Received: 2 July 2019 | Revised: 16 August 2019 | Accepted: 3 September 2019

DOI: 10.1002/ajim.23049

AMERICAN JOURNAL OF INDUSTRIAL MEDICINE WILEY

RESEARCH ARTICLE

Comparative analyses of workers' compensation claims of injury among temporary and permanent employed workers in Ohio

Ibraheem S. Al-Tarawneh PhD[1] | Steven J. Wurzelbacher PhD[2] | Stephen J. Bertke PhD[2]

[1]Pi Square Consulting, LLC, Orlando, Florida

[2]Division of Field Studies and Engineering, National Institute for Occupational Safety and Health, Cincinnati, Ohio

Correspondence
Stephen Bertke, PhD, Division of Field Studies and Engineering, National Institute for Occupational Safety and Health, 4676 Columbia Pkwy, Cincinnati, OH 45226.
Email: sbertke@cdc.gov

Background: A small but increasing number of studies have examined the risk of injury among temporary workers compared to that among workers in permanent employer arrangements. The purpose of this study was to conduct a comparative analysis of injury risk among temporary and permanent employer workers using a large dataset of workers' compensation (WC) claims of injury.

Methods: Over 1.3 million accepted WC claims in Ohio during the years 2001 to 2013 were analyzed, including 45 046 claims from workers employed by temporary services agencies. General descriptive statistics, injury rates and rate ratios (temporary to permanent workers) were calculated by injury type and event, industry group, and industry manual classes.

Results: Injured temporary workers were younger and had less tenure compared to injured permanent workers. Temporary workers had higher injury rates, and lower lost-time and medical costs. Differences in injury rates between temporary and permanent workers varied by injury event, industry, and manual class.

Conclusion: Temporary workers had higher overall injury rates than permanent workers, controlling for industry manual class. These differences were pronounced for certain industries and injury events. We were not able to control for age and tenure of the worker, so it is not clear how these factors affected observed results. These findings were mostly similar to those from other studies using WC data from the states of Washington and Illinois. Together, these studies provide insights to improve injury prevention among temporary workers, however, additional research is still needed to improve safety and health programming for this group of workers.

KEYWORDS
claim rate, temporary workers, workers' compensation, workplace injuries

1 | BACKGROUND

Accounting for occupational injuries and illnesses (OII) among temporary workers has been an ongoing challenge to researchers, safety professionals, and occupational safety and health regulators at the federal and state levels. Recent reports estimate that there are 1.4 million temporary help agency workers in the US,[1] and that the percentage of workers in alternative work arrangements (defined more broadly as "temporary help agency workers, on-call workers, contract workers, and independent contractors or freelancers") has increased modestly during the 2000s.[2,3] Despite this, few studies have described OII among these populations of workers. This challenge is driven by major gaps related to identifying the populations of temporary workers working in any given industry sector combined with lack of data accounting for injuries among temporary workers. The latter issue is inherent to the methods used

for surveillance of OII. At the national level, the Bureau of Labor Statistics (BLS) Survey of Occupational Injuries and Illnesses (SOII) does not have mechanisms in place to recognize whether the injured worker is a temporary employee.

SOII, which represents the most comprehensive instrument for accounting for OII in the United States (US), is based on robust and complex sampling plans of OII records in various economic sectors and industry subsectors. The sampling plans and survey data collection are performed at the state level through a complex design resulting in estimates of OII rates in various industry subsectors at the national and state levels. The sampled OII records are completed and kept by businesses according to the Occupational Safety and Health Administration (OSHA) record-keeping regulations. OSHA's record-keeping regulations are designed to account for OII taking place in the workplace without accounting for the employer-of-record (EOR) of the injured worker. In other words, an injury of a temporary worker who is working as a laborer on a construction site that is administered and managed by a construction company will be listed in the OSHA OII records of the construction company and not in the OII records of the EOR of the temporary worker. Therefore, OII rates for companies that supply temporary workers are significantly lower than the majority of the economic sectors in the SOII, such as manufacturing and construction and their subsectors, to which these companies supply temporary workers.

Both SOII and the Census of Fatal Occupational Injuries (CFOI) report OII and fatalities according to the North American Industry Classification System (NAICS), which classifies companies that supply temporary workers under the Employment Services industry group (NAICS 5613), which belongs to the services economic sector as defined by the National Institute for Occupational Safety and Health's (NIOSH's) National Occupational Research Agenda (NORA). Because most of the injuries among temporary workers take place at their host employers' workplaces and while performing work directed by those host employers, injury rates as reported by SOII for this industry group appear to be relatively low even when compared to the rest of the industry groups within the services economic sector. For example, Utterback, Charles, Schnorr, Tiesman, Storey, Vossenas [4] conducted a comprehensive study utilizing 2003 to 2007 SOII and CFOI data to establish priorities for preventing OII and fatalities among workers in the services sector. Based on the combined rankings of days away from work injury counts and rates, the Employment Services industry group was not among the top 25 priority services sector industry groups. The study also showed that the Employment Services industry group had relatively lower fatality rates compared to the rest of the services sector industry groups. These results are mostly driven by undercounting of injuries in the Employment Services industry group.

In contrast, workers' compensation (WC) systems track injury claims back to the EOR rather than the site of injury for temporary workers, allowing for potentially more accurate estimates of injury rates for employment services.[5] A number of recent studies have reported WC claim rates for employment services that exceed those estimated by SOII. For example, researchers reported overall WC rates for employment services of 7.1 per 100 full-time equivalent (FTE) in Ohio from 2001 to 2011, ranking 19th overall among all state-insured private industry 4-digit NAICS industries and 2nd in the services sector based on total claim count and rate.[6] employment services ranked even higher (2nd) in Ohio based on the count and rate of lost-time (LT) claims with 8 or more days away from work. Other researchers determined that the high ranking of employment services in Ohio was driven especially by higher rates and counts of traumatic safety-related injuries.[7] Washington State has reported that employment services ranked 25th overall among all state-insured private industry 4-digit NAICS industries and 4th in the services sector based on LT (4 or more days away from work) claim count and rate from 2002 to 2010.[8,9] WC data analyses from Illinois showed that SOII underestimated injury counts and rates among temporary workers compared to those estimated based on WC data.[10]

Despite evidence from these analyses of higher overall WC rates in employment services, other scientific research of OII among temporary workers in the United States has been relatively limited. A number of previous studies have been survey-based and have been mixed in findings, indicating either negative health outcomes with temporary work,[11,12] or no difference in outcomes[13-16] compared to permanent employed work.

The challenges associated with proper and reliable accounting for occupational injuries among temporary workers limited the number of studies that allow for comparing their risk for injury with that of permanent workers performing similar job-related tasks or working in similar industry sectors. This type of comparative studies has also been limited to specific states with better systems for surveillance of OII such as Washington,[17-19] or in states where researchers were able to acquire data from one or more data sources such as Ohio[6,7] and Illinois.[10]

Three notable comparative studies[17-19] conducted by researchers at the Safety and Health Assessment and Research for Prevention Program at the Washington State Department of Labor and Industries (WA L&I) utilized WC data to account for OII among temporary workers. In these studies, the researchers assembled and analyzed WC data from sources that are unique to WA L&I. WC coverage in WA is exclusive and all businesses, except for a small number of large self-insured ones, are required to attain WC coverage from WA L&I. WA L&I WC data sources account for industry descriptors according to a WA L&I industry classification system along with hours worked by employees in addition to claims of injury. Using this data, the researchers were able to account for injury rates, time loss, and injury costs among temporary workers and compare them to those of permanent workers in the same industries. The three studies covered different study periods 2003 through 2006,[17] 2005 through 2011,[18] and 2011 through 2015,[19] and showed that compared to permanent workers, temporary workers experienced higher rates of injury for all injury types and longer time loss, but lower medical costs. Furthermore, this research demonstrated that temporary workers in certain occupations and industries were at particular elevated risk, especially for certain causes of

injuries (such as traumatic and exposure to physical and environmental elements).

Madigan, Forst, Friedman [10] conducted an analysis of disputed WC claims filed with Illinois (IL) WC Commission from 2007 through 2012 and found key differences between compensation for injured temporary workers vs permanent or direct hire workers. Similar to the WA studies, the study found a lower median total costs per claim for temporary workers. However, the study showed that temporary workers had lower time loss and lower percent disability judgments compared to permanent workers.

While most comparative studies of injuries showed that temporary workers had elevated the risk of injuries compared to their counterpart permanent workers in similar industries or occupations, the majority of these studies did not examine the drivers behind this elevated risk.[7,17,18] Foley[19] examined some of the factors that could be attributed for this elevated risk by conducting case follow-up interviews with temporary and permanent injured workers in Washington. After adjusting for age, sex, and tenure, compared to permanent counterparts, the study found that temporary workers reported lower hazard exposures, yet they were less protected because they had less experience screening, safety training, and schedule control relative to the work they were assigned.

Clearly, additional research on temporary workers is needed using state and national data sources for improved quantification of the risk of injury among temporary workers as well as the factors that may elevate this risk. Evidence-based studies relative to quantifying the risk, nature, and causation of OII among temporary workers will help in improving safety and health prevention plans, policies, and regulations for protecting the growing population of temporary workers in the United States. The information gained will improve prevention efforts by host employers, temporary employment agencies, regulators, and other stakeholders and will result in protecting the growing population of temporary workers in the United States. As an example, the recent emphasis by OSHA and the NIOSH has produced some guidance documents and much-needed focus in this area.[20,21]

2 | METHODS

2.1 | Ohio workers' compensation system

Ohio's WC system is similar to that of WA as it is also an exclusive system. Businesses in Ohio can only attain WC coverage through the Ohio Bureau of Workers' Compensation (OHBWC) or self-insure after meeting strict financial conditions regulated by OHBWC. Self-insuring businesses in Ohio are large businesses employing more than 500 employees and usually, carry operations in and outside Ohio. Generally, less than 1200 private businesses and public entities in Ohio are self-insured with the remaining 250 000+ private businesses and public entities receiving WC coverage through OHBWC in any given year. Approximately 60% of Ohio's workforce receives WC coverage through OHBWC.[22] Due to the relatively large size of Ohio's population and economy, OHBWC is considered the largest underwriter of WC insurance operating in a single state. Combined with the facts that Ohio has a very diversified industry base across industry sectors along with a diverse workforce, the OHBWC WC system is rich with information and data descriptors relative to Ohio businesses as well as OII registering in the system in any given year.

Unlike WA, the OH system does not collect hours-worked for employees and/or employment data. Until recently, this limited the utilization of the OH WC system for the purposes of surveillance of OII in the past. In addition, due to the lack of specific identifiers for companies that supply temporary workers within the system, accounting for OII among temporary workers in the OH system was almost nonexistent. Basically, Ohio's WC system had two major challenges for utilizing the system for surveillance of OII:

1. Lack of employment data. OHBWC operates in a similar fashion to all WC private and state fund insurers in the United States. In that, premiums are calculated based on utilizing standard WC insurance methods, which utilize reported payroll and industry manual classifications (IMCs). Simply, with minor adjustments, OHBWC utilizes the National Council on Compensation Insurance (NCCI) IMC system and businesses will report the amount of payroll under their assigned IMCs. This data are then used to calculate the premiums based on the actuarially calculated base rate for each IMC as well as the business individual experience modifier, when applicable. Thus, the system does not account for exposure in terms of the number of employees or number of hours worked but rather in terms of the IMC rating and amount of reported payroll for the IMC.
2. Lack of industry identifiers according to the NAICS codes. Although OHBWC utilizes an in-house algorithm for assigning businesses to one out of 10 major industry groups, the system does not pinpoint the exact operation of those businesses in the way NAICS codes do. For example, a plastic manufacturer may report payroll under three NCCI IMCs with one associated with plastic manufacturing (4452); a second associated with sales (8742); and a third associated with clerical office employees (8810). Under the above scheme, the OHBWC algorithm will assign this business to the manufacturing industry sector. However, this process does not have identifiers of companies that supply temporary workers. These companies report payroll for every IMC for which they supply workers to their clients. On the other hand, NAICS code: 56132, describes "Temporary Help Services" as "establishments primarily engaged in supplying workers to clients' businesses for limited periods of time to supplement the working force of the client. The individuals provided are employees of the temporary help service establishment. However, these establishments do not provide direct supervision of their employees at the clients' work sites.[5]"

Recent research efforts through a partnership between the OHBWC and NIOSH resulted in the development of a unique

database to be utilized for improved surveillance of OII injuries in the OHBWC system including those among temporary workers. The database, which to date covers the years 2001 through 2013, was designed to address the above-described challenges by including data descriptors that were not inherently available in the OHBWC policy system. This includes NAICS codes and quarterly employment data in addition to the already existing reported payroll and IMC data descriptors. This was achieved by combining OHBWC insured policy data with quarterly unemployment data (UI) supplied by another Ohio state agency. Also, the database includes a number of data descriptors that describe the injury experience for a specific business including the injured worker IMC; injury causation; medical diagnoses; injured worker characteristics such as age, sex, and tenure; and the medical and indemnity costs associated with the injury among others. Wurzelbacher, et al[6] provided a detailed description of the methods used in the development and validation of the database for surveillance of OII in the OHBWC system.

2.2 | Assignment of private businesses to industry groups in the OHBWC system

OHBWC also utilizes an in-house algorithm for assigning private businesses within the system based on their IMCs to one of ten major industry groups including agriculture, extraction, manufacturing, construction, transportation, utility, commercial, service, high-risk commercial/service, and office work/miscellaneous. Table SI in the online supplement provides more information for each of these industry groups and included IMC codes. The algorithm for assigning a business to a specific industry group evolved over many years and the assignment is driven mostly by:

1. Data collected by OHBWC about the business operations at the time of the WC insurance policy initiation and maintenance of coverage processes.
2. A predetermined categorization of the IMCs to one of the 10 industry groups. For example, the "utility" industry group includes IMCs 7502, 75015, 7520, 7539, 7540, 7580, 7600, and 8901. Whereas, the office work/miscellaneous industry group includes IMCs 7402, 8603, 8721, 8742, 8748, 8755, 8803, 8810, 8820, 8871.
3. Whether or not a business reports payroll under more than one IMC and whether or not these IMCs have the same predetermined industry group category.
4. The distribution of the total calculated premium among the various IMCs for which a business reports payroll.

The algorithm is designed to automatically and frequently update the data and assignment and to assign businesses to the most appropriate industry group. In cases in which the algorithm cannot make the automatic assignment, the assignment is made manually by an OHBWC staff member. Also, the algorithm is designed to assign a business to an industry group that is most representative of the business's highest risk exposure in terms of its IMCs and calculated premiums. Finally, the algorithm is designed to ensure that an assignment to the "Office Work/Miscellaneous" takes place only when assignments to one of the other groups fail.

The overall OHBWC system[6] now has several advantages that allow for improved accounting and understanding of OII among temporary workers. The primary advantages include: (a) Identification of temporary worker agencies within the OHBWC system over a relatively long period of time spanning 13 years; (b) The database includes reported payroll data according to the various IMCs associated with temporary worker agencies during the study period; (c) The database is rich with information about OII among temporary workers including demographic variables, IMC, industry group, and wage information for the injured worker along with the injury nature, causation, and medical and indemnity costs; and (d) The database has similar comparative data for injured workers with permanent work arrangements.

However, with all these advantages, one remaining challenge was that these methods could not be directly utilized for estimating injury rates among temporary workers in a certain industry for comparison with those among permanent workers in the same industry. The database has data that allow for estimating and comparing injury rates among industry sectors and groups at any NAICS code level, which to some extent represents part of the challenge with SOII data when attempting to account for and compare injury rates among temporary and permanent workers who work in the same industry group. While the database has data on the total number of employees who work for a temporary worker agency, it does not have enough information to directly estimate the number of temporary employees who worked in manufacturing versus those who worked in the construction or any other industry group. However, the database has a unique set of variables that together, can be utilized to perform injury rate comparisons between temporary workers and permanent workers by industry group and by IMC.

2.3 | Estimation of the number of employees and injury rates

Since temporary workers agencies have a unique NAICS code (56132), we were able to identify these agencies within the OHBWC system along with their reported payroll and injuries by industry group and IMC over the study period 2001 to 2013. Injury rates were calculated as the number of injuries per dollar of payroll. However, since wages are not the same between permanent and temporary workers, an adjustment using the "Average Weekly Wage" (AWW) reported by injured workers was considered.

For the purposes of calculating indemnity payments to injured workers, OHBWC collects wage information from the injured workers and their employers to calculate an AWW. The AWW represents the average wage earned per week for 1 year (52 consecutive weeks) before the injury. Table 1 compares the medians of AWW data for injured temporary workers with that for injured permanent workers for each of the ten industry groups from

TABLE 1 Ratio of the medians of the average weekly wages (AWW) for permanent and temporary injured workers by industry group (based on data from 2006-2011 in the OHBWC system)

		Number of claims		
Industry group[a]	Industry group description	Permanent	Temporary	AWW Ratio of Median
Agriculture	Primary operations in agriculture. Examples include farms for field crops, animals and fish, nurseries, mechanized and nonmechanized logging and tree removal.	1315	73	2.02
Extraction	Major operations in mining and refining.	1585	57	3.25
Manufacturing	Major operations in conversion of metals and materials and making of parts and products.	62 475	4522	2.49
Construction	Includes businesses involved in road and building construction and skilled trades including electromechanical work.	34 267	388	2.43
Transportation	Operations related to moving people and goods. Examples include long and short haul trucking, bus transportation, ambulance and emergency medical services, railroad operations and construction, aviation operations, parcel and delivery services, taxis, etc.	19 052	199	1.26
Utility	Includes businesses with major operations in telecommunications and utilities.	1242	24	1.81
Commercial	Wholesale and retail industry. Examples include beer distributors, merchants, super and convenient stores, gas stations, etc.	36 617	1154	2.18
Service	Includes most businesses that provide business to business and business to individual customer services. Examples include higher education institutions, warehousing, hospitals, nursing homes, physician offices, hotels, nursing homes, etc.	62 372	1405	1.42
High-risk commercial/ service	Major operations in the commercial and services sectors with relatively higher risks. Examples include garbage collectors, atomic energy exposure, distributers of explosives, garbage recycling, etc.	3891	103	2.29
Office	Major operations that involve mostly clerical work in office environment. Examples include law firms, accounting firms, banks, etc.	8546	264	1.73
Overall		231 362	8189	2.09

Abbreviations: AWW, average weekly wage; OHBWC, Ohio Bureau of Workers' Compensation.
[a]Based on grouped industry manual classifications (IMC).

2006 to 2011. The ratios of the medians of permanent injured workers' AWW to those of temporary injured workers ranged from 1.26 in the transportation industry group to 3.25 in the extraction industry group. This is comparable to what is reported by the BLS, in which a ratio of 1.70 between median weekly earnings for workers in traditional arrangements ($884) and temporary help agency workers ($521) was reported.[1]

Unfortunately, it is not possible to tell if this difference in AWW between temporary and permanent workers is due to differences between their hourly pay rates or due to differences between the average number of hours worked in a given week. Therefore, based on the results in Table 1, we decided to present two sets of estimates for injury rates: (a) unadjusted rates and (b) wage-adjusted rates. One estimate is reflective of the assumption that temporary workers' AWW is lower solely because they worked a lower number of hours per week and, therefore, no adjustment to payroll is made (unadjusted rate). The other estimate is reflective of an assumption that compared to permanent workers, temporary workers' AWW is lower solely because their hourly-pay rate is lower, and, therefore, payroll was adjusted by dividing the payroll of temporary workers within each industry by the ratios presented in Table 1 before calculating the wage-adjusted rate. The reality is likely a combination of both (ie, differences between AWW is due to both differences in hours worked and hourly pay rate) and the true estimate is between these two extremes. Injury rates were reported as the number of injuries per $400 000 000 of payroll, which is comparable to 1000 FTEs based on an estimated annual median wage of $40 000 per FTE.[23] The choice of how to present rates will not affect ratios or relative comparisons since this term will cancel out.

2.4 | Controlling for variations in injury rates by IMC and year

The study period of 13 years (2001-2013) represents a period in which the OHBWC system experienced significant reductions in the number of injuries throughout the study period. This decreasing trend in WC claims of injury as well as occupational injuries reported by the BLS was also observed across the nation.[6] During the same period, total reported

payroll across the OHBWC system, by industry group and by the majority of IMCs have fluctuated in part due to fluctuations in employment and growth in wages. Growth of wages over time also affected the indemnity payments provided to injured workers. An additional source of variation is driven by the distribution of reported payroll among IMCs and industry groups between temporary and permanent workers. Thus, it was important to control for the effects of IMC and year. Finally, the variations in the reported payroll and AWW over the study period resulted in variations in the estimates of the total populations of both temporary and permanent workers with WC coverage in the system. The estimated proportion of temporary workers to all workers in the private industry with coverage through OHBWC fluctuated between 2001 and 2006 to peak at 2.3% in 2006. On the other hand, this proportion started to decline in 2007 to reach its lowest of 1.6% in 2009 and then climbed up to 2.6% in 2013. The estimated population of temporary workers with OHBWC coverage grew from 30 694 in 2009 to 51 249 workers in 2013, compared to 48 891 workers in 2006.

2.5 | Event/exposure coding

As part of a previous project, NIOSH used a machine-learning program[24] to auto-code all claims 2001 to 2013 into BLS Occupational Injury and Illness Classification (OIICS) event or exposure categories. This includes violence and other injuries by person or animal, transportation incidents, fires and explosions, falls, slips, and trips, exposure to harmful substances or environments, contact with objects and equipment, overexertion and bodily reaction, and unclassifiable. NIOSH also conducted manual coding for quality control purposes on more than 20 000 LT claims from 2007 to 2013, including claims with bottom quartile auto-coder probabilities and high-cost cases (95 percentile or greater).

2.6 | Comparisons of injury rates among temporary and permanent workers by industry group, IMC and injury event

The analyses followed an approach similar to that used by Smith, et al[17] by calculating an injury rate ratio (IRR), which represents the ratio of injury rate among temporary workers to that among permanent workers. The IRR was calculated using negative binomial regression, controlling for IMC and year. The length of the study period (13 years) and the number of injuries reported during this period amounting to 1 371 472 injuries provided an opportunity to conduct a wide range of comparisons between injury rates among temporary and permanent workers. For the purposes of this study, the injury rate comparisons were primarily based on the industry groups and IMCs and injury severity. The OHBWC system categorizes injury severity into two categories: (a) medical only (MO) injuries: Injuries involving 7 or less days away from work; and (b) LT injuries: injuries involving 8 or more days away from work.

Further, injury rate comparisons were made for each of the ten industry groups as well as seven IMCs based on the event/exposure leading to the injury according to the BLS OIICS codes, version 2.01.[25] Of the 45 046 injuries among temporary workers, 14 760 (32.8%) injuries were associated with seven main IMCs. The rest were distributed among many IMCs. Therefore, comparisons within IMCs by event/exposure were limited to these seven IMCs.

Each of the comparisons was conducted twice, one as an unadjusted rate based on the assumption that compared to permanent workers, temporary workers' AWW was lower solely because they worked less number of hours per week and, as a result, differences in payroll reflect differences in hours worked. The second approach was a wage-adjusted rate based on the assumption that temporary workers' AWW was lower because their hourly pay rate was lower, and, therefore, their payroll was adjusted accordingly to better reflect hours worked. With this approach, the results from these analyses provide two ranges for MO and LT injury rates among temporary workers to be compared to injury rates among permanent workers who worked in the same industry groups and IMCs.

2.7 | Comparisons of costs of injury among temporary and permanent workers by industry group, IMC and injury severity

Medical and indemnity paid costs (valued 30 months after 1 January of the calendar year of the date of claim filing) were assembled for injuries among temporary and permanent workers to perform comparisons according to each of the 10 industry groups and seven IMCs and injury severity for MO and LT injuries. Because the distribution of the WC claim costs was heavily skewed due to the majority of injuries having low costs associated with them, the cost comparisons were limited to comparing the median injury costs among temporary and permanent workers and reporting the 25th and 75th percentile costs within each industry group and IMC. In addition, to test for differences, the ratio of the geometric means was modeled with a linear model of the natural log of the cost. A value of $1 was added to all costs to avoid taking the natural log of 0.

2.8 | Adjustment for outliers

Considering a large amount of data included in this study, some records were excluded in some instances of the analyses. Of particular importance, we excluded, respectively, 163 (0.4%) and 8343 (0.6%) injury records among temporary and permanent workers as these records were identified as outliers. The identification of these outlier records was based on the methodology described elsewhere,[6] which pertains to the same database utilized for the purposes of this study. In summary, certain employer-years and their associated claims were excluded in cases where one of the following conditions were met:

- Annual payroll ≤$100k (~1 FTE) and claims per FTE more than 8;
- $100k less than annual payroll ≤$500k (~2-5 FTEs) and claims per FTE more than 6;

- $500k less than annual payroll ≤$50 M (~6-49 FTEs) and claims per FTE more than 4;
- Annual payroll more than $50M (~ >50 FTEs) and claims per FTE more than 2.

Since individual employer-year level payrolls vary considerably, $100k was chosen to represent a single FTE, in this case, to provide a more conservative approach to identifying outliers at an employer-year level. Other instances in which records were excluded from the analyses are noted where applicable in the results or in the form of footnotes to the tables that describe these results. All analyses were conducted using SAS version 9.4. 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.

3 | RESULTS

3.1 | Injured worker demographics

Table 2 provides general statistics describing the data included in the study. There was a gender effect on MO and LT injuries with a larger proportion of injuries among male temporary workers compared to permanent workers. However, generally, about two-third of temporary and permanent injured workers were males. A significant difference was also found relative to the percentages of LT injuries to all injuries (MO + LT), which were 18.6 and 19.8% among permanent and temporary workers, respectively. Age also had a significant effect when comparing MO and LT injuries among temporary workers with those among permanent workers. Generally, the mean and median age of

TABLE 2 Demographics of injured workers and costs of claims according to injury severity (2001-2013)

		Medical-only (MO) claims					Lost-time (LT)[b] claims				
		Temporary		Permanent		*P* value [a]	Temporary		Permanent		*P* value [a]
N		36 144		1 079 323			8902		247 103		
Sex	Female	9991	(27.6)	338 376	(31.4)	<.0001	2784	(31.3)	80 466	(32.6)	.009
	Male	25 598	(70.8)	725 893	(67.3)		6104	(68.6)	166 396	(67.3)	
	Unknown	555	(1.5)	15 054	(1.4)		14	(0.2)	241	(0.1)	
Age	Missing	63	(0.2)	2186	(0.2)	<.001	0	(0.0)	17	(0.0)	<.001
	<25	11 808	(32.7)	230 523	(21.4)		1435	(16.1)	24 022	(9.7)	
	25-34	11 080	(30.7)	282 775	(26.2)		2332	(26.2)	50 157	(20.3)	
	35-44	7404	(20.5)	250 084	(23.2)		2603	(29.2)	66 975	(27.1)	
	45-65	5628	(15.6)	299 740	(27.8)		2467	(27.7)	100 134	(40.5)	
	>65	161	(0.4)	14 015	(1.3)		65	(0.7)	5798	(2.3)	
	Mean (SD)	32	(11.3)	37	(12.9)	<.001	37	(11.3)	42	(12.4)	<.001
	Med (IQR)	30	(23, 40)	35	(26, 46)		37	(28, 46)	42	(32, 51)	
Hired days[c]	Missing	24 166	(66.9)	661 051	(61.2)	<.001	3729	(41.9)	93 856	(38.0)	<.001
	<1 mo	5110	(14.1)	30 453	(2.8)		1899	(21.3)	10 058	(4.1)	
	1-3 mo	3154	(8.7)	40 261	(3.7)		1309	(14.7)	14 213	(5.8)	
	3m-1 y	2526	(7.0)	92 494	(8.6)		1312	(14.7)	33 652	(13.6)	
	1-5 y	992	(2.7)	139 430	(12.9)		540	(6.1)	49 198	(19.9)	
	5+ y	196	(0.5)	115 634	(10.7)		113	(1.3)	46 126	(18.7)	
	Mean (SD)	177	(633.9)	1703	(3354.8)	<.0001	222	(637.1)	1872	(3859.1)	<.0001
	Med (IQR)	41	(11, 118)	629	(162, 2079)		55	(15 166)	695	(174, 2334)	
Medical cost	Med (IQR)	$387	($213, $646)	$389	($196, $709)	.0067	$2434	($859, $7494)	$3994	($1224, $10804)	<.0001
	Mean (SD)	$581	($857)	$728	($1416)		$7041	($14 569)	$9689	($25 082)	
Indemnity cost	Med (IQR)	…	…	…	…	…	$1514	($0, $5655)	$1812	($0, $6532)	<.0001
	Mean (SD)	…	…	…	…	…	$5529	($11 511)	$6594	($14 231)	
Days away	Med (IQR)	…	…	…	…	…	35	(7369)	34	(9, 159)	.295

Abbreviations: IQR , interquartile range; SD, standard deviation.

[a]*P* values are the results of χ^2 tests for categorical comparisons (sex, age, hired days) or the results of the nonparametric Wilcoxon-Mann-Whitney tests for continuous outcomes (age, hired days, medical cost, indemnity cost).

[b]LT claims are those with eight or more days away from work.

[c]Date of hire minus date of injury.

temporary workers with MO and LT injuries were 5 years lower than their respective values for permanent workers

Tenure (defined as the time between the date of injury and date of hiring), also had a significant effect relative to both MO and LT injuries. Although the date of hiring was missing in a large number of claims (61.9% for temporary and 56.9% for permanent), only 10.2% of temporary workers with MO injuries had tenure of 3 months or longer compared to 32.2% of permanent workers. About 22.1% of temporary workers with LT injuries had tenure of 3 months or longer compared to 52.2% of permanent workers.

The medians for medical costs were significantly higher for both MO and LT injuries among permanent workers compared to temporary workers. Medians for indemnity costs were also significantly higher for permanent workers.

3.2 | Unadjusted and wage-adjusted injury rates for temporary and permanent workers by event/exposure

Table 3 provides the results of unadjusted and wage-adjusted MO and LT injury rates among temporary and permanent workers according to the seven primary OIICS event/exposure categories. When considering all injuries, the results showed that the unadjusted injury rates for both injury severity types (MO and LT) among temporary workers were significantly higher overall and for six out of the seven primary OIICS event/exposure categories. The exception was the "fire and explosion" event/exposure category for which no significant difference was found. This trend did not hold for the wage-adjusted injury rates. In the case of MO injuries, the wage-adjusted injury rates among

TABLE 3 Comparison of injury rates for temporary and permanent workers by event/exposure of injury (2001-2013)

		Temporary			Permanent				
Claim type	Event/exposure	N	%	IR	N	%	IR	IRR (95% CI)	IRR-adj (95% CI)
Medical-only (MO)	Violence	462	1.5	14.3	29 688	2.9	11.5	1.88 (1.69, 2.09)	1.06 (0.95, 1.18)
	Transportation	208	0.7	6.4	17 454	1.7	6.8	1.2 (1.04, 1.38)	0.66 (0.57, 0.76)
	Fires and explosion	4	0.0	0.1	196	0.0	0.1	1.65 (0.6, 4.51)	0.76 (0.27, 2.08)
	Falls, slips, trips	3292	11.0	101.8	173 320	16.7	67.1	1.58 (1.52, 1.65)	0.77 (0.74, 0.81)
	Env exposure	1961	6.6	60.7	62 909	6.1	24.4	2.47 (2.34, 2.61)	1.13 (1.07, 1.19)
	Phys exposure	17 736	59.3	548.6	535 592	51.7	207.3	2.41 (2.34, 2.47)	1.09 (1.06, 1.12)
	Overexertion	6152	20.6	190.3	214 020	20.6	82.9	1.93 (1.86, 2)	0.89 (0.86, 0.93)
	Unknown	95	0.3	2.9	3241	0.3	1.3	2.16 (1.75, 2.67)	1.02 (0.82, 1.26)
	Total	29 910	100.0	925.2	1 036 420	100.0	401.2	2.22 (2.16, 2.29)	1.03 (1, 1.06)
Lost-time (LT)	Violence	70	0.9	2.2	3808	1.6	1.5	1.83 (1.41, 2.37)	1.06 (0.82, 1.37)
	Transportation	272	3.5	8.4	12 479	5.2	4.8	2.28 (2.01, 2.59)	1.25 (1.1, 1.42)
	Fires and explosion	7	0.1	0.2	337	0.1	0.1	1.41 (0.63, 3.17)	0.63 (0.28, 1.42)
	Falls, slips, trips	1573	20.4	48.7	69 661	29.2	27.0	1.97 (1.86, 2.08)	0.98 (0.93, 1.04)
	Env exposure	230	3.0	7.1	6597	2.8	2.6	2.62 (2.29, 3.02)	1.15 (1, 1.32)
	Phys exposure	2663	34.5	82.4	53 884	22.6	20.9	3.18 (3.04, 3.33)	1.42 (1.35, 1.48)
	Overexertion	2872	37.2	88.8	91 000	38.1	35.2	2.14 (2.05, 2.24)	1.02 (0.97, 1.06)
	Unknown	41	0.5	1.3	1031	0.4	0.4	3.19 (2.31, 4.41)	1.53 (1.1, 2.12)
	Total	7728	100.0	239.1	238 797	100.0	92.4	2.42 (2.35, 2.5)	1.14 (1.1, 1.17)
All claims	Violence	532	1.4	16.5	33 496	2.6	13.0	1.93 (1.75, 2.14)	1.08 (0.98, 1.2)
	Transportation	480	1.3	14.9	29 933	2.3	11.6	1.67 (1.51, 1.83)	0.91 (0.83, 1)
	Fires and explosion	11	0.0	0.3	533	0.0	0.2	1.51 (0.8, 2.83)	NC
	Falls, slips, trips	4865	12.9	150.5	242 981	19.1	94.1	1.7 (1.64, 1.76)	0.83 (0.8, 0.86)
	Env exposure	2191	5.8	67.8	69 506	5.5	26.9	2.49 (2.37, 2.63)	1.13 (1.07, 1.19)
	Phys exposure	20 399	54.2	631.0	589 476	46.2	228.2	2.5 (2.44, 2.57)	1.14 (1.11, 1.17)
	Overexertion	9024	24.0	279.2	305 020	23.9	118.1	2.02 (1.96, 2.09)	0.94 (0.91, 0.97)
	Unknown	136	0.4	4.2	4272	0.3	1.7	2.38 (2, 2.85)	1.12 (0.94, 1.34)
	Total	37 638	100.0	1164.3	1 275 217	100.0	493.7	2.29 (2.23, 2.35)	1.06 (1.03, 1.09)

Note: IR, estimated as a number of injuries per $400 000 000 of payroll, which, if assuming one FTE earns $40 000, is comparable to 10 000 FTEs. IRR, estimated from a negative binomial regression model that controls for year and industry manual classification (IMC). RR-adj = wage-adjusted IRR. The payroll of temporary employees within each industry was divided by the average weekly wage (AWW) ratio found in Table 1 to account for potential differences in hourly pay rates between temporary and permanent workers.

Abbreviations: AWW, average weekly wage; FTE, full-time equivalent; IMC, industry manual classification; IR, injury rate; IRR, injury rate ratio.

temporary workers were found to be slightly, but significantly higher than those among temporary workers for two primary OIICS categories: environmental and physical exposures. On the other hand, the wage-adjusted MO injury rates among temporary workers were found to be significantly lower than those among permanent workers for three primary OIICS categories: transportation; falls, slips, and trips; and overexertion. For LT injuries, the wage-adjusted injury rates were found to be significantly higher among temporary workers compared to permanent workers overall and for three primary OIICS categories: environmental and physical exposures; and transportation.

3.3 | Unadjusted and wage-adjusted injury rates for temporary and permanent workers by industry group and event/exposure

Table 4 provides the results for the unadjusted and wage-adjusted MO and LT injury rates among temporary and permanent workers for the 10 OHBWC industry groups. Except for utilities, the unadjusted MO and LT injury rates among temporary workers were significantly higher than those among permanent workers. After adjustment, MO injury rates among temporary workers were significantly higher in the agriculture, extraction, construction, and office industry groups, and were significantly lower in the utility,

TABLE 4 Comparison of injury rates for temporary and permanent workers by industry group (2001-2013)

		Temporary			Permanent				
Claim type	Industry group	N	%	IR	N	%	IR	IRR (95% CI)	IRR-adj (95% CI)
Medical-only (MO)	Agriculture	349	1.2	10081.3	7765	0.7	914.8	13.32 (9.45, 18.8)	6.6 (4.68, 9.3)
	Extraction	153	0.5	7607.7	5377	0.5	621.3	14.14 (9.68, 20.67)	4.35 (2.98, 6.36)
	Manufacturing	17 887	59.8	2194.3	299 223	28.9	934.3	2.37 (2.28, 2.46)	0.95 (0.92, 0.99)
	Construction	1273	4.3	2527.0	127 822	12.3	663.2	3.03 (2.78, 3.29)	1.25 (1.15, 1.36)
	Transportation	406	1.4	989.3	38 503	3.7	634.0	1.45 (1.21, 1.74)	1.15 (0.96, 1.38)
	Utility	54	0.2	231.7	4646	0.4	273.0	0.73 (0.5, 1.08)	0.4 (0.27, 0.6)
	Commercial	3916	13.1	1237.0	166 229	16.0	678.3	1.95 (1.83, 2.08)	0.9 (0.84, 0.95)
	Service	3905	13.1	697.8	305 949	29.5	483.6	1.49 (1.4, 1.59)	1.05 (0.99, 1.12)
	High-risk commercial/service	262	0.9	679.8	13 268	1.3	505.7	1.4 (1.11, 1.76)	0.61 (0.48, 0.77)
	Office	1116	3.7	81.9	35 683	3.4	34.5	2.67 (2.25, 3.18)	1.55 (1.3, 1.84)
Lost-time (LT)	Agriculture	31	0.4	895.5	1338	0.6	157.6	6.31 (4.02, 9.9)	3.12 (1.99, 4.9)
	Extraction	22	0.3	1093.9	1533	0.6	177.1	NC	NC
	Manufacturing	4188	54.2	513.8	60 946	25.5	190.3	2.69 (2.57, 2.81)	1.08 (1.03, 1.13)
	Construction	313	4.1	621.3	34 647	14.5	179.8	3.25 (2.89, 3.66)	1.34 (1.19, 1.51)
	Transportation	189	2.4	460.6	18 491	7.7	304.5	1.4 (1.17, 1.68)	1.11 (0.93, 1.33)
	Utility	22	0.3	94.4	1262	0.5	74.1	1.16 (0.66, 2.03)	0.64 (0.37, 1.12)
	Commercial	1106	14.3	349.4	37 283	15.6	152.1	2.31 (2.12, 2.51)	1.06 (0.97, 1.15)
	Service	1340	17.3	239.4	62 991	26.4	99.6	1.8 (1.68, 1.94)	1.27 (1.18, 1.36)
	High-risk commercial/service	105	1.4	272.5	3908	1.6	149.0	2.27 (1.79, 2.88)	0.99 (0.78, 1.26)
	Office	256	3.3	18.8	8446	3.5	8.2	2.65 (2.2, 3.19)	1.53 (1.27, 1.84)
All claims	Agriculture	380	1.0	10976.8	9103	0.7	1072.4	12.5 (8.84, 17.67)	6.19 (4.38, 8.75)
	Extraction	175	0.5	8701.6	6910	0.5	798.5	13.85 (9.53, 20.13)	4.26 (2.93, 6.19)
	Manufacturing	22 075	58.7	2708.1	360 169	28.2	1124.6	2.44 (2.35, 2.53)	0.98 (0.95, 1.01)
	Construction	1586	4.2	3148.4	162 469	12.7	843.0	3.05 (2.82, 3.29)	1.25 (1.16, 1.35)
	Transportation	595	1.6	1449.9	56 994	4.5	938.5	1.45 (1.23, 1.72)	1.15 (0.98, 1.37)
	Utility	76	0.2	326.1	5908	0.5	347.1	0.84 (0.6, 1.17)	0.46 (0.33, 0.65)
	Commercial	5022	13.3	1586.4	203 512	16.0	830.4	2.04 (1.92, 2.17)	0.94 (0.88, 1)
	Service	5245	13.9	937.2	368 940	28.9	583.2	1.6 (1.51, 1.7)	1.13 (1.06, 1.2)
	High-risk commercial/service	367	1.0	952.3	17 176	1.3	654.7	1.52 (1.24, 1.86)	0.66 (0.54, 0.81)
	Office	1372	3.6	100.7	44 129	3.5	42.7	2.7 (2.29, 3.19)	1.56 (1.32, 1.84)

Note: IR, estimated as a number of injuries per $400 000 000 of payroll, which, if assuming one full-time equivalent (FTE) earns $40 000, is comparable to 10 000 FTEs. IRR, estimated from a negative binomial regression model that controls for year and industry manual classification (IMC). IRR-adj = wage-adjusted IRR. The payroll of temporary employees within each industry was divided by the average weekly wage (AWW) ratio found in Table 1 to account for potential differences in hourly pay rates between temporary and permanent workers.

Abbreviations: AWW, average weekly wage; FTE, full-time equivalent; IMC, industry manual classification; IR, injury rate; IRR, injury rate ratio.

commercial and high-risk commercial industry groups. Also, the wage-adjusted LT injury rates among temporary workers were significantly higher in the agriculture, extraction, manufacturing, construction, service, and office industry groups.

Table 5 provides the results for the unadjusted and wage-adjusted MO and LT injury rates among temporary and permanent workers for four industry groups and OIICS event/exposure primary categories. These four industry groups comprised the majority (90%) of the injuries among temporary workers. The rest of the industries were grouped together into one category: all other industries. Table 5 also shows that the overall unadjusted MO and LT injury rates among temporary workers were significantly higher than those among permanent workers in the four industry groups as well as the combined all other industries group. Also, with a few exceptions, the unadjusted MO and LT injury rates among temporary workers were significantly higher than those among permanent workers for most of OIICS event/exposure primary categories across the various industry groups. After wage-adjustment, most differences were not significant.

The wage-adjusted MO rates for falls, slips, and trips and overexertion events in the manufacturing and commercial industry groups, and for transportation and overexertion events in the service industry group were significantly lower among temporary workers. The wage-adjusted LT rates for transportation falls, slips, and trips, and overexertion events in the commercial industry groups were significantly lower among temporary workers.

3.4 | Unadjusted and wage-adjusted injury rates for temporary and permanent workers by IMC

Almost a third of the injuries among temporary workers for which the IMC for the injured workers could be identified fell under seven IMCs. Therefore, the results described in this section are limited to these seven IMCs. Four of these IMCs were related to primary manufacturing job tasks, two to wholesale and retail and warehousing job tasks, and one to office work job tasks. Table 6 provides the results of the overall unadjusted and wage-adjusted MO and LT injury rates among temporary and permanent workers for each of the seven IMCs. Unadjusted MO and LT injury rates among temporary workers were found to be significantly higher than those among permanent workers for all IMCs. After adjustment, the MO and LT injury rates among temporary workers were significantly higher than those among permanent workers for two manufacturing IMCs (3400 and 3632) and one office work IMC (8810). On the other hand, the wage-adjusted MO injury rate among temporary workers was significantly lower than among permanent workers for IMC 8018, which is associated with wholesale job tasks.

Table SII in the online supplement provides the results for the unadjusted and wage-adjusted MO and LT injury rates for each of the seven IMCs and seven primary OIICS injury events. The results show that, with a few exceptions, the unadjusted MO and LT injury rates among temporary workers were significantly higher than those among permanent workers for most of OIICS primary categories across the seven IMCs. These trends did not hold after adjustment, but for MO and LT injury rates for some OIICS categories in IMCs 3400 and 3632, which are associated with manufacturing job tasks, and IMC 8810, which is associated with office clerical job tasks. The wage-adjusted MO rates for transportation; falls, slips, and trips; and overexertion events in IMC 8018, which is associated with wholesale and retail job tasks, were significantly lower among temporary workers. The unadjusted LT injury rate for overexertion injuries in IMC 8018 was also significantly lower among temporary workers.

3.5 | Comparisons of costs associated with injuries among temporary and permanent workers

Table 7 provides the results for comparing the medians of the 30-month paid medical, indemnity, and total costs associated with MO and LT injuries among temporary and permanent workers by industry group and IMC. After controlling for IMC and year effects, the overall median medical cost of MO injuries among temporary workers was significantly lower than among permanent workers. This trend held for the majority of industry groups and IMCs. In the exceptional cases, which included agriculture, extraction, utility, high-risk commercial/service, and IMC 3400 (machine shop manufacturing work operations), no significant differences in the median costs were established.

After controlling for IMC and year effects, the overall median medical cost of LT injuries among temporary workers was significantly lower than among permanent workers. This trend held for the majority of industry groups and IMCs. In the exceptional cases, which included transportation, high-risk commercial/service, and office industry groups and IMC 8810 (clerical and office work operations), no significant differences were established. On the other hand, the median medical cost of LT injuries was found to be significantly higher among temporary workers in the utility industry group.

After controlling for IMC and year effects, the overall median indemnity cost of LT injuries among temporary workers was significantly lower than among permanent workers. This trend held for the manufacturing, construction, and commercial industry groups and most of the IMCs except for IMC 8810 (clerical and office work). No significant differences in the median indemnity costs were established for the rest of the industry groups and IMCs.

4 | DISCUSSION

Results from this study show that workers supplied by temporary employment agencies generally had a significantly higher risk of injury, particularly severe types of injuries with 8 or more days away from work, across most industry groups. Also, temporary workers had a significantly higher risk for injury events involving transportation, and exposures to environmental and physical elements. It is difficult to compare these findings with results from other studies without gaining a better understanding of the contextual differences

TABLE 5 Comparison of injury rates for temporary and permanent workers by industry group and event/exposure (2001-2013)

			Temporary		Permanent			
Claim type	Industry group	Event/exposure	N	IR	N	IR	IRR (95% CI)	IRR-adj (95% CI)
Medical only (MO)	Manufacturing	Violence	93	11.4	1446	4.5	2.56 (2.06, 3.16)	1.03 (0.83, 1.27)
		Transportation	56	6.9	1259	3.9	1.87 (1.42, 2.46)	0.75 (0.57, 0.99)
		Fires and explosion	2	0.3	65	0.2	1.11 (0.26, 4.71)	0.44 (0.1, 1.89)
		Falls, slips, trips	1540	188.9	30 700	95.9	1.87 (1.76, 1.99)	0.75 (0.71, 0.8)
		Env exposure	1263	154.9	19 311	60.3	2.57 (2.39, 2.77)	1.03 (0.96, 1.11)
		Phys exposure	11284	1384.3	184 926	577.4	2.46 (2.37, 2.55)	0.99 (0.95, 1.02)
		Overexertion	3589	440.3	60 577	189.1	2.16 (2.06, 2.27)	0.87 (0.83, 0.91)
		Unknown	60	7.4	939	2.9	2.46 (1.87, 3.23)	0.99 (0.75, 1.3)
		Total	17887	2194.3	299 223	934.3	2.37 (2.28, 2.46)	0.95 (0.92, 0.99)
	Construction	Violence	12	23.8	1822	9.5	2.38 (1.33, 4.27)	0.98 (0.55, 1.76)
		Transportation	10	19.9	2012	10.4	1.91 (1.01, 3.59)	0.78 (0.42, 1.48)
		Fires and explosion	0	0.0	28	0.2	NC	NC
		Falls, slips, trips	154	305.7	18 664	96.8	3.06 (2.59, 3.61)	1.26 (1.07, 1.49)
		Env exposure	115	228.3	6326	32.8	5.81 (4.78, 7.07)	2.39 (1.97, 2.91)
		Phys exposure	743	1474.9	75 272	390.5	3.17 (2.89, 3.49)	1.31 (1.19, 1.43)
		Overexertion	238	472.5	23 231	120.5	3.56 (3.1, 4.08)	1.46 (1.28, 1.68)
		Unknown	1	2.0	467	2.4	0.79 (0.11, 5.81)	0.32 (0.04, 2.39)
		Total	1273	2527.0	127 822	663.2	3.03 (2.78, 3.29)	1.25 (1.15, 1.36)
	Commercial	Violence	48	15.2	2005	8.2	2.04 (1.48, 2.8)	0.94 (0.68, 1.29)
		Transportation	31	9.8	3033	12.4	0.98 (0.67, 1.42)	0.45 (0.31, 0.65)
		Fires and explosion	1	0.3	32	0.1	0.98 (0.67, 1.42)	1.47 (0.19, 11.52)
		Falls, slips, trips	483	152.6	26 427	107.8	1.36 (1.23, 1.52)	0.63 (0.56, 0.7)
		Env exposure	164	51.8	6389	26.1	2.21 (1.86, 2.62)	1.01 (0.85, 1.2)
		Phys exposure	2343	740.1	92 726	378.4	2.2 (2.06, 2.35)	1.01 (0.94, 1.08)
		Overexertion	838	264.7	35 164	143.5	1.56 (1.41, 1.72)	0.72 (0.65, 0.79)
		Unknown	8	2.5	453	1.9	1.32 (0.64, 2.73)	0.61 (0.29, 1.25)
		Total	3916	1237.0	166 229	678.3	1.95 (1.83, 2.08)	0.9 (0.84, 0.95)
	Service	Violence	236	42.2	19 107	30.2	1.58 (1.33, 1.86)	1.11 (0.94, 1.31)
		Transportation	43	7.7	4035	6.4	0.71 (0.51, 0.97)	0.5 (0.36, 0.68)
		Fires and explosion	0	0.0	37	0.1	NC	NC
		Falls, slips, trips	595	106.3	63 588	100.5	1.05 (0.95, 1.16)	0.74 (0.67, 0.82)
		Env exposure	245	43.8	25 038	39.6	1.52 (1.32, 1.74)	1.07 (0.93, 1.23)
		Phys exposure	1885	336.8	129 295	204.4	1.62 (1.51, 1.73)	1.14 (1.07, 1.22)
		Overexertion	887	158.5	63 918	101.0	1.1 (1.01, 1.2)	0.77 (0.71, 0.85)
		Unknown	14	2.5	931	1.5	1.56 (0.9, 2.7)	1.1 (0.63, 1.9)
		Total	3905	697.8	30 5949	483.6	1.49 (1.4, 1.59)	1.05 (0.99, 1.12)
	All other industries	Violence	66	4.5	3099	2.7	2.47 (1.9, 3.2)	1.37 (1.05, 1.77)
		Transportation	67	4.6	6288	5.4	1.56 (1.22, 2)	0.97 (0.76, 1.25)
		Fires and explosion	1	0.1	32	0.0	4.22 (0.54, 33.06)	2.5 (0.32, 19.68)
		Falls, slips, trips	472	32.1	27 872	24.1	1.62 (1.44, 1.84)	0.95 (0.84, 1.08)
		Env exposure	141	9.6	4474	3.9	2.9 (2.36, 3.58)	1.55 (1.26, 1.92)
		Phys exposure	1099	74.7	38 472	33.3	3.52 (3.07, 4.05)	1.93 (1.69, 2.21)
		Overexertion	482	32.8	24 660	21.4	2.22 (1.97, 2.51)	1.3 (1.16, 1.47)
		Unknown	12	0.8	345	0.3	1.17 (0.44, 3.07)	6.54 (4.43, 9.64)

(Continues)

TABLE 5 (Continued)

Claim type	Industry group	Event/exposure	Temporary		Permanent		IRR (95% CI)	IRR-adj (95% CI)
			N	IR	N	IR		
		Total	2340	159.1	105 242	91.1	2.79 (2.45, 3.17)	1.55 (1.37, 1.75)
Lost-time (LT)	Manufacturing	Violence	22	2.7	177	0.6	4.88 (3.08, 7.73)	1.96 (1.24, 3.11)
		Transportation	86	10.6	789	2.5	4.45 (3.49, 5.68)	1.79 (1.4, 2.28)
		Fires and explosion	3	0.4	106	0.3	1.14 (0.34, 3.83)	0.46 (0.14, 1.54)
		Falls, slips, trips	658	80.7	10 759	33.6	2.42 (2.23, 2.62)	0.97 (0.9, 1.05)
		Env exposure	147	18.0	2348	7.3	2.54 (2.12, 3.04)	1.02 (0.85, 1.22)
		Phys exposure	1668	204.6	20 710	64.7	3.24 (3.05, 3.44)	1.3 (1.22, 1.38)
		Overexertion	1586	194.6	25 812	80.6	2.43 (2.29, 2.59)	0.98 (0.92, 1.04)
		Unknown	18	2.2	245	0.8	3.11 (1.9, 5.09)	1.25 (0.76, 2.04)
		Total	4188	513.8	60 946	190.3	2.69 (2.57, 2.81)	1.08 (1.03, 1.13)
	Construction	Violence	0	0.0	125	0.7	NC	NC
		Transportation	16	31.8	1524	7.9	4.26 (2.57, 7.08)	1.75 (1.06, 2.91)
		Fires and explosion	0	0.0	81	0.4	NC	NC
		Falls, slips, trips	76	150.9	10 888	56.5	2.6 (2.06, 3.28)	1.07 (0.85, 1.35)
		Env exposure	10	19.9	930	4.8	3.78 (1.99, 7.19)	1.56 (0.82, 2.96)
		Phys exposure	116	230.3	8873	46.0	4.43 (3.66, 5.37)	1.82 (1.51, 2.21)
		Overexertion	90	178.7	12 029	62.4	2.77 (2.23, 3.43)	1.14 (0.92, 1.41)
		Unknown	5	9.9	197	1.0	9.83 (3.96, 24.4)	4.05 (1.63, 10.04)
		Total	313	621.3	34 647	179.8	3.25 (2.89, 3.66)	1.34 (1.19, 1.51)
	Commercial	Violence	4	1.3	266	1.1	1.3 (0.45, 3.71)	0.6 (0.21, 1.7)
		Transportation	30	9.5	2028	8.3	1.35 (0.93, 1.98)	0.62 (0.42, 0.91)
		Fires and explosion	4	1.3	75	0.3	4.01 (1.11, 14.57)	1.84 (0.51, 6.68)
		Falls, slips, trips	251	79.3	10 267	41.9	1.9 (1.65, 2.18)	0.87 (0.76, 1)
		Env exposure	23	7.3	600	2.5	2.83 (1.81, 4.42)	1.3 (0.83, 2.03)
		Phys exposure	405	127.9	8794	35.9	3.17 (2.81, 3.57)	1.45 (1.29, 1.64)
		Overexertion	383	121.0	15 105	61.6	1.85 (1.62, 2.1)	0.85 (0.74, 0.96)
		Unknown	6	1.9	148	0.6	3.48 (1.46, 8.32)	1.6 (0.67, 3.82)
		Total	1106	349.4	37 283	152.1	2.31 (2.12, 2.51)	1.06 (0.97, 1.15)
	Service	Violence	35	6.3	2381	3.8	1.32 (0.91, 1.9)	0.93 (0.64, 1.34)
		Transportation	75	13.4	2479	3.9	2.16 (1.66, 2.8)	1.52 (1.17, 1.97)
		Fires and explosion	0	0.0	35	0.1	NC	NC
		Falls, slips, trips	358	64.0	22 468	35.5	1.56 (1.39, 1.75)	1.1 (0.98, 1.23)
		Env exposure	28	5.0	2151	3.4	1.62 (1.05, 2.5)	1.14 (0.74, 1.76)
		Phys exposure	294	52.5	9079	14.4	2.43 (2.14, 2.77)	1.71 (1.51, 1.95)
		Overexertion	543	97.0	24 143	38.2	1.56 (1.41, 1.72)	1.1 (0.99, 1.21)
		Unknown	7	1.3	255	0.4	2.13 (0.96, 4.71)	1.5 (0.68, 3.31)
		Total	1340	239.4	62 991	99.6	1.8 (1.68, 1.94)	1.27 (1.18, 1.36)
	All other industries	Violence	7	0.5	492	0.4	1.97 (0.91, 4.27)	1.12 (0.52, 2.45)
		Transportation	60	4.1	5136	4.5	1.62 (1.24, 2.11)	1.06 (0.81, 1.38)
		Fires and explosion	0	0.0	34	0.0	NC	NC
		Falls, slips, trips	200	13.6	12 679	11.0	1.64 (1.41, 1.92)	1 (0.86, 1.17)
		Env exposure	15	1.0	451	0.4	3.11 (1.82, 5.31)	1.64 (0.96, 2.81)
		Phys exposure	116	7.9	4911	4.3	2.79 (2.29, 3.39)	1.63 (1.34, 1.99)
		Overexertion	223	15.2	11 117	9.6	2.19 (1.87, 2.56)	1.33 (1.14, 1.56)

(Continues)

TABLE 5 (Continued)

Claim type	Industry group	Event/exposure	Temporary		Permanent		IRR (95% CI)	IRR-adj (95% CI)
			N	IR	N	IR		
		Unknown	4	0.3	158	0.1	2.86 (1.03, 7.96)	1.74 (0.63, 4.84)
		Total	625	42.5	34 978	30.3	2.03 (1.83, 2.25)	1.22 (1.1, 1.34)

Note: IR, estimated as a number of injuries per $400 000 000 of payroll, which, if assuming one FTE earns $40 000, is comparable to 10 000 FTEs. IRR, estimated from a negative binomial regression model that controls for year and industry manual classification (IMC). IRR-adj = wage-adjusted IRR. The payroll of temporary employees within each industry was divided by the average weekly wage (AWW) ratio found in Table 1 to account for potential differences in hourly pay rates between temporary and permanent workers.
Abbreviations: AWW, average weekly wage; FTE, full-time equivalent; IMC, industry manual classification; IR, injury rate; IRR, injury rate ratio.

related to the data utilized for performing the analyses involved in each of these studies.

Of relevance, are studies that utilized WC data from WA L&I,[17-19] and data from the IL WC Commission.[10] Compared to this study, the studies from WA L&I covered, relatively shorter periods of time: 4, 5, and 7 years; and the study from Illinois covered 6 years. In addition, each of these studies evaluated much smaller numbers of injuries compared to this study. Another source of variation between this study and those from WA L&I is related to the severity of the injury. In the WA system, LT injuries involve 4 or more days away from work, while in the OHBWC system, LT injuries involve 8 or more days away from work, and in IL, LT injuries involve 6 or more days away from work.

This study also differed from the WA studies in that it estimated injury rates by using employer reported payroll and AWW data for temporary and permanent injured workers with injuries resulting in 8 or more days away from work. On average, the AWW for permanently injured workers was twice that of temporary injured workers and varied by industry group with a range between 1.3 and 3.3 in the transportation and excavation industry groups, respectively. Therefore, adjustments had to be made to account for the source of variation in the AWW between temporary and permanent workers. That resulted in introducing two types of injury rates with and without adjustment. Applying this adjustment translates into an average 50% reduction in the estimated unadjusted injury rates among temporary workers. This is an extremely conservative adjustment as it assumes that temporary workers, on average, earned half the hourly pay rate of permanent workers performing similar job tasks.

This study also differed from those from WA in how industry groupings and the event/exposure of claims were determined. WA defined industries based on the employer where the temporary worker was employed using the WA IMCs (not derived from NCCI) and did a match between the temporary IMCs and the permanent

TABLE 6 Comparison of injury rates for temporary and permanent employees by predominant IMCs (2001-2013)

Claim type	IMC	Description	Temporary		Permanent		IRR (95% CI)	IRR-adj (95% CI)
			N	IR	N	IR		
Medical only (MO)	3076	Sheet metal products Mfg-shop only	722	2076.15	9 288	1234.77	1.66 (1.18, 2.33)	0.67 (0.48, 0.94)
	3400	Metal goods Mfg-NOC	2019	3671.45	20 127	1223.22	3.02 (2.65, 3.44)	1.21 (1.07, 1.38)
	3632	Machine shop noc	2285	3814.29	25 078	874.46	4.17 (3.5, 4.98)	1.68 (1.4, 2)
	4484	Plastics mfg molded products noc	2601	2332.72	23 643	1115.81	2.22 (1.96, 2.51)	0.89 (0.79, 1.01)
	8018	Store: wholesale noc	2155	1141.18	20 752	831.75	1.5 (1.24, 1.81)	0.69 (0.57, 0.83)
	8292	Storage warehouse noc	1148	1829.49	3864	872.04	2.2 (1.85, 2.61)	1.55 (1.3, 1.84)
	8810	Clerical office employees noc	904	75.57	20,414	33.05	2.17 (1.92, 2.44)	1.25 (1.11, 1.41)
Lost-time (LT)	3076	Sheet metal products Mfg-shop only	179	514.73	1595	212.04	2.39 (1.97, 2.89)	0.96 (0.79, 1.16)
	3400	Metal goods Mfg-NOC	536	974.69	3994	242.74	4.07 (3.66, 4.53)	1.64 (1.47, 1.82)
	3632	Machine shop NOC	402	671.05	4274	149.03	4.54 (3.86, 5.34)	1.82 (1.55, 2.14)
	4484	Plastics Mfg molded products NOC	610	547.08	4787	225.92	2.65 (2.37, 2.97)	1.07 (0.95, 1.19)
	8018	Store: wholesale NOC	579	306.61	4899	196.36	1.75 (1.45, 2.11)	0.8 (0.66, 0.97)
	8292	Storage warehouse NOC	327	521.12	1106	249.6	2.24 (1.91, 2.64)	1.58 (1.34, 1.86)
	8810	Clerical office employees NOC	199	16.64	4525	7.33	2.25 (1.92, 2.63)	1.3 (1.11, 1.52)

Note: IR, estimated as a number of injuries per $400 000 000 of payroll, which, if assuming one FTE earns $40 000, is comparable to 10 000 FTEs. IRR, estimated from a negative binomial regression model that controls for year and industry manual classification (IMC). IRR-adj = Wage-adjusted IRR. The payroll of temporary employees within each industry was divided by the average weekly wage (AWW) ratio found in Table 1 to account for potential differences in hourly pay rates between temporary and permanent workers.
Abbreviations: AWW, average weekly wage; FTE, full-time equivalent; IMC, industry manual classification; IR, injury rate; IRR, injury rate ratio; Mfg, manufacturing; NOC, not otherwise classified.

TABLE 7 Comparison of injury costs for temporary and permanent workers by industry group and IMCs (2001-2013)

Claim type	Payment type	Industry group/IMC	Temporary Med (IQR)	Permanent Med (IQR)	GM ratio
Medical only (MO)	Paid medical	All grouped industries	$396 ($218, $660)	$401 ($206, $723)	0.95 (0.93, 0.97)
		Agriculture	$320 ($187, $523)	$371 ($189, $719)	0.9 (0.8, 1.03)
		Extraction	$434 ($247, $762)	$450 ($246, $851)	0.86 (0.7, 1.06)
		Manufacturing	$410 ($230, $668)	$405 ($217, $703)	0.97 (0.95, 1)
		Construction	$373 ($203, $635)	$422 ($219, $751)	0.91 (0.83, 0.99)
		Transportation	$357 ($214, $692)	$440 ($217, $878)	0.98 (0.81, 1.18)
		Utility	$327 ($177, $767)	$374 ($185, $765)	0.95 (0.62, 1.46)
		Commercial	$421 ($238, $698)	$400 ($201, $719)	0.94 (0.88, 1.01)
		Service	$378 ($194, $656)	$386 ($197, $699)	0.92 (0.86, 0.97)
		High-risk commercial/service	$420 ($234, $787)	$418 ($214, $790)	1.12 (0.91, 1.37)
		Office	$359 ($180, $641)	$433 ($195, $951)	0.84 (0.74, 0.95)
		3076-Sheet metal products Mfg- shop only	$449 ($273, $727)	$423 ($231, $716)	1.01 (0.87, 1.16)
		3400-Metal goods Mfg- NOC	$419 ($232, $708)	$406 ($217, $683)	1.05 (0.95, 1.15)
		3632-Machine shop NOC	$377 ($208, $615)	$391 ($212, $673)	0.97 (0.88, 1.06)
		4484-Plastics Mfg molded products NOC	$412 ($227, $687)	$432 ($247, $727)	0.86 (0.8, 0.91)
		8018-Store: wholesale NOC	$432 ($238, $730)	$411 ($216, $752)	0.91 (0.84, 0.98)
		8292-Storage warehouse NOC	$409 ($227, $663)	$411 ($224, $749)	0.87 (0.77, 0.98)
		8810-Clerical office employees NOC	$368 ($179, $658)	$422 ($195, $904)	0.84 (0.73, 0.96)
Lost-time (LT)	Paid indemnity	All grouped industries	$1750 ($152, $6156)	$2260 ($120, $7458)	0.97 (0.89, 1.07)
		Agriculture	$484 ($0, $1822)	$1931 ($65, $6500)	0.18 (0.06, 0.51)
		Extraction	$2433 ($107, $9295)	$3123 ($317, $10 093)	1.86 (0.54, 6.33)
		Manufacturing	$1500 ($102, $5471)	$2147 ($66, $6871)	0.86 (0.75, 0.98)
		Construction	$2157 ($181, $7694)	$3298 ($230, $11 411)	0.92 (0.6, 1.4)
		Transportation	$3380 ($914, $14280)	$3346 ($577, $11 605)	1.11 (0.61, 2.02)
		Utility	$11 250 ($4506, $29 238)	$3236 ($359, $9843)	5.68 (1.1, 29.37)
		Commercial	$2000 ($256, $6620)	$2147 ($127, $6857)	1.2 (0.93, 1.55)
		Service	$2028 ($281, $7619)	$1834 ($71, $5808)	1.14 (0.92, 1.41)
		High-risk commercial/service	$2231 ($469, $6744)	$2575 ($252, $7851)	0.88 (0.42, 1.83)
		Office	$2501 ($651, $7953)	$2515 ($0, $6994)	1.75 (1.06, 2.9)
		3076-Sheet metal products Mfg- shop only	$1757 ($200, $3675)	$2045 ($72, $6643)	1.09 (0.52, 2.29)
		3400-Metal goods Mfg- NOC	$1639 ($347, $6450)	$2207 ($35, $6817)	1.29 (0.86, 1.94)

(Continues)

TABLE 7 (Continued)

Claim type	Payment type	Industry group/IMC	Temporary Med (IQR)	Permanent Med (IQR)	GM ratio
		3632-Machine shop NOC	$1687 ($32, $5556)	$2330 ($112, $7233)	0.71 (0.45, 1.11)
		4484-Plastics Mfg molded products NOC	$1262 ($33, $4394)	$2147 ($145, $6567)	0.62 (0.43, 0.9)
		8018-Store: wholesale NOC	$2042 ($452, $6778)	$2067 ($122, $6559)	1.2 (0.84, 1.71)
		8292-Storage warehouse NOC	$1591 ($231, $6778)	$2526 ($438, $7866)	0.7 (0.42, 1.15)
		8810-Clerical office employees NOC	$2576 ($695, $7953)	$2398 ($0, $6679)	1.94 (1.09, 3.46)
	Paid medical	All grouped industries	$2493 ($879, $7781)	$3825 ($1167, $10564)	0.77 (0.74, 0.81)
		Agriculture	$834 ($365, $2883)	$4475 ($1310, $13003)	0.31 (0.18, 0.53)
		Extraction	$1987 ($553, $9707)	$3923 ($1379, $11682)	0.8 (0.46, 1.39)
		Manufacturing	$2181 ($828, $7091)	$3489 ($1031, $9540)	0.73 (0.69, 0.78)
		Construction	$2874 ($943, $9235)	$4788 ($1379, $13292)	0.78 (0.63, 0.96)
		Transportation	$4489 ($1565, $10648)	$4278 ($1392, $12364)	1.06 (0.78, 1.45)
		Utility	$11357 ($3416, $16307)	$4539 ($1490, $12257)	2.18 (1.02, 4.68)
		Commercial	$2725 ($987, $7994)	$3828 ($1162, $10419)	0.79 (0.7, 0.9)
		Service	$2773 ($940, $8349)	$3540 ($1128, $9709)	0.8 (0.72, 0.89)
		High-risk commercial/service	$3269 ($1189, $7588)	$4061 ($1241, $11208)	0.94 (0.66, 1.35)
		Office	$4150 ($1107, $11695)	$4829 ($1523, $12024)	0.96 (0.73, 1.25)
		3076-Sheet metal products Mfg-shop only	$2379 ($811, $6239)	$3468 ($1086, $10040)	0.5 (0.35, 0.72)
		3400-Metal goods Mfg-noc	$2347 ($859, $7699)	$3566 ($1035, $9416)	0.83 (0.68, 1)
		3632-Machine shop NOC	$1937 ($665, $5746)	$3597 ($1058, $9276)	0.63 (0.5, 0.79)
		4484-Plastics Mfg molded products NOC	$1956 ($712, $6301)	$3488 ($981, $9501)	0.6 (0.51, 0.72)
		8018-Store: wholesale NOC	$2790 ($994, $7715)	$3513 ($1084, $9513)	0.84 (0.7, 1)
		8292-Storage warehouse NOC	$2413 ($943, $7582)	$3595 ($1194, $9921)	0.61 (0.48, 0.76)
		8810-Clerical office employees NOC	$4440 ($1199, $12366)	$4792 ($1523, $12197)	1.03 (0.75, 1.4)

Note: GM, estimated from a linear regression model that controls for year and industry manual classification (IMC).
Abbreviations: GM, geometric mean; IMC, industry manual classification; Mfg, manufacturing; NOC, not otherwise classified.

IMCs using the occupation as listed on the claims. This study used the OHBWC algorithm to determine industry groups based on NCCI IMCs. WA manually coded all claims for BLS OIICS (and other causation groupings for musculoskeletal disorders [MSDs]), while this study used an auto-coder[24] to code the majority of claims into BLS OIICS categories and performed a manual review on a proportion of claims.

4.1 | Injured worker demographics

This study found that injured temporary agency workers in the OHBWC database were younger, more predominantly male, had less tenure (especially those with less than a year on the job), and had higher rates of injury for all MO and LT claims compared to permanently employed workers. All of the above findings concur with similar studies conducted using WC data from WA (2003-2006,[17] 2005-2011,[18] 2011-2015[19]); WC data from IL (2007-2012),[10] injury data from Spain (2001-2002)[12]; and injury data from Finland (1997-2007).[26] A recent BLS report also indicated that temporary agencies have higher proportions of younger workers, especially age 20 to 24 and that the workers tend to be male (52.3%).[1] These underlying differences in the temporary and permanently employed worker populations do not indicate excess risk of injury for younger or male temporary workers. However, the general agreement of these studies provides evidence that prevention of injury among temporary workers must include a general focus on younger workers as well as onboarding processes and proper training to ensure the safety of temporary workers before placement at the host worksite and within the first few months on the job.

4.2 | Event/exposure leading to injury

Temporary agency workers had higher unadjusted injury rates for every 1-digit OIICS event/exposure except fires and explosions. After adjustment, temporary workers still had higher rates for specific event/exposures of injury, including contact with objects and equipment and exposure to harmful substances or environments, especially within the construction and service industries. Recent studies also found higher rates or proportions of injuries associated with contact with objects and equipment in WA and IL[10,17,19] and higher rates of exposure to harmful substances or environments in WA.[17,19]

Some of this impact could be due to the fact that temporary workers are generally younger than permanently employed workers. Proportionally, younger injured workers are injured more often due to traumatic injuries that are not falls, slips, trips or ergonomic related.[27] None of the main WC studies on temporary workers from WA, IL, and this study controlled for age in the WC claim analyses portions of these studies since age as a variable was not available in the denominators used for the purpose of calculating claim rates. Foley[19] did match for age, tenure, and sex, ethnicity, education, and income of the worker in the case-control interview portion of his study. He found that temporary workers reported significantly fewer specific types of hazards (biological, dust, crowding, and falls), less job control, less screening for preassignment experience, and less frequent safety training. This could indicate that temporary workers were assigned in some cases less hazardous work, but also that training to recognize such hazards may have been inadequate.

Nonetheless, both the OH and WA datasets indicate elevated rates of injury due to contact with objects and equipment among temporary workers in certain industry groups such as construction, service, and manufacturing. This information is useful for tailoring safety training for workers in these industries. As next steps, a current NIOSH OHBWC study is mining the narratives among large samples of temporary worker WC claims to develop common injury scenarios and prevention strategies.

The relation of temporary work to other causes of injury is less clear. For falls, slips, and trips, this study showed lower MO injury rates (7 or fewer days away from work) among temporary workers compared to permanent workers. The IL study[10] also found lower falls, slips, and trips injury rates (6 or more days away from work) among temporary workers. Results from the WA studies[17,19] were mixed, finding no significant differences between temporary and permanent workers for falls, slips, and trips across all industries. By contrast, the most recent WA study[19] showed lower falls, slips, trips injury rates (4 or more days away from work) among temporary workers compared to permanent workers from 2011 to 2015 across all industries. Typically, younger workers are injured proportionally less due to falls, slips, trips and some of the mixed findings could be due to this age effect.[27] As well, in WA it may be that recent prevention efforts geared toward temporary workers are having an impact on reducing falls injury rates among these workers. For example, in the recent study conducted by Foley[19], all temporary agencies reported having work policies to disallow temporary workers from performing work at high elevations.

For overexertion and bodily reaction injuries, this study found lower MO injury rates (7 or fewer days away from work) among temporary workers while the IL study[10] found higher proportions of overexertion and bodily reaction injuries (6 or more days away from work) among temporary workers. The earlier WA studies did not use BLS OIICS strict event/exposure classifications, but found higher rates from 2003 to 2006 of the neck, back upper extremity MSDs (4 or more days away from work) across all industries.[17] By contrast, recent WA study[19] showed lower rates of overexertion and bodily reaction injuries (4 or more days away from work) among temporary workers compared to permanent workers from 2011 to 2015. A possible explanation for these mixed findings is that younger workers are injured proportionally less than middle-aged workers due to overexertion and bodily reaction. Overexertion and bodily reaction injuries are also typically associated with repeated, cumulative exposures over time and longer tenure, while temporary workers may not stay on the job long enough to develop musculoskeletal symptoms. There may also be an increased under-reporting of such musculoskeletal injuries among temporary workers, as has been noted in other industries such as construction.[28] Since 46.4% of temporary agency workers report preferring a traditional work

arrangement,[1] there could be added incentive among temporary workers to not report injuries in hopes that this could increase chances of being offered full-time employment. Temporary workers may also have more claims denied, as suggested in a State of Minnesota report.[29] However, current evidence is mixed as to whether temporary workers underreport to a greater degree than permanent workers. One study showed greater underreporting among temporary workers,[30] while others did not find evidence of differential underreporting between temporary and permanent employed workers.[19,31]

4.3 | Industry groups and IMC

Temporary agency workers in the OHBWC database from 2001 to 2013 had higher unadjusted rates for every industry grouping of IMCs, except utilities. After adjusting for wage differences, temporary agency workers in the OHBWC database from 2001 to 2013 still had higher rates of injury in a number of industry groups, including agriculture, extraction, construction, services, and offices. Temporary workers also had higher rates for two specific manufacturing related IMCs (3400: metal goods manufacturing; 3632: machine shop manufacturing) and one related to office work (8810: clerical office employees). By contrast, temporary workers had lower MO injury rates in the utility, commercial, high-risk commercial/services industry groups and lower LT injury rate in IMC 8018 (store, wholesale) after wage adjustment.

The reason for these rate differences is unclear, but it is notable that the overall trends by cause of injury remained fairly consistent within these industry groups and IMCs. For example, for industries or IMCs where temporary workers have lower overall rates, it is most often due to having lower rates of falls, slips, trips, transportation or overexertion related injuries. Conversely, for industries or IMCs where temporary workers have higher overall rates, it is most often due to having higher rates of contact with objects and equipment or exposure to harmful substances or environments. Again, age and tenure effects could explain some of these differences.

Nonetheless, WA studies also found higher rates of injury for temporary workers in NORA sectors construction and manufacturing.[17-19] Combined across studies, this information may be helpful for temporary agencies and employers to increase safety focus, particularly when workers are placed in these industries.

4.4 | Medical and indemnity costs

Temporary agency workers in this study had lower medical and LT costs. The WA studies[17-19] also found lower medical costs for temporary workers. This compares with the IL study,[10] which also found lower overall median costs. In general, temporary workers earn lower wages than direct-hire workers performing similar work, so it is not surprising that indemnity (wage loss) costs would be lower among temporary workers. The differences in medical costs could be a function of worker age since temporary workers tend to be younger and younger workers typically have lower medical costs.[32,33]

4.5 | Limitations

There are several limitations to this study of temporary workers in Ohio. OHBWC does not directly track hours worked, therefore, injury rate estimates were based on deriving the population of workers from payroll, indemnity payment, and AWW data. The AWW data showed that across all industry groups, the AWW for permanently injured workers was approximately twice that of temporary injured workers. Because there were no available data to ascertain if this difference in the AWW is due to temporary workers having lower hourly pay rate or due to working a lower number of hours per week, a wage adjustment was applied to the rates. This adjustment was developed by comparing the AWW in the OHBWC database for temporary and permanent workers for each of the industry groups. Using this approach, we presented two types of injury rates, one without adjustment for wage and a more conservative rate after adjustment for differences in wage between temporary workers and their peers with permanent work arrangements. Both types of rates were reported to provide a range of likely differences in injury rates between temporary and permanent workers. In addition, WC data has a number of inherent limitations, including under-reporting[34-40] and differences between states in terms of reporting and compensability requirements. Finally, about 60% of the companies insured by OHBWC are small employers with a payroll of less than $100 000. Small employers tend to have less formal safety programs in place and that may have affected the study results.

5 | CONCLUSIONS

This study found that temporary agency employed workers had higher overall injury rates than permanently employed workers performing comparable work from 2001 to 2013 among Ohio-insured private employers. Injured temporary agency workers were younger, more predominantly male, had less tenure (especially those with less than a year on the job) compared to permanently employed workers. These differences were pronounced in certain industries and causes of injuries, including contact with objects and equipment and exposure to harmful substances or environments. These findings are similar to those published using large datasets of WC claims from WA[17-19] and IL[10] and have several possible implications for improving surveillance, risk assessment, training, and safety for temporary workers.

First, the general agreement of these studies provides evidence that prevention of injuries among temporary workers must include proper training with a focus on younger workers to ensure the safety of temporary workers before placement at the host worksite along with continuing safety training after placement. The recent OSHA-NIOSH guidance document[20] for protecting temporary workers has a key recommendation that temporary agencies and employers should conduct task-specific safety and health training and new project orientation. Foley[19] conducted a study in which 460 workers

(194 temporary and 266 permanent) were interviewed to understand differences in more detail. A key finding from the study was that over 40% of temporary workers reported never receiving safety training from either their temporary agency or host employer compared to 25% of permanent workers. In addition, only 42.7% of temporary workers were screened for job experience by their host employers. The study also found that temporary workers were more likely to report fewer workplace exposures for a number of hazards (biological, dust, crowding, and falls), which may have been due to lack of training and work experience to learn to identify these hazards in the first place.

A number of organizations already have programs that emphasize the importance of conveying safety to young and short-tenured workers. These approaches include components of basic hazard recognition and skill-building. For example, NIOSH's Safe, Skilled, Ready Workforce Program[41] advocates for the development of standards for job skills and competencies for a number of industries as a foundational path for improving safety and competitiveness of the US workforce.[42] Bush and Andrew [43] reported that integrating such training in trade schools is particularly important for high risk industries such as construction. Providing such training as early as possible in high school is particularly important to temporary workers since the majority (57.5%) of temporary agency workers have a high school education or less, compared to 31.2% of workers with traditional work arrangements.[1]

Secondly, the current study from OH and the past WA[17-19] and IL[10] studies also indicate that it may be helpful to increase safety focus when temporary workers are placed in high-risk industries such as construction, manufacturing, and agriculture. BLS data indicates that temporary workers are especially likely to work in manufacturing, with 32.2% of temporary agency workers reporting employment in manufacturing compared to 11.1% of workers with traditional arrangements.[1] Further, these recent WC studies indicate that certain job classes (IMCs) are especially high risk and these could serve as triggers for an additional onsite safety review of the host employer worksite by the temporary agency.

Other key recommendations of the recent OSHA/NIOSH[20] report state that temporary agencies must evaluate the host employer's worksite before taking on the employer as a client and that temporary agency staff should be trained to recognize safety and health hazards. The report goes on to state that WC insurers may be key collaborators in the process. One particularly promising approach in this regard has been developed by the Rhode Island state-based WC insurer, Beacon Mutual Insurance.[44] Beacon Mutual Insurance provides temporary agencies with risk assessment training and assessment forms that can be used by the agency for host employer workplace reviews. Another key recommendation by the OSHA/NIOSH report[20] on protecting temporary workers is that temporary agencies should conduct client injury and illness prevention program assessments. Both client job risk assessments and overall safety program assessments are services that WC insurers routinely provide and can extend to their temporary agency clients through specialized training.

As next steps, temporary worker training, risk assessment, risk reduction, and overall safety program development could be further improved by reviewing representative sampled sets of WC claims by industry, IMC, and cause of injury to read narratives and develop common theme scenarios for how temporary workers are injured. These claim-based studies could then be further enhanced by conducting interviews with injured temporary workers, host employers, and temporary staffing agencies. These steps reflect other recommended practices by the OSHA/NIOSH report[20] to track injuries/illnesses and conduct incident investigations. Although individual temporary agencies may lack comprehensive claim sets, partnerships can be created with WC insurers and state bureaus to conduct detailed analyses on a broader level.

Another potential implication of the current OH study and those from WA[17-19] and IL[10] is that state WC rating bureaus and WC organizations should consider ways to incorporate the tracking of temporary agencies into the manual class code rating systems. Clearly, there is an increased risk of injury for temporary workers compared to their permanent peers performing similar work. This increased risk is not reflected in the current WC rating system for prevention purposes. WA is the only state with an approach where temporary work is identified using a separate set of IMC codes. This approach could be emulated most simply in other states by maintaining the same numerical class code system but modifying the code with some type of indicator when the code is associated with a temporary agency. Such modification would allow the temporary agency class code to be more accurately rated for actual risk and would also enable a better understanding of the distribution of temporary agency work across different industries and occupations. BLS and OSHA could also consider ways to improve tracking of injuries to temporary workers.

Finally, several states including MA, CA, and IL have established Right-to-Know laws to inform temporary workers of their rights under the WC system.[45-47] In MA, this law also requires that the worker be informed about the types of work and tasks involved in the work for which they are hired. Other state WC systems may consider similar systems to improve temporary worker WC coverage and safety.

In conclusion, the current study in OH is the latest in a series where states were able to use WC data to demonstrate that temporary agency employed workers have higher overall injury rates than permanently employed workers performing comparable work tasks. These differences are pronounced in certain industries and causes of injuries. Together, these studies provide insights to improve prevention strategies for temporary workers, but additional research and partnerships between insurers, temporary agencies, host employers, and regulators are needed to optimize safety and health programs for this important population of workers.

ACKNOWLEDGMENTS

The authors would like to thank Mike Foley and Katherine Schofield for their contributions and comments on an earlier draft of this paper.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

DISCLOSURE BY AJIM EDITOR OF RECORD

John D. Meyer declares that he has no conflict of interest in the review and publication decision regarding this article.

AUTHOR CONTRIBUTIONS

A. T. was the primary author of the manuscript and developed the study design and guided analyses. S. W. assisted in drafting the manuscript as well as contributed to study design and analyses. S. B. conducted all analyses and assisted in drafting the manuscript.

DATA ACCESSIBILITY

Data analysis was conducted at NIOSH through a partnership with the OHBWC; the manuscript was drafted at Pi Square Consulting, LLC.

ETHICS APPROVAL AND INFORMED CONSENT

This study was approved by the NIOSH Institutional Review Board.

DISCLAIMER

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Ohio Bureau of WC or the NIOSH, Centers for Disease Control and Prevention.

ORCID

Stephen J. Bertke http://orcid.org/0000-0002-3047-3816

REFERENCES

1. Bureau of Labor Statistics (BLS). Contingent and alternative employment arrangements —May 2017. 2018; https://www.bls.gov/news.release/pdf/conemp.pdf. Accessed May 28, 2019.
2. Katz LF, Krueger AB The Rise and Nature of Alternative Work Arrangements in the United States, 1995–2015. 2019;72(2):382-416.
3. Katz LF, Krueger AB Understanding Trends in Alternative Work Arrangements in the United States. *National Bureau of Economic Research Working Paper Series*. 2019;No. 25425.
4. Utterback DF, Charles LE, Schnorr TM, Tiesman HM, Storey E, Vossenas P. Occupational injuries, illnesses, and fatalities among workers in the services sector industries: 2003 to 2007. *J Occup Environ Med*. 2012;54(1):31-41.
5. Foley M, Ruser J, Shor G, Shuford H, Sygnatur E. Contingent workers: workers' compensation data analysis strategies and limitations. *Am J Ind Med*. 2014;57(7):764-775.
6. Wurzelbacher SJ, Al-Tarawneh IS, Meyers AR, et al. Development of methods for using workers' compensation data for surveillance and prevention of occupational injuries among State-insured private employers in Ohio: methods for Ohio Workers' Compensation Data Analysis. *Am J Ind Med*. 2016;59(12):1087-1104.
7. Meyers AR, Al-Tarawneh IS, Wurzelbacher SJ, et al. Applying machine learning to workers' compensation data to identify industry-specific ergonomic and safety prevention priorities: Ohio, 2001 to 2011. *J Occup Environ Med*. 2018;60(1):55-73.
8. Anderson N, Bonauto D, Adams DJWSDoL, Report IT Prioritizing Industries for Occupational Injury and Illness Prevention and Research, Washington State Workers' Compensation Claims Data, 2002–2010. 2013:64-61.
9. Anderson NJ, Bonauto DK, Adams D. Prioritizing industries for occupational injury prevention and research in the services sector in Washington State, 2002–2010. *J Occup Med Toxicol*. 2014;9(1):37.
10. Madigan D, Forst L, Friedman LS. Workers' compensation filings of temporary workers compared to direct hire workers in Illinois, 2007-2012: workers' compensation of IL temporary workers. *Am J Ind Med*. 2017;60(1):11-19.
11. Saha A, Ramnath T, Chaudhuri RN, Saiyed HN. An accident-risk assessment study of temporary piece rated workers. *Ind Health*. 2004;42(2):240-245.
12. Benavides FG. Associations between temporary employment and occupational injury: what are the mechanisms? *Occup Environ Med*. 2006;63(6):416-421.
13. Virtanen M, Kivimäki M, Elovainio M, Vahtera J, Cooper CL. Contingent employment, health and sickness absence. *Scand J Work Environ Health*. 2001;27(6):365-372.
14. Virtanen M. From insecure to secure employment: changes in work, health, health related behaviours, and sickness absence. *Occup Environ Med*. 2003;60(12):948-953.
15. Bardasi E, Francesconi M. The impact of atypical employment on individual wellbeing: evidence from a panel of British workers. *Soc Sci Med*. 2004;58(9):1671-1688.
16. Saloniemi A, Salminen S. Do fixed-term workers have a higher injury rate? *Safety Science*. 2010;48(6):693-697.
17. Smith CK, Silverstein BA, Bonauto DK, Adams D, Fan ZJ. Temporary workers in Washington State. *Am J Ind Med*. 2010;53(2):135-145.
18. National Institute for Occupational Safety and Health (NIOSH). Use of Workers' Compensation Data for Occupational Safety and Health: Proceedings from June 2012 Workshop. 2013; https://www.cdc.gov/niosh/docs/2013-147/. Accessed May 28, 2019.
19. Foley M. Factors underlying observed injury rate differences between temporary workers and permanent peers. *Am J Ind Med*. 2017;60(10):841-851.
20. Occupational Safety and Health Administration and National Institute for Occupational Safety and Health. Recommended Practices: Protecting Temporary Workers. 2014; https://www.osha.gov/Publications/OSHA3735.pdf. Accessed April 10, 2019.
21. CAL/OSHA. Safety and Health Factsheet: Protecting Temporary Agency Employees.2015; http://www.dir.ca.gov/dosh/dosh_publications/Protecting-Temp-Agency-Employees-fs.pdf. Accessed April 10, 2019.
22. Ohio Bureau of Workers' Compensation (OHBWC). Fiscal Year 2018 Annual Report. https://www.ic.ohio.gov/news/annualreport_pdfs/bwc_ic_annual_2018.pdf. Accessed April 10, 2019.
23. (BLS) BoLS. Occupational Employment Statistics (OES) Survey - May 2013. 2014; https://www.bls.gov/oes/tables.htm. Accessed August 12, 2019.
24. Bertke SJ, Meyers AR, Wurzelbacher SJ, Measure A, Lampl MP, Robins D. Comparison of methods for auto-coding causation of injury narratives. *Accident Analysis & Prevention*. 2016;88:117-123.
25. Bureau of Labor Statistics (BLS). Occupational injury and illness classification manual, 2012. 2014; https://www.bls.gov/iif/oshoiics.htm. Accessed February 15, 2018.

26. Hintikka N. Accidents at work during temporary agency work in Finland–comparisons between certain major industries and other industries. *Safety Science*. 2011;49(3):473-483.
27. Centers for Disease Control and Prevention. Occupational injuries and deaths among younger workers—United States, 1998-2007. *MMWR Morb Mortal Wkly Rep*. 2010;59(15):449-455.
28. Dale AM, Ryan D, Welch L, Olsen MA, Buchholz B, Evanoff B. Comparison of musculoskeletal disorder health claims between construction floor layers and a general working population. *Occup Environ Med*. 2015;72(1):15-20.
29. Zaidman B Examining the Injuries of Temporary Help Agency Workers. Minnesota Department of Labor and Industry. 2017; https://static1.squarespace.com/static/55ddc72fe4b0f656b822f51d/t/5a301d5053450af01ffd9a8d/1513102673640/Brian+Zaidman_Ocuupational+Injury_Temp+workers+MIPA+Nov+2017.pdf. Accessed April 10, 2019.
30. Shannon HS, Lowe GS. How many injured workers do not file claims for workers' compensation benefits? *Am J Ind Med*. 2002;42(6):467-473.
31. Riley K, Morier D Patterns of Work-Related Injury and Common Injury Experiences of Workers in the Low-Wage Labor Market. In: UCLA Labor Occupational Safety and Health Program, Los Angeles, CA; 2015.
32. Mallon TM, Cherry SE. Investigating the relationship between worker demographics and nature of injury on federal department of defense workers' compensation injury rates and costs from 2000 to 2008:. *J Occup Environ Med*. 2015;57(Suppl 3):S27-S30.
33. Nelson CJL, Bigley DP, Mallon TM. Analysis of new workers' compensation claims in the department of defense civilian workforce, 2000-2012:. *J Occup Environ Med*. 2015;57(Suppl 3):S20-S26.
34. Biddle J, Roberts K, Rosenman KD, Welch EM. What percentage of workers with work-related illnesses receive workers' compensation benefits? *J Occup Environ Med*. 1998;40(4):325-331.
35. Rosenman KD, Gardiner JC, Wang J, et al. Why most workers with occupational repetitive trauma do not file for workers' compensation. *J Occup Environ Med*. 2000;42(1):25-34.
36. Azaroff LS, Davis LK, Naparstek R, Hashimoto D, Laing JR, Wegman DH. Barriers to use of workers' compensation for patient care at Massachusetts community health centers. *Health Serv Res*. 2013;48(4):1375-1392.
37. Azaroff LS, Levenstein C, Wegman DH. Occupational injury and illness surveillance: conceptual filters explain underreporting. *Am J Public Health*. 2002;92(9):1421-1429.
38. Fan ZJ, Bonauto DK, Foley MP, Silverstein BA. Underreporting of work-related injury or illness to workers??? Compensation: individual and industry factors:. *J Occup Environ Med*. 2006;48(9):914-922.
39. Scherzer T, Wolfe N. Barriers to workers' compensation and medical care for injured personal assistance services workers. *Home Health Care Serv Q*. 2008;27(1):37-58.
40. Lipscomb HJ, Dement JM, Silverstein B, Cameron W, Glazner JE. Who is paying the bills? Health care costs for musculoskeletal back disorders, Washington State Union Carpenters, 1989-2003:. *J Occup Environ Med*. 2009;51(10):1185-1192.
41. National Institute for Occupational Safety and Health (NIOSH). Safe • Skilled • Ready Workforce Program. 2018; https://www.cdc.gov/niosh/programs/ssrw/default.html. Accessed April 10, 2019.
42. Palassis J, Schulte PA, Sweeney MH, Okun AH. Enhancing occupational safety and health through use of the national skill standards. *Int J Occup Environ Health*. 2004;10(1):90-98.
43. Bush D, Andrew K. Integrating Occupational Safety and Health Training into Career Technical Education in Construction. *University of California Berkeley Labor Occupational Health Program*, 2013. Accessed April 10, 2019.
44. Beacon Mutual Insurance. Temporary Employment & Employee Leasing Agencies Related Documents. 2019; https://www.beaconmutual.com/employers/temp-agencies/. Accessed April 10, 2019.
45. Commonwealth of Massachusetts. An Act Establishing A Temporary Workers Right To Know. 2012; https://malegislature.gov/Laws/SessionLaws/Acts/2012/Chapter225. Accessed March 16, 2019.
46. Tanenbaum JM, AC A California Says Think Twice Before Using Temporary Workers or Others from Staffing Agencies and Other Labor Contractors. 2015; https://www.nixonpeabody.com/en/ideas/articles/2015/01/27/california-says-think-twice-before-using-temporary-workers-or-others-from-staffing-agen. Accessed April 10, 2019.
47. Illinois General Assembly. Employment: Day and Temporary Labor Services Act. 2018; http://www.ilga.gov/legislation/ilcs/ilcs3.asp?ActID=2417&ChapterID=68. Accessed April 10, 2019.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

How to cite this article: Al-Tarawneh IS, Wurzelbacher SJ, Bertke SJ. Comparative analyses of workers' compensation claims of injury among temporary and permanent employed workers in Ohio. *Am J Ind Med*. 2020;63:3–22. https://doi.org/10.1002/ajim.23049