Development of Methods for Using Workers' Compensation Data for Surveillance and Prevention of Occupational Injuries Among State-Insured Private Employers in Ohio

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Background *Workers' compensation (WC) claims data may be useful for identifying high-risk industries and developing prevention strategies.*

Methods *WC claims data from private-industry employers insured by the Ohio state-based workers' compensation carrier from 2001 to 2011 were linked with the state's unemployment insurance (UI) data on the employer's industry and number of employees. National Labor Productivity and Costs survey data were used to adjust UI data and estimate full-time equivalents (FTE). Rates of WC claims per 100 FTE were computed and Poisson regression was used to evaluate differences in rates.*

Results *Most industries showed substantial claim count and rate reductions from 2001 to 2008, followed by a leveling or slight increase in claim count and rate from 2009 to 2011. Despite reductions, there were industry groups that had consistently higher rates.*

Conclusion *WC claims data linked to employment data could be used to prioritize industries for injury research and prevention activities among State-insured private employers.* Am. J. Ind. Med. 59:1087–1104, 2016.   © 2016 Wiley Periodicals, Inc.

INTRODUCTION

There is no single data source sufficient to characterize the burden of occupational injuries and illnesses (OII) in the United States. The US National Institute for Occupational Safety and Health (NIOSH) Surveillance program supports the collection of OII data from a large number of national systems, hospital discharge databases, and emergency department databases [NIOSH, 2016a]. Two of the main dedicated systems for capturing occupational injury and fatality data at the employer-level include the Bureau of Labor Statistics (BLS) Survey of Occupational Injuries and Illnesses (SOII) and Census of Fatal Occupational Injuries (CFOI). Although these sources provide necessary information for understanding the nature and extent of OII, all have limitations. To continually improve occupational safety and health, it is imperative to seek other datasets within states that will enhance our understanding to prevent OII. A major underutilized resource for the collection of OII at the employer-level is workers' compensation (WC) claims of injury data.

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Workers' Compensation Data Strengths

WC insurance was estimated to cover over 90% of the US wage and salary workers in 2013, with covered employment increasing virtually in all states between 2009 and 2013 [Sengupta and Baldwin, 2015]. WC claims data are the largest repository of occupational injury information in the US. A major strength of WC data is that the claims are not based on a survey of a population sample, but are administrative data that record all injury claims that have been reported to the state for the insured population. All US states require that employers and insurers report some portion of WC claims data to a central state agency. In 28 states, both medical-only (MO) and lost-time (LT) claims must be reported [US Chamber of Commerce, 2015]. Over the last several decades, much of the data storage has transitioned from paper to computer databases. Many states utilize standard electronic data interchange first report of injury and subsequent report of injury formats developed by the International Association of Industrial Accident Boards and Commissions (IAIABC) [Utterback et al., 2014]. As a result, many states have large databases with uniform, electronically coded data descriptors of injuries (i.e., injury diagnoses, causations, affected body part). Larger states have databases with millions of claims. For example, California reports the largest number of WC claims in the US with over 590,000 in 2014 alone [CA DWC, June 2015].

The BLS SOII provides necessary information to understand the cause, nature, and source of injury in many industries and has a number of strengths, including detailed industry and demographics data for its various levels of data collection. However, recent studies have indicated that the number of WC claims collected in many states is greater than the number of SOII-estimated Occupational Safety and Health Administration (OSHA) recordable cases in the same state. For example, one key study [Boden and Ozonoff, 2008] compared WC claim counts and BLS survey estimates for OSHA recordables in six states (WA, WV, OR, WI, NM, MN) for 1998–2001 and found that in all but one state (MN) there were more WC claims. In one state (WA), there were over 80% more OII cases according to the WC claims data, and in another state (NM) there were over 35% more cases associated with WC claims. Boden and Ozonoff also reported estimates of the percentage of cases (over 3 or 7 lost work days) captured by OSHA logs versus WC claims. Conservative (high) estimates of the percentages captured by OSHA logs ranged from 51% to 76% in the six states, versus 65% to 93% captured by WC claims. Jones [2013] reported that WC claims in California were more than 25% greater than the total number of OSHA recordables as estimated by the BLS. Another recent study reported that in Washington, from 2003 to 2011, WC captured 96% of LT cases in SOII, while SOII captured 70% of LT WC claims [Wuellner et al., 2016].

There are a number of possible reasons driving this difference. Numerous studies have indicated that the SOII undercounts both injuries and illnesses [Azaroff et al., 2002; Leigh et al., 2004; Rappin et al., 2016; Wuellner et al., 2016]. Employers may have limited knowledge of the OSHA and SOII reporting requirements and may have confusion about which conditions should be reported as work-related [Azaroff et al., 2002]. The timing of the SOII data collection may also impact recall since the survey is just once per year, and employers are expected to provide data within 30 days of receiving survey instructions. Some employers may not keep their logs up to date and then may be forced to recall the previous year's injuries without complete records.

The advent of electronic data interchange may make the WC claims data easier to report in some cases than OSHA recordables, but the impact of these systems for smaller employers is not clear. Employers, fearing regulatory compliance actions, may view the reporting of claims for WC of less consequence than reporting OSHA cases. Some researchers have recently suggested that the disincentives for OSHA reporting likely differ by industry [Rappin et al., 2016; Wuellner et al., 2016]. Workers may also file a claim without the employer's initiative or consent. Although filing of a claim by a worker is voluntary, the worker has incentive to file a claim if the required medical care would result in deductible and/or copayment costs if it were paid by regular medical insurance.

Another general reason that WC collects more OII than OSHA logs is that WC systems may have a tendency to capture more of the minor occupational injuries that do not meet the definition of an OSHA recordable case. This can happen when a worker seeks professional medical care, but no treatment is actually provided beyond first aid. For example, a worker could report discomfort/pain and be sent to an occupational medicine clinic where they are prescribed over the counter medications but no physical therapy. In this case, a WC claim had to be filed to see the doctor but the treatment itself is not considered beyond first aid. In other situations, an employer or an employee may file a claim when an incident occurs, such as a minor cut, "just in case" the injury becomes more severe at a later date. Such zero-cost WC claims are generally not counted against an employer's experience modification rating so there is less disincentive to report.

Another main strength of WC data is that claims provide detailed and dynamic information that tracks the progression of the OII from onset to outcome. For example, claims data usually include an unstructured narrative to describe how the injury/illness occurred as well as additional structured information on the cause of injury, nature of injury, resulting diagnoses, medical treatments, disability type, and costs for medical care, rehabilitation, and partial wage replacement. The data may also include information on the injured worker (age, sex, job tenure, occupation) and their employer

(industry, employee payroll, prior claim history). WC data also collects a unique identifier for each injured worker that allows insight into the prevention of repeated injury and whether there is an association with certain industries, occupations, types of injury causes, injury diagnoses, or worker characteristics. Many of the above described data elements (e.g., medical and wage replacement, progression of injury and treatment, injured worker characteristics) are not fully included in SOII and CFOI. WC claims data are also just part of an overall system with capacity for prevention, including insurer-based employer exposure/control assessments and the infrastructure to reach employers for prevention purposes.

Workers' Compensation Data Limitations

WC data also have a number of limitations as surveillance sources, including under-reporting of OII and state differences in reporting and compensability. Similar to SOII and OSHA recordable data, a number of studies have noted that WC data suffer from the under-reporting of OII, especially illnesses, with up to an estimated 50% or more of the compensable injuries going unreported [Biddle et al., 1998; Rosenman et al., 2000; Azaroff et al., 2002, 2013; Fan et al., 2006; Scherzer and Wolfe, 2008; Lipscomb et al., 2009]. For example, a large review of WC claims in Michigan [Biddle et al., 1998] found especially elevated rates of under-reporting in certain higher risk industries such as manufacturing and in cases involving "chronic conditions with long latency periods between exposure and development of disease." Azaroff et al. [2013] reported several barriers to WC reporting, including "lack of familiarity with WC, uncertainty about work-relatedness, and reliance on patients to identify work-relatedness of their conditions." Non-reporting of WC claims by workers to employers can also be due to a fear of employer retaliation that similarly impacts the reporting of OSHA recordables. The nature of the WC claim under-reporting is complex and can be driven by multiple stakeholders and interested parties including employers, employees, medical care providers, and insurers. By design, the WC systems across the US do not cover all workers. For example, self-employed and independent contract workers are exempt from WC coverage in many states and coverage of other contract and otherwise contingent workers can be complex. However, WC still covers the vast majority of workers [Sengupta and Baldwin, 2015]. In summary, a number of limitations preclude the use of WC data as a stand-alone surveillance source, but WC claims data still can be used to augment other data sources and help develop prevention strategies.

Barriers to Use of Workers' Compensation Data

Much of the WC data needed to understand the nature and extent of OII in the private insurers and state funds data systems are not shared with the public. Due to many barriers and challenges, attempts to utilize WC data for the purpose of nationwide surveillance of OII have been very limited. The first major barrier is related to the fact that WC insurance coverage and management of claims is regulated at the state level and each state has it is own set of WC laws/regulations and codified administrative rules for determining which illnesses are compensable, which claims are "allowed" versus "disallowed," the minimum number of lost work days required to qualify for benefits, and benefit levels. States also differ in degree of electronic reporting, and the extent of access to data for public health research.

A second major barrier is that multiple private and state-based WC carriers operate in many states which can complicate reporting of data to the central state agencies. Most of the providers of WC insurance coverage are private insurance companies that operate in multiple states with varied market shares. There are also 27 WC state-based insurance funds that underwrite about 25% of the total WC net premiums in the US [American Association of State Compensation Insurance Funds, 2016]. ND, OH, WY, and WA state WC insurance funds are the exclusive providers of WC insurance in their states while state funds in other states are competitive funds that compete with private insurance companies. Since the various states have different WC laws and various carriers in operation, it is difficult to use WC claim of injury data for surveillance purposes unless it is done on a state by state basis.

A third primary barrier is related to the fact that the majority of WC data systems do not track insured client employee counts and employee hours worked. These data are needed to estimate rates with full-time equivalents (FTEs) as the denominator. FTEs are the most consistent basis for comparing risks to workers in different industries. Instead, WC insurance rating bureaus and some states use a manual classification system with codes that are a cross between occupation and industry and which are meant to group employers with similar exposures and claim costs. Employers report annual payroll by class to rating bureaus for the purpose of premium setting. In 38 states, the National Council on Compensation Insurance (NCCI) acts as this bureau. In this way, the calculation of exposure to risk from the standpoint of the insurance industry is based on the NCCI industry classification and the amount of payroll reported under that classification. Although this system has advantages in quantifying and comparing financial risks between and within industries, it is necessary to couple WC data with additional state employment data to generate WC claim rates for prevention purposes.

Increasing Use of Workers' Compensation Data for Public Health Purposes

Despite the above barriers, WC claims data are increasingly being used as OII prevention and surveillance sources that may be complementary to the BLS estimates of OSHA recordables. For example, Boden and Ozonoff's study in 2008 found limited overlap in the sets of OII captured by WC and BLS and estimated that the percentages of all OII captured increase when the sources are considered together. There remain many methodological differences that limit the use of WC claims data for between-state comparisons. However, using WC claims and BLS data together to focus prevention and research within states, especially among specific populations, is becoming increasingly feasible.

NIOSH recognizes that WC data and systems are important for understanding the nature, extent and burden of OII and deploying effective interventions to protect workers. NIOSH sponsored two workshops in 2009 and 2012 on the use of WC data for occupational safety and health and gathered input from private and state-based WC insurance carriers, insurance associations, self-insured corporations, academic institutions and government agencies. NIOSH subsequently published proceedings from both meetings [NIOSH, 2010, 2013] and developed a primer to provide an introduction to using WC data for public health purposes [Utterback et al., 2014]. To further coordinate efforts, NIOSH established the Center for Workers' Compensation Studies (CWCS) in 2013 [NIOSH, 2016b]. The CWCS mission is to support the use of WC data and systems to improve workplace safety and health by working with private and public insurers and other partners. Since that time, the CWCS has been focused on support for state-level compilation and analysis of WC claims data, developing new partnerships, and creating future outreach opportunities.

All US states and Canadian provinces collect some WC data and a growing number of public health agencies have access to these data systems. For example, a recent survey conducted by the Council of State and Territorial Epidemiologists, indicated that 47% (18) of the 38 responding US state departments of health had access to an electronic database of state WC claims [Davis et al., 2012]. As a result of increased access, a number of researchers have published analyses focusing on particular industries, and specific OII outcomes or causes. However, very few US states and insurers have published WC claims data across industry types and injury outcomes/causes in a systematic way to identify statewide research and intervention priorities and provide benchmarking information for employers. Washington State Labor and Industries (WA-L&I) is a leader in publishing such data, first for 1998–2002 [Bonauto et al., 2006] and again for 2002–2010 [Anderson et al., 2013]. This is a critical, basic use of state WC claims data to provide information on the frequency, cause, diagnoses, cost and severity of OII, to supplement national data and focus safety and health research and practice within states.

NIOSH Partnership With the Ohio Bureau of Workers' Compensation

NIOSH and the Ohio Bureau of Workers' Compensation (OHBWC) established a partnership in 2010 that was a key step in the development of the NIOSH–CWCS. The primary vision of this partnership is to identify high-risk industries and occupations in Ohio, to reduce worker risk by informing prevention efforts, and to conduct intervention trials and identify evidence-based controls, programs, and practices.

The overall goals of an initial core surveillance project for the partnership described in this paper were to: (i) develop rigorous methods of linking administrative WC claims and policy databases with standardized industry codes and denominator (e.g., employee counts) data from other sources; (ii) ensure data reliability along with consistency and repeatability of analyses; (iii) produce systematic WC claims injury trend data across all industries types and causes and health outcomes; and ultimately (iv) identify statewide research and intervention priorities and provide benchmarking information for employers. Since WC data and systems do not fully capture occupational illness, the focus has been primarily on developing information useful for injury prevention. The analyses described here focus on a methodology for developing multi-industry injury rate data by linking WC claim data at an employer-level to an external denominator source and identifying high-risk industries among OHBWC-insured private employers to inform future prevention services and programs. Methods for WC claims analyses in states with mixed systems (i.e., private- and state-based insurers operating in the same state, each with multiple claims administrators) will be different. WC claim trends by causation and health outcomes in this population will be presented in two forthcoming companion manuscripts.

All employers in Ohio with 1–499 employees must be insured by OHBWC. Employers with greater than 500 employees have the option to be self-insured if financially able to do so. Sole proprietors and partners in partnerships are not required to have WC insurance coverage in Ohio, but may choose voluntarily to be insured by OHBWC. All employers, however, must have policies covering their employees, or be self-insured. As a result, OHBWC covers approximately 67% of the Ohio's workforce and 99% of employers in the state. OHBWC offers a range of prevention services such as training and onsite safety, ergonomic, and industrial hygiene consulting. Since 1999, OHBWC has also

provided a program where insured companies are provided funds to implement engineering controls and other prevention activities [Ohio Administrative Code, 2006].

METHODS

The WC data from calendar years 2001–2011 for this study were drawn from the OHBWC data warehouse which contains a large number of variables that are mostly supplied from two sources. One source is a policy system which contains many variables that describe the employer, including NCCI manual classifications for the employer and the amount of reported payroll under each manual class, business tax identification number, address, premium, rating plan, and experience modifier. The second source is the claims system which contains variables associated with claims including information coded from the first report of injury, various diagnoses associated with the claim, and medical, indemnity and reserve costs, along with demographic information related to the injured worker such as age and sex. The WC claims data used in this analysis included all allowed claims, including zero-cost claims. OHBWC typically dismisses or disallows approximately 10% of claims each year [OHBWC, 2012].

To date, the partnership has been focused on analyzing claims and policy data from OHBWC-insured private employers, which from 2006 to 2011 represented 47% of all Ohio claims, 80.5% of OHBWC claims, and 97.3% of OHBWC policies. Data for self-insured employers (0.8% of the policies) and OHBWC-insured public employers (1.9% of the policies), which include state agencies and public taxing districts such as cities, counties, townships, and villages, have not been analyzed in detail yet. For public employers, the methods to link to denominators have not been fully developed, but future analyses in the public sector are planned. The linkage for public employers is complicated because many are very large employers with multiple locations that can differ significantly in function and nature of work. The algorithm described below for defining industry codes in small, private multiple-location employers that are generally more homogenous across locations than large, public multiple-location employers was found to not apply. For self-insured employers, STATE generally collects limited information including year-end claim summaries not suitable for the level of analyses presented here. Table I provides a summary of information for all Ohio WC claims 2006–2011, including the claim-level data for private, OHBWC-insured employers that are analyzed in this paper, as well as additional aggregate data on policies, employees, and claim counts for self-insured employers.

Methods for WC claim rate computations and comparisons for OHBWC-insured private employers involved the steps described below: (i) linkage of WC data and

TABLE I. Ohio Workers' Compensation Summary, Calendar Years 2006–2011

| Policy type | Policy years[a] | | | | Raw employee count[b] | | | | Total workers' compensation claims (medical-only and lost-time) | | | | Lost-time worker's compensation claims (8 or more days away from work) | | | |
	n	% OHBWC-insured	% Total (OHBWC-insured and self-insured)		n	% OHBWC-insured	% Total (OHBWC-insured and self-insured)		n	% OHBWC-insured	% Total (OHBWC-insured and self-insured)		n	% OHBWC-insured	% Total (OHBWC-insured and self-insured)	
All OHBWC policies	1,063,951	100.0	99.2		18,840,490	100.0	61.8		666,190	100.0	58.5		131,912	100.0	66.9	
All private policies	1,043,462	98.1	97.3		15,376,136	81.6	50.4		536,420	80.5	47.1		96,489	73.1	49.0	
Single-location private	1,024,040	96.2	95.5		11,947,192	63.4	39.2		423,812	63.6	37.2		77,556	58.8	39.4	
Multiple-location private	19,422	1.8	1.8		3,428,944	18.2	11.2		112,608	16.9	9.9		18,933	14.4	9.6	
All public policies	20,489	1.9	1.9		3,464,354	18.4	11.4		129,770	19.5	11.4		35,423	26.9	18.0	
Single-location public	14,858	1.4	1.4		585,951	3.1	1.9		19,015	2.9	1.7		3,610	2.7	1.8	
Multiple-location public	5,631	0.5	0.5		2,878,403	15.3	9.4		110,755	16.6	9.7		31,813	24.1	16.1	
Self-insured policies	8,430	n/a	0.8		11,640,262	n/a	38.2		472,172	n/a	41.5		65,129	n/a	33.1	
TOTAL	1,072,381				30,480,752				1,138,362				197,041			

[a]Number of unique policy-year combinations for years 2006–2011.
[b]Includes the reported number of both part- and full-time employees and is not based on employee hours.

unemployment insurance (UI) data; (ii) policy-level raw rate computations using quarterly employee counts; (iii) exclusion of outlier policy/year level raw WC claim rates; (iv) adjustment of employee counts to estimate full-time equivalents; (v) pooling of single- and multiple-location data; and (vi) computation of prevention indices that can be used to help prioritize industries for prevention based on a combination of claim frequency and claim rate.

Linkage of Workers' Compensation and Unemployment Insurance Data

A key first step in developing claim rates with WC data in Ohio was to link WC claims and policy data to other denominator information (e.g., employee count and industry) for the employer. To clarify, this step is not necessary in Washington State because the WA-L&I WC system directly collects employee hours at an employer level. The goal was to classify each claim using the North American Industry Classification System (NAICS), which is the federal industry classification system used by BLS for the SOII and other economic reporting. However, the actual OHBWC WC employer data were limited to annually reported payroll amounts by NCCI manual class codes. As described before, these class codes are a cross between occupation and industry, resulting in complex relationships between NCCI and NAICS codes.

The aggregate industry level data as published in the BLS quarterly census of employment and wages for each state were first considered as a possible denominator source. However, these data were not appropriate to use in this case since the OHBWC-insured employers were but a subset of the employers in Ohio. Instead, the choice was made to link the employer's OHBWC policy level data with that employer's Ohio UI agency data, which included the quarterly employer-reported numbers of employees (including part- and full-time), fields that identify the employer as single- or multiple-location, UI agency-assigned NAICS industry codes by location, and employer names/addresses. The UI data were made available to the OHBWC insurer as part of an intra-agency agreement.

The choice of the employer-level UI data was necessary in the OHBWC analyses, but it may also be preferred in other states for several reasons. First, the employer-level UI data also include the NAICS codes which may be missing from WC data. Second, using the employer-level UI data linked to the WC data assures that the WC claims numerator matches the UI employee count denominator. The UI data also allow the employer-level distribution of WC claim rates within each industry sector to be depicted. This is important to detect data anomalies at an employer-level and improve industry-level accuracy.

The employer-level WC claim rates are also key for the prevention activities of OHBWC because they enable percentile-based benchmarking data (e.g., a given employer could use these data to know exactly where they rank performance-wise, comparing their WC claims by causation to that of their industry-specific peer group). The employer-level UI data also have some drawbacks because they are not publically available and require intra-state agreements to share these data between the various state agencies that maintain these data sources. The large, complex UI datasets are also challenging to link to WC data, especially for large multiple-location public and private employers.

For single-location OHBWC-insured employers, the employer's unique federal employer identification number (FEIN) was used to link the UI employee count and NAICS industry data to the OHBWC dataset at the employer's policy level. There was one FEIN per policy per year and all but approximately 10% of employer policies could not be linked using the FEIN. An attempt was made to link the data using employer name and address, but it was not successful due to differences in naming conventions between the two systems and the unlinked data were excluded from further analyses.

Methods for linkage of WC and UI data differed for multiple-location employers because the WC claims data could only be linked at the employer/policy level, and not at the level of the particular locations within an employer/policy. However, UI data are available at the location-level and different locations for an employer can report different NAICS codes and numbers of employees. Therefore, a rule-set was developed to select a single NAICS code to represent the overall employer/policy, as follows:

> Rule 1: Determine the 6-digit NAICS code associated with at least 75% of the employees for a given employer across locations; if that fails then, rule 2: determine the 3-digit NAICS code associated with at least 75% of the employees across locations; if that fails then, rule 3: determine the NAICS code associated with the most employees for a given employer; if that fails then rule 4: do not select a NAICS code for this employer.

The majority (84.6% of policies representing 84.7% of claims) of the OHBWC-insured, private industry multiple-location data were classified at the 6-digit level using rule 1 above, 4.0% of policies (4.8% of claims) were classified at the 3-digit level using rule 2, 11.3% policies (10.6% of claims) were classified using rule 3, and 0.1% of policies and 0.0% of claims were classified using rule 4. Only multiple-location data that were classified using rules 1 and 2 were analyzed further by industry because 6-digit level NAICS data were needed to determine the NIOSH industry classifications described below.

The UI NAICS data were annualized using the following procedures. For NAICS industry, the same code was usually reported (>99%) for a given employer across the quarters within a given calendar year. For instances where this did not occur, the most frequently reported NAICS code across the quarters was selected as the NAICS code to represent the employer for the year. If there was a tie, the NAICS of the final quarter was selected. For a small proportion of employers (less than 0.5%), the NAICS could not be determined. For employee count, values were typically reported (>99%) for each quarter of a given calendar year. In few instances, employee counts were not reported for every quarter. There are three conditions under which this may have occurred. One condition is that the employer had employees on payroll during the quarter in question, but simply failed to report employee counts to the Ohio UI agency. A second condition is that the employer experienced seasonal fluctuation in business, and did not have employees on payroll during the quarter in question but still had a policy in effect with OHBWC. A third condition is that the employer began or ceased business operations within a given calendar year. There was no consistent way to determine the exact reason why employee counts for a given employer were missing. Accordingly, the WC claim rates were computed only for the quarters in which employee counts were available as described below and expressed as an annual rate (claims per full-year, FTE employee) to be consistent with the rate computations for other employers.

Raw Frequency Counts and Rate Computations Per Employee

The next step in developing WC claim rates was to develop rates of claims for each individual employer. In the case of OHBWC data, raw rates (number of claims per employee) were computed at an individual employer policy/year level before WC claim rates were computed at the industry level. The method used differed depending on whether there were available employee counts for each quarter. For multiple-location employers, the numbers of employees were first summed across locations for each quarter. For a given single- or multiple-location employer policy/year, if there were employee counts available for all four quarters, then the following steps were used: A: sum the number of claims in all quarters; B: compute the average employee count over the entire year by summing the employee counts in all quarters and dividing by four; C: divide A by B to compute the raw rate. For a given policy/year, if any employee count was missing from any of the four quarters, then the following steps were used: A: sum the claims for injuries occurring only in quarters where employee counts are available; B: compute the number of full-year-equivalent employees in the quarters for which

employee counts are available, by summing the employee counts in those quarters and dividing by four; C: divide A by B to compute the raw rate. Using this process, a count of 1 employee for 1 quarter equals a quarter of a full-year employee.

Exclusion of Outlier Policy/Years With Extreme Claim Rates

As indicated above, one of the advantages of employer-level UI-WC linkage is that it can be used to address data anomalies and improve industry-level accuracy. In the case of OHBWC data, some policy-years had implausibly high WC claim rates, presumably due to data errors. We assumed that such errors would likely be due to incorrectly low employee counts, since the number of claims for a policy would be less likely to be inaccurate. We therefore needed to determine a threshold rate for classification as an outlier and exclusion from industry rate computation. We examined the distribution of WC claim rates by 2-digit NAICS code and six employer size classes. The vast majority (>99%) of employer-level claim rates were below one claim per employee. However, some employer-years had much higher WC claim rates, mostly those of small employers. The longitudinal data for all employers with at least one outlier year with over two claims per employee were then examined. Many employers in this group exhibited consistent patterns of relatively high rates with one or more extremely high rates. Some of the highest rate employers with the highest rate policy-years were observed to be in particularly high-risk industry groups (e.g., 7112, Spectator Sports). It was determined that, in such cases, the extremely high WC claim rates could be explained by a combination of turnover and individual workers with multiple reported claims within the same calendar year. For the purpose of computing aggregate industry rates, the decision was made to include all claims per unique injured worker (including multiple claims for the same individual in the same year) and all employer-level WC claim rates except the most extreme.

The threshold for classification as an outlier was set higher for smaller employers, since claim rate variations would naturally yield more policy-years with extreme WC claim rates. Thresholds were chosen so that roughly similar percentages of policy-years were classed as outliers, allowing for the likelihood that employee count errors may be greater among very small employers. If an individual policy/year met one of the following criteria, the policy/year was considered to be an outlier due to data error, and it was excluded from all rate computations, but retained for frequency counts:

- Employee count $<= 1$ and claims per employee >8
- $1<$ Employee count $<= 5$ and claims per employee >6

- 5< Employee count < = 50 and claims per employee >4
- Employee count >50 and claims per employee >2

These criteria resulted in exclusion of less than 0.01% of policy-years and 0.41% of claims from 2001 to 2011. A sensitivity analysis was conducted to determine the effect of applying these criteria for exclusion. The effect on the rate ranks was 2% or less for 80% of the computed WC claim rates for NAICS at the 4-digit level. However, a small percentage of rate ranks (3.6%) did change by 10% or more.

Adjustment of Employee Counts to Estimate Full-time Equivalents

Since the UI denominator data consisted only of employee counts (including both part- and full-time employees), data from the national BLS Labor, Productivity, and Costs (LPC) programs were used to adjust UI data and estimate FTE by detailed industry [BLS, 2015a]. WC rates were computed per FTE rather than per employee to provide a better comparison of injury rates across industries that differ in number of work hours per employee. WC FTE rate data could then also be compared to national data also reported on a FTE basis, including BLS data on injuries and illnesses and other economic data.

Total FTEs in each industry group in the Ohio data were estimated by multiplying UI employee counts (on an employer-level) by an FTE/employee ratio (on an industry-level). LPC data include estimates of actual total work hours by industry (4-digit NAICS) which exclude paid hours for time off for vacation, holidays and sick leave. A FTE was defined as 2,000 hr per year. LPC data also include employee counts by industry, so that industry FTE/employee ratios could be computed. We used a revised version of LPC data available in the public data set in order to exclude workers generally not covered by private- and state- fund insurers: federal workers, unpaid workers, and the self-employed.

FTE/employee ratios can be computed using several alternative data sources, such as the Current Population Survey (CPS, a household survey), the Current Employment Statistics survey (CES, an employer establishment survey), the American Community Survey (ACS, which replaced the US Census long form), as well as data from BLS's Labor, Productivity, and Costs (LPC) programs, which is based on CPS and CES data. We chose to use BLS LPC data, because it uses NAICS industry coding (vs. Census industry codes) and is available on a detailed industry level (4-digit NAICS) and for individual years. The main limitation of this choice is that it is not state-specific, which would be important if an industry's employment and scheduling practices differ substantially across states. Before choosing to rely upon LPC data, we computed FTE claim rates using each of the data sources above and observed that overall Total claim rate

rankings of 4-digit NAICS industries differed only slightly. However, 5% of industries did differ as much as 10% or more in rankings across the four sets of results. Several other researchers are currently preparing detailed methods development papers comparing the relative strengths and weaknesses of alternative denominators for state-based WC rate analyses.

Pooling of Single- and Multiple-Location Data

A final step in developing injury WC claim rates was to determine whether to pool single- and multiple-location data. In the case of OHBWC-insured private employers, the majority of claims and FTEs were associated with single-location employers. One drawback to pooling was that private-employer single-location and multiple-location data were processed differently to determine NAICS and numbers of employees. The main method for determining NAICS was less reliable for multiple-location versus single-location employers, since there is no way to link a WC claim in the OHBWC data back to a specific employer location in UI data. Analyses by establishment size are also complicated with multiple-location data since the method essentially treats a multiple-location employer with several smaller establishments as an employer with one large establishment. On the other hand, the NIOSH National Occupational Research Agenda (NORA) industry sectors differed by the percentage of claims in single- versus multiple-location employers and therefore pooling provides more consistent estimation of risks associated with sectors and industries than does single-location data alone. For example, less than 60% of the claims (and less than 70% of FTEs and policies) for NAICS 45 (Retail Trade), 51 (Information), and 52 (Finance and Insurance) were in single-location employers. Also, when we pooled single- and multiple-location data, at the 2-digit NAICS level pooled Total claim rates were 10% or more higher than single-location rates in several codes (44 [Retail Trade, 12% higher increase]; 45 [Retail Trade, 29% higher increase]; 51 [Information, 19% higher increase]; 52 [Finance and Insurance, 18% higher increase]; 53 [Real Estate and Rental and Leasing, 11% higher increase]; 72 [Accommodation and Food Services, 14% higher increase]). In the end, it was decided to pool to increase the generalizability of results for all OHBWC-insured private employer clients.

Industry Comparison Methods

There are many potential approaches for identifying industries at higher risk for injury using WC claims data.

Main considerations are to weigh overall WC claim injury frequency (number of injuries), injury rate (number of injuries per unit exposure), and injury severity (medical-only vs. lost-time, days lost, cost, disability type, etc.). WC claim rates and costs of medical-only (MO) and lost-time (LT) claims (with 8 or more days away from work) by estimated FTE were first computed and compared by NIOSH NORA industry sector, detailed industry group (4-digit NAICS), year, and employer size group. We then chose to use one of the most basic methods for industry comparison by giving injury frequency and rate equal weighting. This method has been popularized in the WA-L&I prevention index (PI), which represents the average of the rank orders of the WC claim count and WC claim rate [Silverstein et al., 2002; Anderson et al., 2013, 2014].

In order to ensure the stability of industry rate estimates and comparisons, we included only those industries with a certain minimum number of FTEs and claims in the industry rate computations. We based our restrictions on those employed in the most recent Washington State studies [Anderson et al., 2013, 2014]: "NAICS industry groups were limited to those who had reported hours in 6 or more years of the study period, with ≥45 compensable WC claims over the period of the study and ≥100 FTE per year during the study period, from 2002 to 2010." For the current analysis, these criteria (based on a 9-year time frame) were adjusted proportionally to the time frames used. For example, for the 2001–2011 PI, included industry groups had to report employees in 7 or more years of the study period, with ≥55 WC claims from 2001 to 2011 and ≥100 FTE per year during the study period.

Industry sectors were defined by NIOSH NORA classifications. NAICS codes for each NORA sector are as follows: AFF = Agriculture, Forestry, Fishing/Hunting = 11; CON = Construction = 23; HSA = Health Care and Social Assistance = 62, 54194, 81291; MNF = Manufacturing = 31, 32, 33; MIN = Mining = 21; OIL = Oil & Gas = 211, 213111, & 213112; PSA = Public Safety = 92212, 92214, 92216, 62191; SRV = Services (except Public Safety) = 51–56, 61, 71, 72, 81, 92; TWU = Transportation, Warehousing, Utilities = 22, 48, 49; WRT = Whole ale Trade/Retail Trade = 42, 44, 45. It should be noted that for private industry, PSA only includes 62191, Ambulance Services.

Statistical Analyses

Poisson regression models with repeated measures were used to evaluate differences in WC claim rates over time with 95% Confidence Intervals (CI). It was decided post hoc to calculate trends for two time periods separately due to the substantial change in trends

before/after 2008. As a sensitivity analysis, data from other survey sources (CPS, ACS, and CES) were also used to adjust UI data and estimate FTE and just minor differences between rate estimations were noted. All analyses were conducted using SAS version 9.3 (SAS Institute, Inc., Cary, NC).

This study was approved by the NIOSH Institutional Review Board. The requirement for informed consent was waived because the study involved the analysis of coded and previously collected WC data.

RESULTS

Claim Counts

Results are reported for OHBWC-insured private employers (pooled single- and multiple-location) and all allowed claims, including zero-cost claims from 2001 to 2011. The number of zero-cost Total claims ranged from 4.7% in 2001 to 6.2% in 2011. Table II provides policy and employee counts (LPC adjusted FTE) and claim counts across NIOSH industry sectors for calendar years 2001–2011. During this period, both the number of policies (−3.7%) and FTEs (−11.2%) for OHBWC-insured private employers declined. The vast majority (87.0%) of FTEs were in the four sectors (Services [39.5%], Manufacturing [17.2%], Wholesale/Retail Trade [17.0%], and Healthcare/Social Assistance [13.2%]). These same sectors also had the greatest number of Total (MO and LT) claims (Services [27.2%], Manufacturing [25.9%], Wholesale/Retail Trade [14.8%], and Healthcare/Social Assistance [12.2%]).This is important to keep in mind because any ranking by the number of WC claims is driven in part by sheer industry size. However, this table identifies sectors that have a disproportionate share of claims compared to the sector size. For example, Manufacturing had the greatest disparity with 17.2% of the FTE, but 25.9% of the claims, followed by Construction with 8.3% of the FTE, but 11.2% of the claims.

Table III depicts the yearly claim counts across NIOSH industry sectors. All sectors except Ambulance Services and Oil & Gas exhibited substantial Total and LT claim count reductions from 2001 to 2008. Across all sectors from 2001 to 2008, there was an average −5.7% change per year (95% CI: −5.8%, −5.6%) in total claim count and an average −7.5% change per year (95% CI: −7.7%, −7.3%) in LT claim count. From 2001 to 2008, Construction had the greatest decline in Total claim count (−9.8% per year [95% CI: −10.0%, −9.6%]) and LT count (−9.6% per year [95% CI: −10.1%, −9.2%]).This was followed by a levelling or slight increase in Total and LT counts from 2009 to 2011 for most sectors. Across all sectors from 2009 to 2011, there was an average −0.5%

TABLE II. Policy, Full-Time Equivalent, and Claim Count* Summaries Across NIOSH Industry Sectors, for OHBWC-Insured Private Employers, Calendar Years 2001–2011

NIOSH sector[a]	Total policies		Unique policies		Full-time equivalent (FTE) estimated count		Medical -only claims count		Lost -time claims count		Total claims (medical -only and lost -time) claims count	
	n	%	n	%	n	%	n	%	n	%	n	%
AFF	10,838	0.56	1,801	0.55	144,024	0.57	5,972	0.60	1,130	0.49	7,102	0.58
CON	238,399	12.34	40,126	12.18	2,001,214	7.88	108,439	10.88	29,173	12.73	137,612	11.23
HSA	201,854	10.45	29,329	8.90	3,205,552	12.62	122,115	12.26	27,182	11.87	149,297	12.18
MIN	2,186	0.11	375	0.11	52,456	0.21	2,988	0.30	859	0.37	3,847	0.31
MNF	148,707	7.70	22,315	6.77	4,184,365	16.47	263,620	26.46	53,835	23.50	317,455	25.91
OIL	3,736	0.19	586	0.18	31,666	0.12	1,301	0.13	495	0.22	1,796	0.15
PSA	1,158	0.06	213	0.06	52,358	0.21	4,734	0.48	1,095	0.48	5,829	0.48
SRV	885,946	45.88	155,248	47.12	9,594,688	37.77	274,621	27.56	58,701	25.62	333,322	27.20
TWU	57,044	2.95	10,759	3.27	862,664	3.40	34,384	3.45	15,503	6.77	49,887	4.07
WRT	371,480	19.24	64,128	19.46	4,135,318	16.28	147,806	14.83	33,766	14.74	181,572	14.82
ALL Sectors	1,921,348	99.49	324,880	98.60	24,264,305	95.53	965,980	96.95	221,739	96.79	1,187,719	96.92
Other[b]	9,814	0.51	4,620	1.40	1,135,702	4.47	30,381	3.05	7,344	3.21	37,725	3.08
TOTAL	1,931,162	100.00	329,500	100.00	25,400,007	100.00	996,361	100.00	229,083	100.00	1,225,444	100.00

*Counts include all allowed claims- for a small proportion of claims, a reliable employee count could not be determined for the corresponding policy. For this reason, simply dividing the count by the FTE will not produce accurate rates. Lost-time claims in Ohio have 8 or more days away from work.

[a]AFF = Agriculture, Forestry, Fishing / Hunting = 11; CON = Construction = 23; HSA = Health Care and Social Assistance = 62, 54194, 81291; MNF = Manufacturing = 31, 32, 33; MIN = Mining = 21; OIL = Oil & Gas = 211, 213111, & 213112; PSA = Public Safety; for private industry, this only includes 62191, Ambulance Services; SRV = Services (except Public Safety) = 51–56, 61, 71, 72, 81, 92; TWU = Transportation, Warehousing, Utilities = 22, 48, 49; WRT = Wholesale Trade / Retail Trade = 42, 44, 45.

[b]For a small proportion of claims, the NAICS code could not be determined for the corresponding policy (4077 policies, 0.3%; 34 claims, <0.1%), or in the case of multiple-location policies, a reliable 6-digit NAICS code could not be assigned (5044 policies, 0.3%; 37,691 claims, 3.1%).

change per year (95% CI: −1.0%, 0.1%) for Total claim count and an average 3.9% increase per year (95% CI: 2.6%, 5.2%) for LT claim count.

Claim Rates

Table IV provides the yearly adjusted Total and LT WC claim rates across NIOSH industry sectors. All sectors exhibited substantial Total and LT claim rate reductions from 2001 to 2008, followed by leveling or slight rate increases for most sectors from 2009 to 2011. Across all sectors from 2001 to 2008, there was an average −6.6% change per year (95% CI: −6.7%, −6.5%) in Total claim rate and an average −7.4% change per year (95% CI: −7.6%, −7.3) in LT claim rate. From 2001 to 2008, Construction had the greatest decline in Total claim rate (−9.8% per year [95% CI: −10.1%, −9.6%]) and LT WC claim rates (−9.6% per year [95% CI: −10.1%, −9.1%]). Across all sectors from 2009 to 2011, there was an average −0.9% change per year (95% CI: −1.4%, −0.4%) for Total claim rate and an average

3.4% increase per year (95% CI: 2.0%, 4.7%) for LT claim rate. Online Supplemental Tables SIa,b depicts Total and LT claim counts and rates by NIOSH industry sector.

Employer Size Comparisons

The Total claim counts and rates for all employer size categories declined substantially from 2001 to 2008, then leveled or slightly increased 2009–2011. The greatest Total number of claims for each year were for employers with >10 to <50 FTEs, which overall represented 29.5% of the claims from 2001 to 2011. This was followed by employers with > = 100 to <250 FTE (23.3%) and employers with > = 50 to <100 FTEs (18.4%) from 2001 to 2011. The highest rate of Total claims for each year were for employers with > = 100 to <250 FTEs with an average total rate of 6.2 per 100 FTE from 2001 to 2011. This was followed by employers with > = 50 to <100 FTEs, with an average Total rate of 6.0 per 100 FTE from 2001 to 2011. Trends by employer-size were similar for single-location employers. Online Supplemental Table

TABLE III. Claim Counts* Across NIOSH Industry Sectors, for OHBWC-Insured Private Employers, Calendar Years 2001–2011

NIOSH sector[a]	2001 MO + LT	2001 LT	2002 MO + LT	2002 LT	2003 MO + LT	2003 LT	2004 MO + LT	2004 LT	2005 MO + LT	2005 LT	2006 MO + LT	2006 LT	2007 MO + LT	2007 LT	2008 MO + LT	2008 LT	2009 MO + LT	2009 LT	2010 MO + LT	2010 LT	2011 MO + LT	2011 LT
AFF	942	140	916	141	855	148	789	128	706	108	590	80	534	88	532	88	395	54	422	87	421	68
CON	20,512	4,184	19,126	4,100	16,877	3,620	15,392	3,300	14,272	2,904	12,663	2,622	11,171	2,311	8,983	1,993	6,563	1,356	6,103	1,402	5,950	1,381
HSA	14,794	2,935	15,262	3,141	15,392	3,176	14,831	2,951	14,174	2,580	13,912	2,355	13,778	2,319	12,955	2,109	11,857	1,811	11,602	1,994	10,740	1,811
MIN	514	130	401	86	394	87	325	75	350	77	310	71	330	80	324	81	337	59	279	59	283	54
MNF	44,867	7,711	39,291	7,117	34,591	6,398	34,451	6,293	32,868	5,500	30,758	4,853	28,217	4,369	23,578	3,705	15,355	2,294	16,402	2,769	17,077	2,826
OIL	199	47	146	37	152	40	170	55	189	61	178	45	204	65	191	50	139	34	103	29	125	32
PSA	438	90	517	109	571	116	582	104	567	104	565	92	603	108	571	106	561	90	456	92	398	84
SRV	40,812	7,258	39,080	6,924	36,740	6,780	35,210	6,444	33,164	5,731	31,024	5,160	28,978	5,113	26,337	4,557	20,527	3,367	21,250	3,834	20,200	3,533
TWU	5,257	1,585	5,739	1,801	5,308	1,659	4,863	1,547	4,910	1,527	4,718	1,409	4,730	1,469	4,343	1,280	3,205	982	3,439	1,139	3,375	1,105
WRT	24,462	4,497	23,200	4,401	21,504	4,275	19,401	3,872	17,945	3,352	15,936	2,747	14,978	2,641	13,257	2,409	10,399	1,729	10,362	2,020	10,128	1,823
ALL Sectors	152,797	28,577	143,678	27,857	132,384	26,299	126,014	24,769	119,145	21,944	110,654	19,434	103,523	18,563	91,071	16,378	69,338	11,776	70,418	13,425	68,697	12,717
Other[b]	3,058	655	3,971	797	3,602	788	3,637	764	3,880	745	3,493	640	3,553	655	3,499	670	3,014	518	3,039	554	2,979	558
TOTAL	308,652	57,809	291,327	56,511	268,370	53,386	255,665	50,302	242,170	44,633	224,801	39508	210,599	37781	185,641	33426	141,690	24070	143,875	27404	140,373	25,992

*Counts include all allowed claims – for a small proportion of claims, a reliable employee count could not be determined for the corresponding policy. For this reason, simply dividing the count by the FTE will not produce accurate rates. Lost-time claims in Ohio have 8 or more days away from work; MO + LT = medical-only and lost-time claims; LT = lost-time claims only.

[a] AFF = Agriculture, Forestry, Fishing / Hunting = 11; CON = Construction = 23; HSA = Health Care and Social Assistance = 62, 54194, 81291; MNF = Manufacturing = 31, 32, 33; MIN = Mining = 21; OIL = Oil & Gas = 211, 213111, & 213112; PSA = Public Safety; for private industry, this only includes 62191, Ambulance Services; SRV = Services (except Public Safety) = 51–56, 61, 71, 72, 81, 92; TWU = Transportation, Warehousing, Utilities = 22, 48, 49; WRT = Wholesale Trade / Retail Trade = 42, 44, 45.

[b] For a small proportion of claims, the NAICS code could not be determined for the corresponding policy (4077 policies, 0.3%; 34 claims, <0.1%), or in the case of multiple-location policies, a reliable 6-digit NAICS code could not be assigned (5044 policies, 0.3%; 37,691 claims, 3.1%).

TABLE IV. Claim Rates* Per 100 Estimated Full-Time Equivalents Across NIOSH Industry Sectors, for OHBWC-Insured Private Employers, Calendar Years 2001–2011

NIOSH sector[a]	2001		2002		2003		2004		2005		2006		2007		2008		2009		2010		2011	
	MO+LT	LT	MO+LT	LT	MO+LT	LT	MO+LT	LT	MO+LT	LT	MO+LT	LT	MO+LT	LT	MO+LT	LT	MO+LT	LT	MO+LT	LT	MO+LT	LT
AFF	6.86	1.00	6.56	1.01	6.09	1.05	5.97	0.97	5.51	0.84	4.57	0.61	4.03	0.67	4.03	0.66	3.21	0.44	3.36	0.69	3.35	0.54
CON	10.25	2.09	9.70	2.08	8.63	1.85	7.75	1.66	7.15	1.45	6.25	1.29	5.71	1.18	4.93	1.09	4.31	0.89	4.23	0.98	4.05	0.94
HSA	5.55	1.10	5.50	1.13	5.35	1.11	5.08	1.01	4.76	0.87	4.57	0.78	4.50	0.76	4.27	0.70	3.99	0.61	3.93	0.68	3.60	0.61
MIN	8.76	2.22	8.69	1.86	8.89	1.96	7.79	1.80	7.76	1.71	6.39	1.46	6.85	1.66	6.77	1.69	6.99	1.22	6.00	1.27	5.74	1.10
MNF	10.51	1.82	9.74	1.76	8.68	1.61	8.52	1.55	8.16	1.35	7.51	1.18	6.98	1.08	6.06	0.95	4.86	0.72	5.08	0.86	5.13	0.85
OIL	7.80	1.85	6.33	1.60	6.68	1.76	6.81	2.20	6.88	2.22	5.68	1.45	5.89	1.88	5.11	1.34	4.35	1.07	3.61	1.02	4.21	1.09
PSA	11.39	2.35	12.99	2.74	13.17	2.68	12.76	2.28	11.08	2.03	11.11	1.81	11.91	2.13	10.76	2.00	10.19	1.63	9.39	1.89	8.47	1.79
SRV	4.57	0.81	4.44	0.79	4.17	0.77	3.95	0.72	3.69	0.64	3.40	0.56	3.21	0.57	2.95	0.51	2.44	0.40	2.56	0.46	2.39	0.42
TWU	6.91	2.08	7.49	2.34	6.79	2.13	6.04	1.92	6.12	1.90	5.63	1.67	5.53	1.71	5.13	1.51	4.23	1.30	4.63	1.53	4.57	1.48
WRT	5.77	1.06	5.61	1.07	5.32	1.06	4.82	0.96	4.60	0.86	4.10	0.71	3.97	0.70	3.60	0.65	3.10	0.52	3.15	0.62	3.05	0.55
All sectors	6.60	1.23	6.32	1.23	5.83	1.16	5.49	1.08	5.19	0.95	4.75	0.83	4.50	0.81	4.06	0.73	3.40	0.58	3.49	0.66	3.34	0.62

*Rates were computed for the majority (>99%) of allowed claims with reliable employee counts for the corresponding policy-year. The denominator is 100 estimated full-time equivalents.

[a]AFF = Agriculture, Forestry, Fishing / Hunting = 11; CON = Construction = 23; HSA = Health Care and Social Assistance = 62, 54194, 81291; MNF = Manufacturing = 31,32,33; MIN = Mining = 21; OIL = Oil & Gas = 211, 213111, & 213112; PSA = Public Safety; for private industry, this only includes 62191, Ambulance Services; SRV = Services (except Public Safety) = 51–56, 61, 71, 72, 81, 92; TWU = Transportation, Warehousing, Utilities = 22, 48, 49; WRT = Wholesale Trade / Retail Trade = 42, 44, 45. Lost-time claims in Ohio have 8 or more days away from work; MO + LT = medical-only and lost-time claims; LT = lost-time claims only.

SIIa,b depicts Total and LT claim counts and rates by employer size.

Industry Comparisons

For each NIOSH industry sector, Table V provides a summary of key industry groups that are generally in the top 50 PI rankings for LT or Total claims. The Agriculture, Fishing, and Forestry and Mining sectors were under-represented in this population such that they did not appear in top 50 PI rankings due to the relatively smaller number of workers and claims compared to other sectors. Online Supplemental Tables SIII and SIV present the prevention index rankings for LT claims only and Total claims respectively by detailed industries (4-digit NAICS Level) from 2001 to 2011.

DISCUSSION

Claim Counts and Rates

Overall data trends among OHBWC-insured private employers mirrored national trends for declining WC claim counts and rates. WC claim rates were highest among employers with >100 to <250 employees but rates declined across all employer size categories. BLS SOII estimates have also reported the highest rates of OII for employers with >50 to <250 employees [BLS, 2015b]. Most sectors exhibited substantial Total claim and LT claim count and rate reductions from 2001 to 2008. This was followed by a leveling or slight increase in Total and LT claim counts and rates from 2009 to 2011 for most sectors. Similar trends were also observed at specific industry group levels (4-digit NAICS codes).

Similar overall declining OII trends have been found by NCCI, WA-L&I, and BLS SOII. For example, a study by NCCI [NCCI, 2010] found 4% average annual declines in the rates of lost-time claims, for a total decline of 57% from 1990 through 2009 while Washington State reported declines of 5.9% per year for all claims [Silverstein, 2007] from 1997 to 2005. BLS SOII estimates have reported a slightly less steep overall decline with a 40% reduction in private industry total recordable rates (5.7–3.4 cases per 100 FTE) from 2001 to 2011 [BLS, 2002, 2015b]. Reasons are unclear for the general decline in the rate and number of WC claims and OSHA recordables, but researchers have suggested several factors including improvements in technology [NCCI, 2010], under-reporting [Morse et al., 2005], and other economic factors [NCCI, 2012]. The increase in claim rates nationally in 2010 has been linked to the recovery from recession [NCCI, 2012] and general increased employment [Moore and Tompa, 2011]. The decrease in rates in 2011 nationally has been linked to leveling employment [NCCI,

2012]. There were no substantial administrative changes to the OHBWC claim filing procedures, eligibility determination and/or benefits structure over the study period that may have impacted claim trends. The observed trends during the study period are also consistent with those observed in SOII data and NCCI data.

Although WC claim numbers and rates decreased, the relative ranking of sectors among OHBWC-insured private employers remained stable from 2001 to 2011. For example, the PIs for Total claims were highest for Manufacturing, Construction, and Ambulance Services in 2001–2005, 2006–2011, and 2001–2011. This indicates that the relative industry representation within this population and the relative probability of workplace injury across these industries had not changed dramatically despite the overall WC rate and count declines. Additional prevention attention needs to be applied to further reduce injuries/illnesses in traditionally high-risk industries.

Industry Comparisons

Although not directly comparable, general industry trends among OHBWC-insured private employers were also similar to national and WA-L&I published data. Direct comparisons to WA-L&I published data are not possible since their published multi-sector prevention indices [Anderson et al., 2013] are based on LT claims only which are defined differently in WA (4 or more days away from work) compared to OHBWC (8 or more days away from work). Another main difference is that WA-L&I data include public employers, whereas the primary OHBWC data analysis only includes OHBWC-insured private employers. Despite these fundamental differences, general PI ranks of industries still were fairly similar with the main exceptions that Construction was ranked highest overall in WA-L&I, while Manufacturing was ranked highest in OHBWC. However, there appeared to be a number of notable industry differences when data were compared at a more detailed industry level. For example, Logging (NAICS 1133) and Sawmills and Wood Preservation (NAICS 8111) were much higher ranked in WA-L&I versus OHBWC. These PI differences illustrate the importance of each state developing WC benchmarking data that can be used to address the unique injury prevention challenges within the state.

There are several main differences between OHBWC and BLS SOII rates that preclude direct comparisons. First, BLS cases are based on a national survey of OII cases that meet OSHA recordability criteria among all sizes of employers, whereas OHBWC data represent WC claims from a population of small (mostly those with 1–499 employees), OHBWC-insured employers. Second, the definition of LT cases/claims also differ, with BLS being

1 or more day away from work compared to an OHBWC definition of LT as 8 or more days away from work. Third, the numerator used in BLS rates is the count of OII that occurred to people working for that employer, usually including those affecting temporary employees. According to OSHA rules (29 CFR 1904.31(b)(4) [OSHA, 2016]), the OII should be recorded on only one employer's injury and illness log and in most cases, the host employer is the one responsible for recording the OII of temporary workers. For OHBWC, OII for temporary employees are listed under the temporary agency employer, not the employer where that person was working at the time. Fourth, another difference between BLS SOII and OHBWC data is that the denominator used in the BLS rates is the number of FTEs based on 2,000 actual work hours per FTE, derived from reports by individual employers rather than estimates based on number of employees multiplied by national, industry-level FTE/employee ratios. Finally, the BLS SOII also had several changes in reporting and data breaks in the period 2001–2011 that preclude direct comparisons to data from WC or other sources.

Despite these differences, similar rankings of industries by OHBWC-insured private employer claims and BLS SOII data at the large industry sector level were noted. The BLS SOII was not collected in Ohio until 2012, such that there are no Ohio-specific comparisons available for 2001–2011. When the OHBWC and national BLS SOII data were examined at a finer industry level (3- to 4-digit NAICS) additional differences emerge. For example, Employment Services (NAICS 5613) are ranked higher in OHBWC data compared to national data. Rate differences are likely due both to systematic differences in the data collection systems noted above and to the industry mix represented in OHBWC-insured private employers versus nationally. As discussed, counts for Employment Services (NAICS 5613) will be systematically higher in WC data compared to BLS SOII because of the reporting requirement. This makes WC claims data a unique source to track OII in this industry. Claim narratives can also be used to understand the temporary work environment and to develop improved prevention strategies. This illustrates the need for states to utilize additional data sources such as WC to complement BLS SOII data and develop relevant injury prevention strategies.

Although the above issues limit the use of these data for statewide or national level comparisons, the OHBWC-insured private employer WC data were perhaps most useful for identifying specific industries for injury prevention focus within NIOSH sectors in this population. For example, providing a comparison of WC claim count and rates ranks among detailed industries (Tables V and SIII, IV) enables OHBWC and OHBWC-insured private employers to prioritize injury prevention efforts. Within each sector, there are specific industries that have had relatively high rates year

TABLE V. Prevention Index Rankings Across NIOSH Industry Sectors, for OHBWC-Insured Private Employers, Calendar Years 2001–2011

2012 NAICS code name	2012 NAICS industry code	Lost-time claims only (8 or more days away from work)						Total claims (medical-only and lost-time)					
		Claims rate[a] per 100 FTE	Rate rank	Claims count	Count %[b]	Count rank	Rank of prevention index[c]	Claims rate[a] per 100 FTE	Rate rank	Claims count	Count %[b]	Count rank	Ranked prevention index[c]
Manufacturing													
Foundries	3315	2.66	4	2664	1.2	18	2	15.91	1	15414	1.3	13	1
Motor vehicle parts manufacturing	3363	1.73	29	5524	2.5	8	6	9.16	20	29183	2.5	5	4
Forging and stamping	3321	2.13	17	2058	0.9	26	7	11.23	8	10847	0.9	26	6
Rubber product manufacturing	3262	1.83	24	2001	0.9	29	9	9.10	22	9920	0.8	29	10
Plastics product manufacturing	3261	1.46	57	4212	1.9	9	14	9.05	23	25958	2.2	6	5
Cement and concrete product manufacturing	3273	1.84	23	1296	0.6	44	16	8.61	29	6050	0.5	52	22
Steel product manufacturing from purchased steel	3312	2.29	10	810	0.4	65	19	10.74	9	3795	0.3	72	22
Coating, engraving, heat treating, and allied activities	3328	1.56	49	1907	0.9	30	21	9.03	24	11063	0.9	24	8
Architectural and structural metals manufacturing	3323	1.46	56	2032	0.9	28	26	10.72	10	14939	1.3	14	3
Healthcare social assistance													
Nursing care facilities (skilled nursing facilities)	6231	1.79	26	10234	4.6	3	4	9.29	17	53130	4.5	2	2
Continuing care retirement communities and assisted living facilities for the elderly	6233	1.61	40	2293	1.0	21	12	7.83	43	11146	0.9	23	13
Residential intellectual and developmental disability, mental health, and substance abuse facilities	6232	1.41	65	2321	1.0	20	28	8.41	32	13836	1.2	18	9
Home health care services	6216	1.16	96	2932	1.3	13	43	4.08	161	10339	0.9	28	83
Vocational rehabilitation services	6243	1.52	52	837	0.4	64	44	8.41	33	4622	0.4	61	27
Construction													
Foundation, structure, and building exterior contractors	2381	2.06	21	5809	2.6	6	3	8.56	31	24131	2.0	8	7
Building finishing contractors	2383	1.50	53	3402	1.5	10	13	6.53	80	14770	1.2	16	29
Other specialty trade contractors	2389	1.44	59	2955	1.3	12	18	5.44	119	11058	0.9	25	54
Building equipment contractors	2382	1.25	79	7979	3.6	4	24	7.23	62	46277	3.9	4	13
Utility system construction	2371	1.52	51	1742	0.8	33	26	6.81	69	7796	0.7	43	39
Residential building construction	2361	1.35	70	2875	1.3	15	28	5.85	106	12417	1.0	22	47
Nonresidential building construction	2362	1.26	77	2961	1.3	11	31	6.32	87	14883	1.3	15	32
Highway, street, and bridge construction	2373	1.61	41	1134	0.5	51	33	7.04	66	4949	0.4	58	44
Services													
Waste collection	5621	3.21	1	1142	0.5	50	8	13.79	2	4912	0.4	59	11
Employment services	5613	1.44	58	10471	4.7	2	11	7.01	68	50944	4.3	3	19
Services to buildings and dwellings	5617	1.36	68	5654	2.5	7	19	6.25	92	25919	2.2	7	31

(*Continued*)

TABLE V. (*Continued*)

2012 NAICS code name	2012 NAICS industry code	Lost -time claims only (8 or more days away from work)						Total claims (medical-only and lost-time)					
		Claims rate[a] per 100 FTE	Rate rank	Claims count	Count %[b]	Count rank	Rank of prevention index[c]	Claims rate[a] per 100 FTE	Rate rank	Claims count	Count %[b]	Count rank	Ranked prevention index[c]
Remediation and other waste management services	5629	1.77	28	749	0.3	73	38	7.75	46	3278	0.3	83	48
Spectator sports	7112	2.27	11	477	0.2	105	44	9.26	19	1976	0.2	132	59
Lessors of real estate	5311	1.17	93	1718	0.8	35	47	5.33	125	7840	0.7	42	68
Automotive repair and maintenance	8111	0.99	122	2786	1.3	16	53	6.16	94	17298	1.5	12	37
Transportation and warehousing													
General freight trucking	4841	2.14	15	6692	3.0	5	1	5.82	107	18179	1.5	11	43
Specialized freight trucking	4842	2.22	12	2775	1.3	17	4	6.80	70	8511	0.7	35	36
Warehousing and storage	4931	1.72	31	1527	0.7	38	17	7.93	41	7013	0.6	48	24
School and employee bus transportation	4854	2.88	2	521	0.2	95	34	9.27	18	1676	0.1	145	65
Scheduled air transportation	4811	1.65	39	878	0.4	60	36	6.09	96	3226	0.3	84	77
Wholesale and retail trade													
Beer, wine, and distilled alcoholic beverage merchant wholesalers	4248	2.57	6	1129	0.5	52	10	8.41	34	3693	0.3	76	38
Grocery and related product merchant wholesalers	4244	1.60	43	2171	1.0	23	14	6.54	79	8912	0.8	33	39
Miscellaneous durable goods merchant wholesalers	4239	1.57	46	1730	0.8	34	22	7.43	56	8176	0.7	38	27
Metal and mineral (except petroleum) merchant wholesalers	4235	1.59	44	1565	0.7	37	23	8.59	30	8421	0.7	36	13
Agriculture, fishing, and forestry													
Logging	1133	2.50	7	118	0.1	211	103	7.60	53	354	0.0	234	149
Poultry and egg production	1123	1.06	105	201	0.1	179	150	6.17	93	1173	0.1	176	140
Support activities for animal production	1152	1.25	80	98	0.0	222	162	5.96	102	468	0.0	224	175
Mining													
Coal mining	2121	1.67	37	366	0.2	134	68	7.63	50	1669	0.1	146	86
Nonmetallic mineral mining and quarrying	2123	1.26	75	294	0.1	153	108	6.31	88	1472	0.1	155	120

[a]Rates were computed for the majority of allowed claims with reliable employee counts for the corresponding policy-year. The denominator is estimated full-time equivalents.
[b]"Count %" is the percentage of claims for the industry group compared to all OHBWC-Insured Private Employers, Calendar Years 2001–2011.
[c]"Rank of Prevention Index" is the ranked average of the rank orders of the WC claim count and WC claim rate. To be included in the 2001–2011 PI rankings, industry groups had to report employees in 7 or more years of the study period, with ≥55 WC claims from 2001 to 2011 and ≥100 FTE per year during the study period.

after year and prevention must remain a focus. Directing prevention activities at high-risk industries can also be an efficient process. For example, the top 10% (25 of 240) 4-digit NAICS codes in the PI for LT claims represent 40% of all LT claims, but only 22% of the FTE for this population. To support continued research and practice, the Online Supplementary Data includes several tables for specific industry rankings. Additional forthcoming journal articles and reports from the NIOSH–OHBWC partnership will provide cause and diagnoses analyses similar to WA-L&I reports.

As discussed earlier, there are a number of limitations associated with general WC trend analysis and this specific analysis of OHBWC-insured private employer claims. A number of studies have indicated that both OSHA recordable data and WC data under-report the number of actual OII. Illnesses especially are not well captured within the WC system and the level of under-reporting has been found to

differ by industry and diagnoses type. This specific analysis also does not include self-insured or public employers, and these populations may be systematically different. The denominator adjustments and methods used to estimate FTEs may have also impacted WC claim rates, although the sensitivity analyses conducted in this study indicate that the impact is relatively low. As described, there are also a number of differences between OHBWC and SOII/OSHA systems that limit rate comparisons between these sources. The PI is also but one way to condense data and prioritize prevention efforts within industries. It is important to understand that any ranking that includes the number of WC claims is driven in part by sheer industry size. Finally, note that the methods described here were found to apply in OHBWC, which is an exclusive fund for the processing and payment of WC benefits. The information available to researchers was not complicated by differences in reporting systems used by various insurers and claims administrators. Other researchers seeking to conduct similar analyses with states where there are more mixed systems (i.e., private- and state-based insurers operating in the same state, each with multiple claims administrators) may encounter other challenges and will need to develop alternative solutions. For example, when UI-based employer level linkages are not possible, different denominator sources (such as aggregated counts using ACS or LPC survey sources) can be used.

A number of additional analyses are planned as part of the NIOSH–OHBWC partnership. These include multi-industry claim/cost rates by basic and detailed causes of injury. Several claims-trending analyses focused on specific industries (private industry ambulance services, temporary employment services, mining, public/private schools), causes (ergonomic-related, slip/trip/falls, machine-related injuries, nail gun injuries) and outcomes (traumatic brain injury, amputations) are also being conducted. In addition to claim count and rate, several additional severity metrics (days away from work, cost, and disability types) will be considered in the future to help prioritize injury prevention. WC data include an unstructured narrative that describes how the injury/illness occurred. Many of the forthcoming cause-related analyses with OHBWC data were made possible by developing auto-coding methods that leverage the narrative and diagnoses fields [Bertke et al., 2012, 2016]. An additional key value of the narrative is that it acts like a short story that describes how the injury/illness occurred or developed. For this reason, researchers and practitioners are also being encouraged to simply read narratives from representative samples of claims from industries, causes, and outcomes of interest to develop ideas for prevention that may never be possible if one looks simply at coded data. This type of narrative mining has been useful in the analyses of CFOI and other OII case data and will continue to be leveraged in WC claims analyses moving forward.

CONCLUSIONS

This analysis demonstrated that WC claims data could be linked to external employment data to examine overall claims trends among OHBWC-insured private employers. In this case, WC claims data were most useful for identifying specific higher risk industries for injury prevention emphasis within NIOSH sectors in this population. Other states may be able to build similar injury surveillance capacity using WC data. There remain many methodological differences that limit the use of WC claims data for between-state comparisons. Obstacles related to underreporting, misreporting, and non-standardization will continue to challenge attempts to develop a single census of OII as has been developed for occupational fatalities. However, WC claims data can be used to complement BLS data and prioritize industries within states for injury research and prevention activities, and to compare claims of specific types (e.g., causes, diagnoses) or for certain occupations. This is evidenced by the work of WA-L&I and the current NIOSH–OHBWC partnership. Recognizing this potential, NIOSH recently developed a WC surveillance grant announcement. The purpose is to develop collaborations between state WC, health, and labor departments and build surveillance capacity within states to use WC claims data for prevention purposes. Through this funding opportunity, five states are currently undertaking work to develop surveillance of OII using WC data. This includes several states with mixed systems (both private- and state-based insurers operating etc.), such that lessons learned from these researchers may be transferred to others with like systems. Other states are encouraged to develop similar collaborations and increase access to WC data to improve safety and health.

AUTHORS' CONTRIBUTIONS

General study design and methods development: SJW, IST, PTB, ARM, MPL, DCR; data acquisition: DCR, MPL, JR, SJW, IST, ARM; data analysis: CYT, CW, SJB, SJW, ARM, PTB, MPL, DCR; computer programming: CYT, CW, and JR; data management: JR, ARM, DCR, CW, CYT, TMH; drafted the manuscript and led the co-author and peer review process: SJW; all authors participated in the development and editing of the manuscript or providing critical revisions to important intellectual content; and, all authors agree to be accountable for all aspects of the work.

ACKNOWLEDGMENTS

FUNDING

This research was supported by NIOSH intramural funds, awarded as part of the competitive National Occupational Research Agenda process.

ETHICS APPROVAL AND INFORMED CONSENT

This research was approved by the NIOSH Institutional Review Board. The requirement for informed consent was waived because the study involved the analysis of coded and previously collected WC and program evaluation data.

DISCLOSURE (AUTHORS)

The authors report no conflicts of interest.

DISCLOSURE BY AJIM EDITOR OF RECORD

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

DISCLAIMER

The findings and conclusions in this paper are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health or the Ohio Bureau of Workers' Compensation.

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