	32.7	1,486	32.5	1,662	32.2	1,470	31.3
Manufacturing	1,516	16.9	1,436	16.3	1,394	15.4	1,403	16.6	1,213	16.2	992	15.5	976	14.6	870	14.1	569	12.5	698	13.5	701	14.9
Trade	1,450	16.2	1,414	16.0	1,496	16.6	1,369	16.2	1,152	15.4	923	14.4	964	14.4	880	14.3	650	14.2	751	14.6	641	13.7
Healthcare	1,000	11.1	1,021	11.6	1,133	12.6	1,070	12.7	990	13.2	831	13.0	935	14.0	892	14.4	738	16.1	847	16.4	763	16.3
Construction	1,574	17.5	1,535	17.4	1,477	16.4	1,297	15.4	1,141	15.2	1,075	16.8	963	14.4	860	13.9	603	13.2	613	11.9	597	12.7
Transportation	581	6.5	702	8.0	653	7.2	616	7.3	643	8.6	524	8.2	649	9.7	546	8.8	444	9.7	500	9.7	448	9.6
Agriculture	52	0.6	60	0.7	43	0.5	43	0.5	50	0.7	21	0.3	31	0.5	34	0.6	23	0.5	32	0.6	26	0.6
Mining	50	0.6	29	0.3	31	0.3	27	0.3	34	0.5	22	0.3	25	0.4	32	0.5	21	0.5	22	0.4	17	0.4
Public safety	15	0.2	25	0.3	33	0.4	23	0.3	24	0.3	16	0.3	25	0.4	29	0.5	25	0.5	23	0.4	19	0.4

	Lost-Time Claims																					
	Year																					
	2001		2002		2003		2004		2005		2006		2007		2008		2009		2010		2011	
NORA Sector	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**
Oil and gas	17	0.2	10	0.1	12	0.1	19	0.2	15	0.2	14	0.2	14	0.2	14	0.2	11	0.2	6	0.1	9	0.2
Other interventions																						
All NORA sectors	8,599	100.0	8,416	100.0	7,741	100.0	7,650	100.0	6,822	100.0	6,307	100.0	5,911	100.0	5,206	100.0	3,466	100.0	4,033	100.0	4,036	100.0
Services	2,197	25.5	2,105	25.0	2,034	26.3	2,031	26.5	1,844	27.0	1,681	26.7	1,649	27.9	1,405	27.0	1,019	29.4	1,153	28.6	1,133	28.1
Manufacturing	2,782	32.4	2,680	31.8	2,346	30.3	2,447	32.0	2,150	31.5	1,972	31.3	1,788	30.2	1,546	29.7	855	24.7	1,068	26.5	1,137	28.2
Trade	1,254	14.6	1,225	14.6	1,138	14.7	1,107	14.5	968	14.2	844	13.4	788	13.3	749	14.4	514	14.8	559	13.9	567	14.0
Healthcare	474	5.5	545	6.5	515	6.7	441	5.8	391	5.7	416	6.6	407	6.9	365	7.0	304	8.8	364	9.0	324	8.0
Construction	1,261	14.7	1,237	14.7	1,103	14.2	1,020	13.3	895	13.1	841	13.3	726	12.3	634	12.2	414	11.9	433	10.7	433	10.7
Transportation	496	5.8	493	5.9	466	6.0	480	6.3	454	6.7	444	7.0	416	7.0	380	7.3	277	8.0	355	8.8	357	8.8
Agriculture	56	0.7	54	0.6	65	0.8	57	0.7	40	0.6	36	0.6	44	0.7	37	0.7	23	0.7	39	1.0	26	0.6
Mining	40	0.5	32	0.4	34	0.4	22	0.3	26	0.4	33	0.5	33	0.6	34	0.7	26	0.8	23	0.6	27	0.7
Public Safety	18	0.2	24	0.3	22	0.3	19	0.2	20	0.3	21	0.3	18	0.3	30	0.6	14	0.4	23	0.6	16	0.4
Oil & Gas	21	0.2	21	0.2	18	0.2	26	0.3	34	0.5	19	0.3	42	0.7	26	0.5	20	0.6	16	0.4	16	0.4

Data current as of February 2017.

Agriculture sector, Agriculture, Forestry, Fishing/Hunting; Healthcare sector, Healthcare and Social Assistance; NORA, National Occupational Research Agenda; Public Safety, Ambulance Services (NAICS = 62191), the only private industry in the sector. Services sector, Services (except Public Safety); Trade sector, Wholesale Trade/Retail Trade; Transportation sector, Transportation, Warehousing, Utilities.

*The row for All NORA Sectors includes all intervention categories and 68 claims where it was not possible to assign an intervention category due to missing data or vague narratives.

†Ergonomic intervention category includes BLS-defined work-related musculoskeletal disorders caused by ergonomic hazards.

TABLE 4

Number and Percentage of Total Workers' Compensation Claims (Medical-Only and Lost-Time) by Intervention Category and National Occupational Research Agenda (NORA) Sector for Private Employers Insured by the Ohio Bureau of Workers' Compensation—Ohio, 2001–2011

	Total claims																					
	Year																					
	2001		2002		2003		2004		2005		2006		2007		2008		2009		2010		2011	
NORA Sector	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**	***N***	**%**
All NORA sectors*	152,797	100.0	143,678	100.0	132,384	100.0	126,014	100.0	119,145	100.0	110,654	100.0	103,523	100.0	91,071	100.0	69,338	100.0	70,418	100.0	68,697	100.0
Ergonomic intervention category†																						
All NORA sectors	33,738	100.0	32,013	100.0	28,358	100.0	26,635	100.0	24,412	100.0	22,974	100.0	20,753	100.0	17,749	100.0	14,134	100.0	14,216	100.0	13,808	100.0
Services	7,001	20.8	6,586	20.6	5,897	20.8	5,685	21.3	5,236	21.4	4,945	21.5	4,524	21.8	3,966	22.3	3,135	22.2	3,274	23.0	3,185	23.1
Manufacturing	10,468	31.0	9,081	28.4	7,764	27.4	7,461	28.0	6,779	27.8	6,463	28.1	5,669	27.3	4,626	26.1	3,202	22.7	3,361	23.6	3,358	24.3
Trade	5,679	16.8	5,612	17.5	4,935	17.4	4,324	16.2	3,861	15.8	3,440	15.0	3,126	15.1	2,687	15.1	2,147	15.2	2,210	15.5	2,170	15.7
Healthcare	5,120	15.2	5,215	16.3	5,049	17.8	4,925	18.5	4,549	18.6	4,395	19.1	4,043	19.5	3,675	20.7	3,403	24.1	3,263	23.0	3,028	21.9
Construction	3,698	11.0	3,504	10.9	2,870	10.1	2,610	9.8	2,420	9.9	2,089	9.1	1,859	9.0	1,411	7.9	1,094	7.7	1,014	7.1	964	7.0
Transportation	1,282	3.8	1,511	4.7	1,318	4.6	1,132	4.3	1,109	4.5	1,150	5.0	1,067	5.1	940	5.3	757	5.4	751	5.3	772	5.6
Agriculture	155	0.5	144	0.4	154	0.5	130	0.5	99	0.4	97	0.4	79	0.4	96	0.5	58	0.4	55	0.4	56	0.4
Mining	107	0.3	78	0.2	71	0.3	64	0.2	54	0.2	55	0.2	47	0.2	42	0.2	48	0.3	44	0.3	49	0.4
Public safety	197	0.6	252	0.8	278	1.0	279	1.0	279	1.1	307	1.3	321	1.5	281	1.6	276	2.0	226	1.6	205	1.5
Oil and gas	31	0.1	30	0.1	22	0.1	25	0.1	26	0.1	33	0.1	18	0.1	25	0.1	14	0.1	18	0.1	21	0.2
Slip, trip, or fall intervention category																						
All NORA sectors	31,980	100.0	31,194	100.0	31,166	100.0	28,849	100.0	26,629	100.0	23,663	100.0	24,300	100.0	23,118	100.0	17,588	100.0	17,875	100.0	16,660	100.0
Services	10,490	32.8	10,112	32.4	10,052	32.3	9,406	32.6	8,441	31.7	7,671	32.4	7,813	32.2	7,614	32.9	5,895	33.5	6,031	33.7	5,474	32.9
Manufacturing	5,860	18.3	5,407	17.3	5,249	16.8	4,977	17.3	4,532	17.0	4,111	17.4	4,039	16.6	3,706	16.0	2,444	13.9	2,651	14.8	2,647	15.9
Trade	5,371	16.8	5,279	16.9	5,323	17.1	4,671	16.2	4,336	16.3	3,594	15.2	3,686	15.2	3,443	14.9	2,702	15.4	2,713	15.2	2,489	14.9
Healthcare	3,662	11.5	3,865	12.4	4,170	13.4	4,033	14.0	3,905	14.7	3,510	14.8	3,975	16.4	4,032	17.4	3,472	19.7	3,400	19.0	3,072	18.4
Construction	4,531	14.2	4,355	14.0	4,181	13.4	3,754	13.0	3,376	12.7	2,997	12.7	2,798	11.5	2,391	10.3	1,677	9.5	1,558	8.7	1,562	9.4
Transportation	1,584	5.0	1,727	5.5	1,757	5.6	1,590	5.5	1,600	6.0	1,453	6.1	1,628	6.7	1,553	6.7	1,083	6.2	1,243	7.0	1,122	6.7
Agriculture	234	0.7	221	0.7	184	0.6	186	0.6	170	0.6	141	0.6	124	0.5	137	0.6	95	0.5	92	0.5	113	0.7
Mining	121	0.4	104	0.3	106	0.3	79	0.3	105	0.4	67	0.3	77	0.3	96	0.4	87	0.5	72	0.4	84	0.5
Public safety	76	0.2	94	0.3	108	0.3	106	0.4	119	0.4	76	0.3	109	0.4	103	0.4	110	0.6	92	0.5	73	0.4

	Total claims																					
	Year																					
	2001		2002		2003		2004		2005		2006		2007		2008		2009		2010		2011	
NORA Sector	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
Oil and gas	51	0.2	30	0.1	36	0.1	47	0.2	45	0.2	43	0.2	51	0.2	43	0.2	23	0.1	23	0.1	24	0.1
Other interventions																						
All NORA sectors	87,064	100.0	80,457	100.0	72,848	100.0	70,520	100.0	68,089	100.0	64,008	100.0	58,460	100.0	50,181	100.0	37,613	100.0	38,327	100.0	38,229	100.0
Services	23,317	26.8	22,381	27.8	20,791	28.5	20,114	28.5	19,484	28.6	18,408	28.8	16,637	28.5	14,755	29.4	11,496	30.6	11,945	31.2	11,541	30.2
Manufacturing	28,534	32.8	24,798	30.8	21,574	29.6	22,009	31.2	21,552	31.7	20,179	31.5	18,507	31.7	15,246	30.4	9,709	25.8	10,390	27.1	11,072	29.0
Trade	13,412	15.4	12,309	15.3	11,246	15.4	10,406	14.8	9,748	14.3	8,902	13.9	8,166	14.0	7,108	14.2	5,550	14.8	5,439	14.2	5,469	14.3
Healthcare	6,012	6.9	6,181	7.7	6,171	8.5	5,873	8.3	5,716	8.4	6,005	9.4	5,759	9.9	5,248	10.5	4,981	13.2	4,939	12.9	4,640	12.1
Construction	12,279	14.1	11,260	14.0	9,823	13.5	9,028	12.8	8,473	12.4	7,575	11.8	6,511	11.1	5,180	10.3	3,791	10.1	3,531	9.2	3,424	9.0
Transportation	2,390	2.7	2,501	3.1	2,231	3.1	2,140	3.0	2,201	3.2	2,115	3.3	2,035	3.5	1,849	3.7	1,365	3.6	1,445	3.8	1,481	3.9
Agriculture	553	0.6	551	0.7	516	0.7	473	0.7	437	0.6	352	0.5	331	0.6	299	0.6	242	0.6	275	0.7	252	0.7
Mining	286	0.3	219	0.3	217	0.3	182	0.3	191	0.3	188	0.3	206	0.4	186	0.4	202	0.5	163	0.4	150	0.4
Public safety	164	0.2	171	0.2	185	0.3	197	0.3	169	0.2	182	0.3	173	0.3	187	0.4	175	0.5	138	0.4	120	0.3
Oil and gas	117	0.1	86	0.1	94	0.1	98	0.1	118	0.2	102	0.2	135	0.2	123	0.2	102	0.3	62	0.2	80	0.2

Data current as of February 2017.

Agriculture sector, Agriculture, Forestry, Fishing/Hunting; Healthcare sector, Healthcare and Social Assistance; NORA, National Occupational Research Agenda; Public Safety, Ambulance Services (NAICS = 62191), the only private industry in the sector. Services sector, Services (except Public Safety); Trade sector, Wholesale Trade/Retail Trade; Transportation sector, Transportation, Warehousing, Utilities.

*The row for All NORA Sectors includes all intervention categories and 113 claims where it was not possible to assign an intervention category due to missing data or vague narratives.

†Ergonomic intervention category includes BLS-defined work-related musculoskeletal disorders caused by ergonomic hazards.

TABLE 5

Intervention Categories by Possible ERGO and Not ERGO Diagnosis Categories (Table 1) for OHBWC Claims by Claim Type

Claim Type	**Diagnosis Categories**	**Intervention Category**					
Lost-Time Claims		ERGO		STF		OTH	
		N	**% of Total**	***N***	**% of Total**	***N***	**% of Total**
	Not ERGOs	—	0%	31,793	14%	51,475	22%
	Possible ERGOs	80,315	35%	48,080	21%	19,201	8%
	Grand total	80,315	35%	79,873	35%	70,676	30%
Medical-Only Claims		**ERGO**		**STF**		**OTH**	
		N	**% of Total**	***N***	**% of Total**	***N***	**% of Total**
	Not ERGOs	–	0%	95,425	9%	562,130	56%
	Possible ERGOs	178,996	18%	110,294	11%	56,507	6%
	Grand total	178,996	18%	205,719	20%	618,637	62%
Total Claims Distribution		**ERGO**		**STF**		**OTH**	
		N	**% of Total**	***N***	**% of Total**	***N***	**% of Total**
	Not ERGOs	–	0%	127,218	10%	613,605	50%
	Possible ERGOs	259,311	21%	158,374	13%	75,708	6%
	Grand total	259,311	21%	285,592	23%	689,313	56%

Rates current as of February 2017. % of Total includes claims with missing intervention category or missing diagnosis category.

ERGO, Ergonomic intervention category that includes BLS-defined work-related musculoskeletal disorders caused by ergonomic hazards; Lost-time claims, 8 or more days away from work; total claims, lost-time and medical-only (0–7 days away from work) claims; OTH, All other interventions category; STF, Slip, trip, or fall intervention category.

TABLE 6

Claim Rates per 100 Estimated FTE-years for 2001, 2008, and 2011 and Trends for 2001–2008 and 2009–2011 by Claim Type, Intervention Type, and NORA Sector for Private Employers*

		LT Claims					Total Claims				
		Rate			Rate Trend per Year*		Rate			Rate Trend per Year*	
Intervention Category†	NORA Industry Sector	2001	2008	2011	2001–2008% Change (95% CL)	2009–2011% Change (95% CL)	2001	2008	2011	2001–2008% Change (95% CL)	2009–2011% Change (95% CL)
All categories Ergonomic	All NORA industry sectors	1.24	0.73	0.62	−7.7 (−7.9, −7.6)	3.4 (2.2, 4.7)	6.60	4.06	3.34	−6.6 (−6.7, −6.5)	−0.8 (−1.3, −0.3)
	All NORA industry sectors	0.47	0.22	0.19	−10.4 (−10.7, −10.1)	2.7 (0.5, 5)	1.45	0.79	0.67	−8.2 (−8.4, −8)	−1.6 (−2.8, −0.4)
	Agriculture	0.23	0.13	0.13	−9.9 (−15.4, −4.1)	33.1 (−9.8, 96.5)	1.13	0.73	0.45	−7.9 (−10.5, −5.3)	−3 (−19.4, 16.7)
	Construction	0.67	0.27	0.24	−12.6 (−13.5, −11.7)	3.8 (−3.6, 11.8)	1.85	0.78	0.66	−11.4 (−12, −10.9)	−4.4 (−8.5, −0.2)
	Healthcare	0.55	0.28	0.24	−9.7 (−10.5, −8.9)	−3.5 (−8.2, 1.5)	1.92	1.21	1.01	−6.4 (−6.8, −6)	−5.9 (−8.2, −3.6)
	Manufacturing	0.80	0.33	0.29	−11.4 (−12, −10.8)	3.3 (−1.2, 8.1)	2.43	1.19	1.00	−9.0 (−9.4, −8.7)	−0.5 (−2.8, 2)
	Mining	0.68	0.31	0.20	−8.9 (−14.4, −3)	−8.7 (−38.7, 35.9)	1.82	0.88	0.99	−10 (−13.3, −6.6)	0 (−18.2, 22.2)
	Oil and gas	0.35	0.27	0.24	−3.4 (−12.1, 6.1)	45.2 (−19.4, 161.8)	1.22	0.67	0.71	−8.9 (−14, −3.5)	26.4 (−9.1, 75.7)
	Public Safety	1.49	0.89	1.04	−5.8 (−9.5, −2)	6.1 (−12.9, 29.2)	5.13	5.29	4.36	−0.3 (−2.2, 1.5)	−6.8 (−14.8, 2)
	Services	0.26	0.13	0.11	−9.6 (−10.3, −9)	3.9 (−0.7, 8.8)	0.78	0.44	0.37	−7.6 (−8, −7.2)	0.5 (−2, 3)
	Trade	0.42	0.21	0.19	−10.1 (−10.9, −9.3)	4.7 (−0.9, 10.7)	1.34	0.73	0.65	−8.7 (−9.1, −8.2)	1.2 (− 1.8, 4.2)
	Transportation	0.67	0.41	0.40	−7.8 (−9.1, −6.5)	7.9 (−0.8, 17.3)	1.69	1.11	1.04	−6.8 (−7.7, −6)	2.2 (−2.9, 7.5)
Slip, trip, or fall											
	All NORA industry sectors	0.39	0.27	0.23	−5.8 (−6.1, −5.5)	0.8 (−1.2, 2.9)	1.38	1.03	0.81	−5 (−5.2, −4.9)	−3 (−4, −2)
	Agriculture	0.38	0.25	0.21	−7.7 (−12, −3.2)	4.3 (−20.2, 36.4)	1.71	1.03	0.90	−7.6 (−9.7, −5.4)	8.1 (−6, 24.2)
	Construction	0.79	0.47	0.41	−8.0 (−8.8, −7.2)	1.7 (− 3.9, 7.6)	2.26	1.31	1.07	−8.1 (−8.6, −7.7)	−1.7 (−5, 1.7)
	Healthcare	0.37	0.29	0.26	−4.4 (−5.3, −3.4)	1.4 (−3.5, 6.5)	1.37	1.33	1.03	−1.5 (−2, −1)	−6 (−8.2, −3.7)
	Manufacturing	0.36	0.22	0.21	−7.1 (−7.9, −6.3)	7.1 (1.4, 13.1)	1.38	0.95	0.79	−5.6 (−6.1, −5.2)	1.2 (−1.5, 4)
	Mining	0.85	0.67	0.34	−4.5 (−9.4, 0.7)	−10.3 (−34.1, 22.1)	2.06	2.01	1.70	−3.3 (−6.2, −0.4)	−2.9 (−16.7, 13.2)
	Oil and gas	0.67	0.37	0.31	−6.8 (−13.7, 0.7)	−6.8 (−41.5, 48.3)	2.01	1.15	0.81	−5.1 (−9.3, −0.8)	6.2 (−20, 41.1)
	Public Safety	0.39	0.55	0.40	−2.7 (−8.6, 3.5)	−5.2 (−29.3, 27.2)	1.98	1.94	1.55	−2.6 (−5.5, 0.5)	−11.4 (−23.4, 2.5)
	Services	0.31	0.23	0.17	−5.3 (−5.9, −4.7)	−0.8 (−4.2, 2.8)	1.18	0.85	0.65	−5.4 (−5.7, −5.1)	−3.9 (−5.7, −2.1)
	Trade	0.34	0.24	0.19	−6.1 (−6.9, −5.3)	−0.1 (−5.2, 5.4)	1.27	0.94	0.75	−5.3 (−5.7, −4.8)	−3.4 (−6, −0.8)
	Transportation	0.75	0.65	0.60	−3.4 (−4.6, −2.2)	0.9 (−5.4, 7.6)	2.07	1.84	1.51	−3 (−3.7, −2.2)	2.7 (−1.4, 7.1)

		LT Claims					Total Claims				
		Rate			Rate Trend per Year*		Rate			Rate Trend per Year*	
Intervention Category†	NORA Industry Sector	2001	2008	2011	2001–2008% Change (95% CL)	2009–2011% Change (95% CL)	2001	2008	2011	2001–2008% Change (95% CL)	2009–2011% Change (95% CL)
Other											
	All NORA industry sectors	0.37	0.23	0.20	−6.8 (−7.1, −6.4)	7.6 (5.2, 10)	3.77	2.23	1.86	−6.6 (−6.7, −6.5)	0.5 (−0.2, 1.2)
	Agriculture	0.39	0.28	0.21	−5.5 (−9.6, −1.3)	3.7 (−19.7, 33.8)	4.00	2.26	2.00	−7.9 (−9.3, −6.6)	0.9 (−7.5, 10)
	Construction	0.63	0.35	0.29	−8.9 (−9.8, −7.9)	3.8 (−2.9, 11)	6.14	2.84	2.33	−10.0 (−10.3, −9.7)	−3.2 (−5.4, −1)
	Healthcare	0.18	0.12	0.11	−6.9 (−8.3, −5.6)	3.3 (−4.2, 11.5)	2.26	1.73	1.56	−3.6 (−4, −3.2)	−3.6 (−5.5, −1.7)
	Manufacturing	0.66	0.39	0.34	−7.2 (−7.8, −6.6)	12.4 (7.6, 17.4)	6.71	3.91	3.34	−6.3 (−6.5, −6.1)	4.2 (2.8, 5.6)
	Mining	0.68	0.71	0.55	−0.1 (−5.2, 5.2)	0.8 (−23.3, 32.6)	4.87	3.89	3.04	−3.3 (−5.2, −1.3) -	−14.8 (−23.4, −5.4)
	Oil and gas	0.83	0.70	0.54	0.6 (−5.1, 6.6)	−7 (−33.3, 29.5)	4.57	3.29	2.68	−3.2 (−5.9, −0.4)	−9.3 (−22.1, 5.6)
	Public Safety	0.47	0.57	0.34	−1.6 (−7.9, 5.1)	14.1 (−17.6, 58)	4.25	3.52	2.55	−3.8 (−6, −1.6)	−10.4 (−20.2, 0.6)
	Services	0.24	0.16	0.13	−5.9 (−6.6, −5.2)	5.5 (1.1, 10)	2.61	1.65	1.37	−6 (−6.2, −5.8)	−0.1 (−1.4, 1.2)
	Trade	0.29	0.20	0.17	−5.9 (−6.9, −5)	5.6 (−0.5, 12.1)	3.16	1.93	1.65	−6.5 (−6.7, −6.2)	−0.1 (−2, 1.8)
	Transportation	0.65	0.45	0.48	−5 (−6.4, −3.6)	14.4 (5.9, 23.5)	3.14	2.19	2.00	−5.2 (−5.8, −4.5)	6 (2.1, 10)

Rates current as of February 2017.

Agriculture sector, Agriculture, Forestry, Fishing/Hunting; CL, confidence limit; FTE, full-time equivalent employee (2000 hours/year); Healthcare sector, Healthcare and Social Assistance; LT, lost-time claims with 8 or more days away from work; NORA, National Occupational Research Agenda; Other, All other interventions category; Public Safety, Ambulance Services, the only private NAICS code in Public Safety; Services sector, Services (except Public Safety); Total Claims, medical-only and lost-time claims; Trade sector, Wholesale Trade/Retail Trade; Transportation sector, Transportation, Warehousing, Utilities.

*Among privately owned employers in Ohio with single and multiple locations.

†Ergonomic intervention category includes BLS-defined work-related musculoskeletal disorders caused by ergonomic hazards.

TABLE 7

Claim Rates per 100 Estimated FTEs by Year, Claim Type, Intervention Category, and National Occupational Research Agenda (NORA) Industry Sector for Private Employers Insured by the Ohio Bureau of Workers' Compensation— Ohio, 2001–2011

	Year																					
	2001		2002		2003		2004		2005		2006		2007		2008		2009		2010		2011	
NORA Sector	LT	Total	LT	Total	LT	Total	LT	Total	LT	Total	LT	Total	LT	Total	LT	Total	LT	Total	LT	Total	LT	Total
Ergonomic intervention category*																						
All NORA sectors	0.47	1.45	0.47	1.41	0.42	1.25	0.38	1.16	0.33	1.06	0.29	0.99	0.26	0.90	0.22	0.79	0.18	0.69	0.21	0.70	0.19	0.67
Services	0.26	0.78	0.25	0.75	0.23	0.67	0.21	0.64	0.19	0.58	0.16	0.54	0.15	0.50	0.13	0.44	0.10	0.37	0.12	0.39	0.11	0.37
Manufacturing	0.80	2.43	0.74	2.25	0.67	1.95	0.60	1.85	0.53	1.68	0.46	1.58	0.40	1.41	0.33	1.19	0.27	1.01	0.31	1.04	0.29	1.00
Trade	0.42	1.34	0.43	1.35	0.41	1.22	0.35	1.07	0.32	0.99	0.25	0.89	0.24	0.83	0.21	0.73	0.17	0.64	0.22	0.67	0.19	0.65
Healthcare	0.55	1.92	0.57	1.88	0.53	1.76	0.49	1.69	0.40	1.53	0.37	1.46	0.32	1.33	0.28	1.21	0.26	1.15	0.27	1.10	0.24	1.01
Construction	0.67	1.85	0.67	1.77	0.53	1.47	0.49	1.31	0.43	1.21	0.35	1.03	0.32	0.95	0.27	0.78	0.22	0.72	0.25	0.70	0.24	0.66
Transportation	0.67	1.69	0.79	1.97	0.69	1.69	0.56	1.40	0.54	1.39	0.53	1.38	0.47	1.25	0.41	1.11	0.34	1.00	0.38	1.01	0.40	1.04
Agriculture	0.23	1.13	0.19	1.03	0.28	1.10	0.21	0.99	0.14	0.77	0.17	0.75	0.10	0.61	0.13	0.73	0.07	0.47	0.13	0.44	0.13	0.45
Mining	0.68	1.82	0.54	1.69	0.50	1.60	0.62	1.53	0.38	1.20	0.33	1.13	0.46	0.98	0.31	0.88	0.25	1.00	0.30	0.95	0.20	0.99
Public safety	1.49	5.13	1.51	6.33	1.41	6.41	1.36	6.11	1.17	5.45	1.08	6.04	1.28	6.34	0.89	5.29	0.93	5.01	0.95	4.65	1.04	4.36
Oil and gas	0.35	1.22	0.26	1.30	0.44	0.97	0.40	1.00	0.44	0.95	0.39	1.06	0.26	0.52	0.27	0.67	0.09	0.44	0.25	0.63	0.24	0.71
Slip, trip, or fall intervention category																						
All NORA sectors	0.39	1.38	0.39	1.37	0.40	1.37	0.37	1.26	0.33	1.16	0.27	1.02	0.29	1.06	0.27	1.03	0.22	0.86	0.26	0.88	0.23	0.81
Services	0.30	1.17	0.30	1.15	0.31	1.14	0.29	1.05	0.25	0.94	0.22	0.84	0.23	0.87	0.23	0.85	0.18	0.70	0.20	0.73	0.17	0.65
Manufacturing	0.36	1.38	0.36	1.34	0.35	1.32	0.35	1.23	0.30	1.13	0.24	1.01	0.24	1.00	0.22	0.95	0.18	0.77	0.22	0.82	0.21	0.79
Trade	0.34	1.27	0.34	1.28	0.37	1.32	0.34	1.16	0.30	1.11	0.24	0.93	0.26	0.98	0.24	0.94	0.19	0.81	0.23	0.83	0.19	0.75
Healthcare	0.37	1.37	0.37	1.39	0.40	1.45	0.37	1.38	0.33	1.31	0.27	1.16	0.31	1.31	0.29	1.33	0.25	1.17	0.29	1.15	0.26	1.03
Construction	0.79	2.26	0.78	2.21	0.75	2.13	0.65	1.89	0.57	1.69	0.53	1.48	0.49	1.43	0.47	1.31	0.39	1.10	0.43	1.09	0.41	1.07
Transportation	0.75	2.07	0.91	2.25	0.84	2.25	0.76	1.98	0.80	1.98	0.62	1.73	0.76	1.90	0.65	1.84	0.59	1.44	0.67	1.67	0.60	1.52
Agriculture	0.38	1.71	0.42	1.58	0.30	1.30	0.33	1.40	0.39	1.33	0.16	1.09	0.24	0.95	0.25	1.03	0.19	0.77	0.25	0.73	0.21	0.90
Mining	0.85	2.06	0.63	2.25	0.70	2.39	0.65	1.89	0.75	2.33	0.45	1.38	0.52	1.60	0.67	2.01	0.44	1.80	0.47	1.55	0.34	1.70
Public Safety	0.39	1.98	0.63	2.36	0.76	2.49	0.50	2.32	0.47	2.32	0.31	1.49	0.49	2.15	0.55	1.94	0.45	2.00	0.47	1.89	0.40	1.55
Oil and gas	0.67	2.01	0.43	1.30	0.53	1.58	0.76	1.88	0.55	1.64	0.45	1.35	0.40	1.47	0.37	1.15	0.34	0.72	0.21	0.81	0.31	0.81

	Year																					
	2001		2002		2003		2004		2005		2006		2007		2008		2009		2010		2011	
NORA Sector	LT	Total	LT	Total	LT	Total	LT	Total	LT	Total	LT	Total	LT	Total	LT	Total	LT	Total	LT	Total	LT	Total
Other interventions †																						
All NORA sectors	0.37	3.77	0.37	3.54	0.34	3.21	0.33	3.07	0.30	2.97	0.27	2.75	0.26	2.54	0.23	2.23	0.17	1.84	0.20	1.90	0.20	1.86
Services	0.24	2.61	0.24	2.54	0.23	2.36	0.23	2.25	0.20	2.17	0.18	2.02	0.18	1.84	0.16	1.65	0.12	1.37	0.14	1.44	0.13	1.37
Manufacturing	0.66	6.71	0.66	6.15	0.59	5.41	0.60	5.44	0.53	5.35	0.48	4.93	0.44	4.58	0.39	3.92	0.27	3.07	0.33	3.22	0.34	3.34
Trade	0.29	3.16	0.30	2.98	0.28	2.78	0.27	2.59	0.25	2.50	0.22	2.29	0.21	2.16	0.20	1.93	0.15	1.65	0.17	1.66	0.17	1.65
Healthcare	0.18	2.26	0.20	2.23	0.18	2.15	0.15	2.01	0.13	1.92	0.14	1.96	0.13	1.86	0.12	1.73	0.10	1.68	0.12	1.67	0.11	1.56
Construction	0.63	6.14	0.63	5.72	0.56	5.02	0.51	4.55	0.45	4.25	0.41	3.74	0.37	3.33	0.35	2.84	0.27	2.49	0.30	2.45	0.29	2.33
Transportation	0.65	3.14	0.64	3.27	0.59	2.84	0.60	2.67	0.57	2.75	0.53	2.53	0.49	2.38	0.45	2.19	0.36	1.79	0.48	1.95	0.48	2.01
Agriculture	0.39	4.01	0.39	3.95	0.46	3.68	0.43	3.59	0.31	3.41	0.28	2.73	0.33	2.48	0.28	2.26	0.19	1.96	0.31	2.19	0.21	2.00
Mining	0.68	4.87	0.69	4.75	0.77	4.90	0.53	4.36	0.58	4.24	0.68	3.87	0.69	4.28	0.71	3.89	0.54	4.19	0.49	3.50	0.55	3.04
Public safety	0.47	4.25	0.60	4.30	0.51	4.27	0.42	4.32	0.39	3.30	0.41	3.58	0.36	3.42	0.57	3.52	0.25	3.18	0.47	2.84	0.34	2.55
Oil and gas	0.83	4.57	0.91	3.73	0.79	4.13	1.04	3.93	1.24	4.30	0.61	3.28	1.21	3.90	0.70	3.29	0.63	3.20	0.56	2.18	0.54	2.68

Rates current as of February 2017.

Agriculture sector, Agriculture, Forestry, Fishing/Hunting; CL, confidence limit; FTE, full-time equivalent employee (2000 hours/year); Healthcare sector, Healthcare and Social Assistance; LT, lost-time claims with 8 or more days away from work; NORA, National Occupational Research Agenda; Other, All other interventions category; Public Safety, Ambulance Services (NAICS = 62191), the only private industry in the sector; Services sector, Services (except Public Safety); Total Claims, medical-only and lost-time claims; Trade sector, Wholesale Trade/Retail Trade; Transportation sector, Transportation, Warehousing, Utilities.

*Ergonomic intervention category includes BLS-defined work-related musculoskeletal disorders caused by ergonomic hazards.

†Other, all other interventions category.