Mining Injuries 2012–2019

Using Workers' Compensation Claims Data From 35 States to Identify Rates and Costs Associated by Nature of Injury, Event/Exposure, and Body Part Affected

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Objective: This study summarized the frequency and cost of mining-related injuries. **Methods:** Mining-related workers' compensation (WC) claims data from 35 states were summarized to report counts, claim rates, and costs for 2012–2019. These data were compared with Mine Safety and Health Administration injury and employment data for the same period. **Results:** Despite system differences, both WC and Mine Safety and Health Administration counts and rates declined over time and injury patterns were similar. Total WC costs were approximately $2.325B. Medical-only claims represented 59.4% of the claims by count, but only 3.3% of costs. Lost-time nonfatal claims represented 40.2% of the claims by count, but 90.2% of costs. Claims frequency and costs varied greatly by injury event/exposure, part of body, and nature. **Conclusions:** Injury frequency has declined but costs remain high. The most costly and disabling cases were identified.

Keywords: mining, workers' compensation, injury, OIICS, injury costs, MSHA

LEARNING OUTCOMES

- Describe how costs differ dramatically by levels of severity (medical-only, lost-time nonfatal, lost-time fatal) and injury event/exposure, nature, and part of body in mining-related injuries
- Differentiate between the National Council on Compensation Insurance mining related workers' compensation claims data and the Mine Safety and Health Administration accident/injury/illness data
- Illustrate how workers' compensation claims data can supplement existing mining occupational surveillance data

The US mining industry employs approximately 300,000 workers in all 50 states.[1] Mining is known for its physical, chemical, noise, whole body vibration, respiratory, ergonomic, thermal, and psychosocial occupational hazards[2] and its dangerous work situations[3] due to the nature of the work and the work environment. Recent injury trends in mining show a gradual decline of injury rates since 2010.[4] This has been attributed to improved rule enforcement, automation, increased safety awareness, and implementations of new safety technologies.[5,6] Even with the decreasing injury rates, mining-related injuries tend to be more severe because they average more days away from work compared with other industries.[7]

Understanding occupational injury burden in the mining industry is critical for setting priorities for research and intervention development. The National Institute for Occupational Safety and Health (NIOSH) uses an evidence-based method that employs the criteria of "burden, need, and impact" to identify research priorities and aid in the evaluation of the taxpayers' investment in research.[8] The burden of work-related injuries is the impact of injury as measured by injury rates/counts, functional impairments, economic costs, and other indicators. The true burden of occupational and work-related diseases and injuries is unknown, and what is reported as burden is significantly underestimated.[9] Occupational injuries and illnesses are underreported in the United States, including the US mining sector.[10–12] A study from Illinois found that 66% of mining workers' compensation (WC) claims were not reported in the Mine Safety and Health Administration (MSHA) injury data,[13] and an MSHA analysis of injuries in Kentucky and California from 2000 to 2012 estimated that between 23% and 46% of mining injuries were unreported.[14] This underestimation affects the way decision makers view investments in research and worker protection, which in turn has a substantial impact on national welfare and public health.[9]

Although the MSHA injury and employment datasets are commonly used for mining injury analyses, public health researchers are increasingly using other data sources, such as WC systems to address the underreporting issue as well as provide prevention insights. In addition, the current National Mining Agenda includes a surveillance objective which incorporates a need for utilizing existing state WC data to supplement the MSHA's injury reports.[15] In the United States, WC involves state-regulated systems designed to provide medical care and partial wage replacement (ie, indemnity) for injured and ill workers. All states except Texas require private and state/local public employers to offer WC coverage, which is provided by a range of private and state-based carriers depending upon the state.[16] Large employers in most states can also self-insure if they demonstrate sufficient fiscal resources.[17] Recently, several states have published WC data, and the mining industry in these states has been highlighted as having relatively high rates of injury. For example, mining had one

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Ethical approval of studies/informed consent: This study was internally reviewed by NIOSH, and it was determined that it did not constitute human subjects' research. Rather, the study is considered surveillance because it involved the analysis of coded and previously collected WC administrative claims data.
J.R.H. and S.J.W. are responsible for the reported research and participated in manuscript conceptualization and design, analysis, data interpretation, and drafting. Both authors have approved of the submitted manuscript.
The Mine Safety and Health Administration (MSHA) employment and injury/illness data is available online here: CDC—Mining —MSHA Data File Downloads—NIOSH. The workers' compensation claims data is not available to the public, but the summarized data is included in the Supplementary Tables.
EQUATER Network Reporting Guidelines: This study adhered to STrengthening the Reporting of OBservational studies in Epidemiology guidelines for observational studies.
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TABLE 1. NCCI Mining-Related Class Codes

NCCI Class Code	Title	Description
0156	Disease experience in connection to coal mining	
0157	Disease experience in connection to coal mining	
0158	Disease experience in connection to coal mining	
0159	Coal workers pneumoconiosis	
0161	Coal workers pneumoconiosis	
0162	Coal workers pneumoconiosis	
0164	Disease experience related to mining	
1019	Coal Mining	
1005	Coal mining, surface and drivers	This code applies to employers that perform surface coal mining.
1016	Coal mining – Not otherwise classified	This code applies to employers that perform coal mining, only if no other classification more specifically describes the employer's business. This code includes excavation and tunneling.
1164	Mining - not coal, underground and drivers	This code applies to employers that perform underground mining, only if no other classification more specifically describes the employer's business.
1165	Mining - not coal, surface and drivers	This code applies to employers that perform surface mining of all types of ore and certain minerals, only if no other classification more specifically describes the employer's business.
1624	Quarry not elsewhere classified	This code applies to employers that quarry various rock materials, only if no other classification more specifically describes the employer's business. This code includes open pit-type quarrying, and the stripping of surface material (overburden) covering the minerals or rocks to be quarried. Important: This code does not include underground mining operations.
1654	Quarry, cement rock, surface, and drivers	This code applies only to cement rock surface quarries operated by cement manufacturers provided that 75% or more of the stone quarried is used in their manufacturing of cement. This code includes all operations to excavate the cement rock.
1655	Lime manufacturing, quarry, and surface	This code applies to surface quarries operated by lime manufacturers, provided that at least 75% of the stone quarried is used in the actual lime manufacture. If more than 25% of the quarry output is used for other than lime manufacture, such operations shall be classified under 1624—Quarry NOC. The crushing of the limestone at the quarry site prior to processing at the plant is included within this classification.
1710	Stone crushing and drivers	This code applies to employers that crush a wide variety of gravel, rock, or stone as a separate and distinct business.
4000	Sand or gravel, digging and drivers	This code applies to employers that dig and strip clay and shale. This code also applies to the digging and the stripping of diatomite, marl, overburden, peat moss or humus, and shale from strip mines.
1169	Kaolin mining—surface—& drivers (GA, SC only)	Kaolin is a sedimentary clay, which is a secondary mineral of the earth's crust resulting from the decomposition of feldspar and other aluminous materials.
1218	Phosphate mining & drivers (FL only)	This code applies to insureds who mine phosphate rock using electric dragline.
1219	Potash mining & drivers (NM)	
1321	Uranium extraction—mining process & drivers (TX only)	No more information other than title.
1604	Quarry—dimension stone & drivers (GA, IN, TN, VT only)	This code applies to employers that exclusively operate open-pit quarries that produce dimension stone for use by others.
6204	Drilling and drivers, not elsewhere classified.	This code applies to specialist contractors who perform drilling operations, only if no other classification more specifically describes the employer's business.

of the highest rates of injury among private employers in Ohio from 2007 to 2017, especially for traumatic injuries related to contact with objects and equipment.[18]

While there are no national WC data sources, there are some organizations that collect multistate data. The National Council on Compensation Insurance (NCCI) is a licensed rating and statistical organization providing to 35 states (and the District of Columbia) and collects a set of WC claims data from carrier-insured (private and state-funded) employers in these states. The NCCI data does not include claims from self-insured employers.[19] The NCCI provides analysis of WC claim costs to guide the setting of rates/loss costs by insurance companies.[20] One of the two principal data sets used in this research article has been provided by NCCI to NIOSH in support of NIOSH research initiatives. The views and conclusions contained in this article are those of the authors and should not be interpreted as representing the opinions of NCCI and NCCI makes no guarantees nor assumes responsibility for the accuracy of any results obtained through the use of the NCCI data.

The primary aim of this study is to summarize aggregate NCCI mining-related injury WC data by state, injury event/exposure, part of body, and nature to identify counts, claim rates, and incurred costs for 2012–2019. A secondary aim is to compare the NCCI data with MSHA injury and employment data from the same states for 2012–2019.

METHODS

Data Sources

The NCCI agreed to share with NIOSH aggregated mining-related WC claims data from 2012–2019 for 35 states. The dataset grouped claims by type: medical-only, lost-time nonfatal, or lost-time fatal. It is noteworthy that the definition of lost-time varies from four or more to eight or more days away from work in US state WC systems.[21] Medical-only claims include only medical costs, while lost-time claims normally include both medical and indemnity costs. The NCCI dataset only includes claims that have been accepted for payment.

The NCCI dataset included information on claims aggregated by state, by year, and by manual class code. Manual class codes group employees at a given employer into distinct classes that are similar in injury risk and type of work performed. Manual class codes are

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TABLE 2. NCCI Mining-Related Employee Counts, Claim Counts, Claim Rates (and Percent), and Claim Costs (and Percent) by Year

Year	Employee Count*	Medical-Only Claim Count (Row %)	Medical-Only Claim Rate **	Medical-Only Claim Costs (All Claim Costs)	Lost-Time Nonfatal Claim Count (Row %)	Lost-Time Nonfatal Claim Rate**	Lost-Time Nonfatal Costs (All Claim Costs)	Lost-Time Fatal Claim Count (Row %)	Lost-Time Fatal Claim Rate**	Lost-Time Fatal Costs (All Claim Costs)	All Claims Count	All Claims Rate**	All Claims Costs
2012	224,478	6,204 (62.8%)	2.76	$12,107,509 (3.3%)	3,636 (36.8%)	1.62	$321,585,631 (88.3%)	40 (0.4%)	0.02	$30,593,587 (8.4%)	9,880	4.40	$364,286,727
2013	220,878	5,323 (61.4%)	2.41	$10,020,608 (3.1%)	3,322 (38.3%)	1.50	$295,217,046 (91.7%)	27 (0.3%)	0.01	$16,527,692 (5.1%)	8,672	3.93	$321,765,347
2014	217,507	5,129 (57.3%)	2.36	$9,658,628 (3.0%)	3,776 (42.2%)	1.74	$282,200,169 (86.3%)	44 (0.5%)	0.02	$35,111,873 (10.7%)	8,949	4.11	$326,970,670
2015	209,880	4,567 (53.1%)	2.18	$9,648,084 (3.2%)	4,010 (46.6%)	1.91	$277,532,275 (93.4%)	24 (0.3%)	0.01	$10,099,237 (3.4%)	8,601	4.10	$297,279,596
2016	199,745	4,374 (59.7%)	2.19	$8,737,038 (3.3%)	2,925 (39.9%)	1.46	$238,050,605 (90.2%)	24 (0.3%)	0.01	$17,079,830 (6.5%)	7,323	3.67	$263,867,473
2017	209,448	4,474 (61.1%)	2.14	$8,713,318 (3.7%)	2,834 (38.7%)	1.35	$214,393,515 (90.8%)	19(0.3%)	0.01	$13,131,112 (5.6%)	7,327	3.50	$236,237,945
2018	224,782	4,753 (62.9%)	2.11	$9,548,581 (3.5%)	2,769 (36.7%)	1.23	$241,863,510 (89.8%)	30 (0.4%)	0.01	$17,971,177 (6.7%)	7,552	3.36	$269,383,267
2019	210,688	3,949 (57.1%)	1.87	$8,835,838 (3.6%)	2,952 (42.7%)	1.40	$226,690,793 (92.4%)	15 (0.2%)	0.01	$9,888,550 (4.0%)	6,916	3.28	$245,415,181
Total	Avg: 214,676	38,773 (59.4%)	2.26	$77,269,603 (3.3%)	26,224 (40.2%)	1.53	$2,097,533,545 (90.2%)	223 (0.3%)	0.01	$150,403,058 (6.5%)	65,220 Avg: 8,153	3.80	$2,325,206,206

*Estimated counts based on NCCI payroll.

**Claim rates per 100 employees. The definition of lost-time varies from 4 to 8 days away from work in US state WC systems.

TABLE 3. NCCI Mining-Related Costs per Claim 2012–2015

Claim Type*	Count (% of Claims)	Mean	Median
Medical-only	21,223 (58.8%)	$1,952	$798
Lost-time nonfatal	14,744 (40.8%)	$79,798	$27,368
Lost-time fatal	135 (0.4%)	$683,944	$511,704

*The definition of lost-time varies from 4 to 8 days away from work in US state WC systems.

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defined by industry or occupation, or a combination of industry and occupation. Employers report yearly payroll and claims separately by each class code. These data are then used as part of a system to adjust WC insurance premium rates based on prior employer loss history. For example, if the class code claim rates per unit of payroll in prior years for the employer are higher than other employers in the same state and class code, WC insurance premiums may be set higher than the premiums for other employers in the same class code.

The NCCI dataset also included total payroll (which may include some overtime but excludes most benefits) reported by employers in each manual class code by state and year.[19] The NCCI data also include specific WC codes developed by the Workers' Compensation Insurance Organizations (WCIO) that are used by many state WC systems to describe the cause, nature, and part of body associated with each WC claim.[22] Bureau of Labor Statistics' Occupational Employment and Wage Statistics (OEWS) data[23,24] for years 2012–2019 were used to obtain median annual wages by state for the mining industry (North American Industry Classification System [NAICS] = 212000), which was later used with the NCCI payroll data to estimate employee counts.

To compare the NCCI mining claim data to standard mining injury surveillance data, we used public domain datasets provided by MSHA. Under the US Code of Federal Regulations 30 CFR Part 50 —Notification, Investigation, Reports and Records of Accidents, Injuries, Illnesses, Employment, and Coal Production in Mines, MSHA maintains databases of reported employment and reported cases of accident/injury/illness to provide mandated surveillance information. This reporting requirement applies to mine operators as well as to contractors working on mine property. A Mine Accident, Injury, and Illness Report (MSHA Form 7000-1) must be completed for all reportable accidents, injuries, or illnesses occurring at US mining facilities. Reportable occupational injuries include all incidents that require medical treatment or result in death, loss of consciousness, inability to perform all job duties on any workday after the injury, or temporary assignment or transfer to another job. MSHA defines lost-time cases as those with one or more days away from work. The injury data captures the accidents, injuries, and illnesses reported in the US mining industry from 1983 to 2022.

Mine operators and contractors whose employees perform mining work on mine property are also required to file a Quarterly Mine Employment and Coal Production Report (MSHA Form 7000-2) within 15 days after the end of each calendar year quarter. This information becomes a part of MSHA's address and employment files and includes contact information, production of clean coal tonnage, average number of persons employed during the reporting period, and the corresponding number of employee hours worked. The employment data captures all the mines and mine workers in the United States and provides the denominator data for rate calculations.

The annual records of accidents, injuries, or illnesses and employment records are publicly available through MSHA's open government data portal. The National Institute for Occupational Safety and Health's Mining Program (NIOSH Mining) adds several recoded and computed variables to the accident, injury, or illness records and publishes these along with the employment records as Microsoft Assess and SPSS (IBM SPSS, Inc, Chicago, IL) datasets, details of which can be accessed at www.cdc.gov/niosh/mining/data/default.html. The

TABLE 4. MSHA Employee Count, Injury/Illness Counts, and Rates*

Year	Employee Count*	Medical-Only Injury/Illness Count (Row %)	Medical-Only Rate **	Lost-Time Nonfatal Injury/Illness Count (Row %)	Lost-Time Nonfatal Rate**	Lost-Time Fatal Injury/Illness Count (Row %)	Lost-Time Fatal Rate**	All Injuries/Illnesses Count	All Injury/Illness Rate**
2012	166,871	2,912 (54%)	1.75	2,498 (46%)	1.50	26 (0.5%)	0.02	5,436	3.26
2013	161,379	2,824 (54%)	1.75	2,338 (45%)	1.45	28 (0.5%)	0.02	5,190	3.22
2014	158,782	2,702 (53%)	1.70	2,357 (46%)	1.48	28 (0.6%)	0.02	5,087	3.20
2015	149,472	2,472 (54%)	1.65	2,061 (45%)	1.38	13 (0.3%)	0.01	4,546	3.04
2016	135,508	2,222 (56%)	1.64	1,730 (44%)	1.28	17 (0.4%)	0.01	3,969	2.93
2017	140,891	2,019 (51%)	1.43	1,883 (48%)	1.34	21 (0.5%)	0.01	3,923	2.78
2018	146,080	1,990 (53%)	1.36	1,750 (47%)	1.20	16 (0.4%)	0.01	3,756	2.57
2019	147,242	2,038 (53%)	1.38	1,787 (47%)	1.21	15 (0.4%)	0.01	3,840	2.61
Total	Avg: 150,778	19,179 (54%)	1.59	16,404 (46%)	1.36	164 (0.5%)	0.01	35,747 Avg: 4,468	2.96

MSHA defines lost-time as 1 or more days away from work.
*For the 35 NCCI states, excludes contractors and office workers.
**Claim rates per 100 employees.

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TABLE 5. Mining-Related Counts, Rates and Costs*** by Event/Exposure for MSHA Injury/Illness Data and NCCI Claims, 2012–2019

Event/Exposure Type	MSHA Injury/ Illness Count 2012–2019* (% of Total)	MSHA Rate**	NCCI Claim Count 2012–2019 (% of Total)	NCCI Claim Rate**	Total Cost 2012–2019 (% of Total)	Indemnity Cost 2012–2019	Indemnity Cost % of Total Cost	Medical Cost 2012–2019	Medical Cost % of Total Cost
Contact with objects and equipment	13,692 (38.3%)	1.14	25,195 (38.6%)	1.47	$687,080,496 (29.5%)	$368,121,437	53.6%	$318,959,060	46.4%
Overexertion and bodily reaction	9,428 (26.4%)	0.78	17,257 (26.5%)	1.00	$559,434,824 (24.1%)	$347,890,555	62.2%	$211,544,269	37.8%
Falls, slips, and trips	9,018 (25.2%)	0.75	9,291 (14.2%)	0.54	$341,881,283 (14.7%)	$178,649,860	52.3%	$163,231,424	47.7%
Exposure to harmful substances or environments	2,768 (7.7%)	0.23	6,648 (10.2%)	0.39	$388,269,181 (16.7%)	$270,047,864	69.6%	$118,221,318	30.4%
Other—miscellaneous, not classified	841 (2.4%)	0.07	3,454 (5.3%)	0.20	$120,856,575 (5.2%)	$83,414,887	69.0%	$37,441,688	31.0%
Transportation incidents	—	—	2,562 (3.9%)	0.15	$190,019,323 (8.2%)	$104,600,006	55.0%	$85,419,317	45.0%
Violence and other injuries by persons or animals	—	—	520 (0.8%)	0.03	$4,309,308 (0.2%)	$1,468,616	34.1%	$2,840,692	65.9%
Fires and explosions	—	—	290 (0.4%)	0.02	$32,652,380 (1.4%)	$18,828,411	57.7%	$13,823,969	42.3%
Total	35,747	2.96	65,220	3.80	$2,325,206,206	$1,373,549,488	59.1%	$951,656,718	40.9%

NR means "not reported" and indicates fewer than five case counts.
*For the 35 NCCI states, excludes contractors and office workers.
**Rate per 100 workers.
***All costs in this table include both paid and reserves.

TABLE 6. NCCI Mining-Related Claim Counts and Costs** by Event/Exposure by Claim Severity Type, *Continued on next page*

	Medical-Only Claims				Lost-Time Nonfatal Claims		
Event-Exposure Type	Count 2012–2019	Medical Cost 2012–2019	Mean Claim Cost*** 2012–2015	Median Claim Cost*** 2012–2015	Count 2012–2019	Total Cost 2012–2019	Mean Claim Cost*** 2012–2015
Contact with object and equipment	18,337 (47.3%)	$33,259,427 (43.0%)	$1,770	$846	6,780 (25.9%)	$596,312,619 (28.4%)	$85,589
Overexertion and bodily reaction	8,859 (22.8%)	$17,227,262 (22.3%)	$1,966	$805	8,392 (32.0%)	$539,225,196 (25.7%)	$66,047
Falls, slips, and trips	5,352 (13.8%)	$12,561,351 (16.3%)	$2,350	$957	3,924 (15.0%)	$319,330,645 (15.2%)	$85,102
Exposure to harmful substances or environments	2,515 (6.5%)	$4,860,086 (6.3%)	$1,716	$506	4,108 (15.7%)	$371,563,900 (17.7%)	$90,175
Other—miscellaneous, not classified	1,683 (4.3%)	$3,256,692 (4.2%)	$1,930	$602	1,745 (6.7%)	$105,521,425 (5.0%)	$62,908
Transportation incidents	1,395 3.6%	$4,666,378 (6.0%)	$3,536	$923	1,103 (4.2%)	$140,529,001 (6.7%)	$119,287
Violence and other injuries by persons or animals	460 (1.2%)	$656,941 (0.9%)	$936	$393	60 (0.2%)	$3,652,366 (0.2%)	$59,948
Fires and explosions	171 (0.4%)	$773,383 (1.0%)	$5,243	$663	111 (0.4%)	$21,336,609 (1.0%)	$139,152
Total	38,773 (100%)	$77,269,603 (100%)	$1,952	$798	26,224 (100%)	$2,097,533,545 (100%)	$79,798

NR means "not reported" and indicates fewer than five case counts.
**All costs in this table include both paid and reserves.
***Mean and median cost per claim based on 2012–2015 data only.

two separate MSHA datasets—the accident, injury, or illness dataset and the employment dataset—published by NIOSH Mining were also used for this analysis.

Case Selection

To identify mining-related WC cases in the NCCI data, two NIOSH researchers familiar with WC systems mapped NCCI manual class codes to the NAICS codes to identify class codes related to the mining industry. This was based on the 2022 NAICS definition for subsector 212 Mining (except oil and gas), which includes mining, mine development, and mineral/material preparation.[25] The mapping was accomplished by consulting NCCI manual class code descriptions, a published class code/NAICS code crosswalk,[26] and data from the Ohio Bureau of Workers' Compensation that described the distribution of class codes within NAICS code 212. Class codes that could be commonly found in other industries, such as office/clerical and general construction workers, were excluded. The NCCI then provided NIOSH aggregated data for the chosen mining-related class codes shown in Table 1. From the NCCI data, 65,220 WC claims from 35 states for 2012–2019 were aggregated and analyzed to characterize occupational injury and illness incidents. The District of Columbia was excluded from rate calculations due to very few claims and limited payroll data available.

The cases selected from MSHA data included injury/illness cases reported for the years 2012–2019 from the 35 states that use NCCI. Contractors were excluded, as contractors generally perform work related to construction, demolition, equipment installation/service/repair, mine development, and drilling/blasting. In addition, contractors do not report hours by state, so they cannot be matched to the NCCI states. Office employees were also excluded as they do not have similar job hazards as mine workers and they were not included in the mining related NCCI class codes. Injury/illness classified as natural causes, nonemployee (eg, delivery drivers), and nonchargeable cases (including first aid only) were excluded to align with the NCCI WC cases.

Case Coding

The NCCI data uses WCIO codes and the MSHA data uses its own coding scheme. To make comparisons, both NCCI and MSHA data for nature of injury, part of body, and event/exposure/cause were converted to the Bureau of Labor Statistics' (BLS) Occupational Injury and Illness Classification System (OIICS).[27] The authors refined a crosswalk from the WCIO nature of injury, part of body, and cause of injury codes to the BLS OIICS as provided in Tables S1a-c in the online Appendix (Supplementary Digital Content, http://links.lww.com/JOM/B517). The WCIO codes are not as detailed as BLS OIICS codes and do not have a defined coding hierarchy or instructions. The NIOSH, the Massachusetts Department of Public Health, and others have developed past crosswalks between WCIO cause and BLS OIICS event/exposure codes at the basic one- and two-digit levels.[28] Two NIOSH researchers familiar with WC systems first reviewed the code sets and developed two independent draft crosswalks based on the descriptions and coding rules associated with each code set. Researchers then utilized a dataset from the state of Alaska from an unrelated NIOSH study that included WCIO class codes and NIOSH-coded OIICS codes for nearly 30,000 claims to develop distributions that showed how the WCIO and OIICS codes were associated. The two NIOSH researchers then used this distribution information from Alaska to review the two independent draft crosswalks to develop a final consensus crosswalk at the one-digit OIICS level for body part and event/exposure and at the two-digit level for nature of injury. More detailed crosswalks between WCIO and OIICS are problematic because the WCIO codes are not hierarchal, are less detailed, and may map to more than one OIICS code even at the two-digit level.[18]

The authors then developed a crosswalk from the MSHA injury codes for part of body, nature of injury, and accident type/event to the associated BLS OIICS codes. The MSHA part of body was coded to OIICS one-digit level part of body. The nature of injury was coded to the OIICS two-digit level nature of injury, and the MSHA accident type coded to OIICS one-digit level event/exposure. The authors attempted to obtain the BLS coding scheme to recode the MSHA variables into the OIICS, as used in the BLS Resource Tables,[29] but the BLS was unable to share it due to confidentiality reasons. However, the coding was relatively straightforward, and the authors were able to develop a final consensus crosswalk for classifying MSHA data by OIICS code so that it could be compared with NCCI data.

Rate Development

The authors utilized the NCCI data to calculate the number of claims per unit of payroll by state and year. We used BLS OEWS data on the median annual wage of mining occupations by each NCCI state for each year from 2012 to 2019[24] to estimate employee counts from the NCCI payroll. Median wages were used instead of mean wages because wage estimates are right skewed, mostly because of office- and management-related occupations, which increases the mean of all

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TABLE 6. NCCI Mining-Related Claim Counts and Costs** by Event/Exposure by Claim Severity Type, *Continued*

Lost-Time Nonfatal Claims			Lost-Time Fatal Claims					
Median Claim Cost*** 2012–2015	Indemnity Cost 2012–2019	Medical Cost 2012–2019	Count 2012–2019	Total Cost 2012–2019	Mean Claim Cost*** 2012–2015	Median Claim Cost*** 2012–2015	Indemnity Cost 2012–2019	Medical Cost 2012–2019
$24,365	$312,301,725	$284,010,894	78 (35.0%)	$57,508,451 (38.2%)	$791,419	$655,252	$55,819,711	$1,688,739
$27,825	$344,919,657	$194,305,539	6 (2.7%)	$2,982,367 (2.0%)	$461,856	$606,745	$2,970,899	$11,468
$38,810	$169,232,101	$150,098,544	15 (6.7%)	$9,989,287 (6.6%)	$621,710	$460,923	$9,417,758	$571,528
$23,363	$259,570,432	$111,993,467	25 (11.2%)	$11,845,195 (7.9%)	$573,356	$342,801	$10,477,432	$1,367,764
$26,443	$71,926,261	$33,595,164	26 (11.7%)	$12,078,458 (8.0%)	$532,802	$533,991	$11,488,626	$589,832
$36,572	$60,852,209	$79,676,792	64 (28.7%)	$44,823,943 (29.8%)	$526,899	$332,461	$43,747,797	$1,076,147
$31,155	$1,468,616	$2,183,750	NR	NR	NR	NR	NR	NR
$38,603	$8,942,922	$12,393,687	8 (3.6%)	$10,542,388 (7.0%)	$1,598,373	$1,337,700	$9,885,489	$656,899
$27,368	$1,229,266,916	$868,266,629	223 (100%)	$150,403,058 (100%)	$683,944	$511,704	$144,282,572	$6,120,486

mining occupations. The OEWS wages are defined as base pay, which excludes overtime, bonuses, and benefits. Mining is defined as having a North American Industry Classification System (NAICS) code 212000, which is *Mining (excluding oil and gas),* and all occupations were used (Standard Occupation Code 00-0000). These annual median wage estimates are based on assuming 2080 hours of work per year (52 weeks × 40 hours per week).[23] To estimate the annual number of mine employees for each state, total annual NCCI state payroll was divided by the state median annual mining wage. These data were then applied to the NCCI injury count data to estimate the number of WC claims per 100 full year, full-time equivalent workers as shown in Equation 1. The authors want to note that this is not an NCCI calculation. Payroll was used to estimate employees based on average mining wages. This is not an official NCCI claim incidence.

$$\text{NCCI claim incidence rate per 100 mine employees} = \frac{\text{Total number of injuries}}{\left[\frac{\text{Total NCCI payroll}}{\text{Median annual mining wage}}\right]} \times 100$$

Equation 1

For the MSHA data, injury rates were calculated for each state and by the OIICS codes for injured body region, nature of injury, and event. Injury incidence rates were calculated per 100 full-time equivalent (FTE) mine workers per year using Equation 2. This equation assumes that miners work on average 2000 hours annually. Total employment hours are reported by each mine in the employment dataset.

$$\text{MSHA injury incidence rate per 100 FTE} = \frac{\text{Total number of injuries}}{\text{Total employment hours}} \times 200,000$$

Equation 2

Cost Valuation

The NCCI dataset provided incurred costs of medical treatments and indemnity for lost wages due to temporary and permanent disability. These include both paid costs and reserves for anticipated future costs. Costs were valued as of the fifth report, which is provided approximately 5.5 years after the policy year of injury. Not all 2012–2019 WC cases were closed, which means additional costs will continue to accrue. At the time of data receipt from NCCI, only 2012–2015 data had full fifth report development. For this reason, calculations of mean and median costs per claim were limited to 2012–2015 claims. All costs are adjusted for inflation to 2022 dollars using the gross domestic product deflator published by the US Department of Commerce's Bureau of Economic Analysis.[30]

Institutional Review Board Statement

This study was internally reviewed by the NIOSH, and it was determined that it did not constitute human subjects research. Rather, the study is considered surveillance because it involved the analysis of coded and previously collected WC administrative claims data. The study design adhered to STrengthening the Reporting of OBservational studies in Epidemiology guidelines and the checklist can be found in the Supplementary Digital Content, http://links.lww.com/JOM/B518.

RESULTS

Overall

Yearly mining-related estimated FTE employee counts, WC claim counts, rates, and costs from the 2012–2019 NCCI data are provided in Table 2. State-level data are provided in Tables S2a-b in the online Appendix (Supplementary Digital Content, http://links.lww.com/JOM/B517). There were 65,220 mining-related WC claims during this period, with an annual mean of 8153 claims. The number of estimated FTE employees per year was 214,676 and FTE employees declined 6% from 2012 to 2019, with 54% of states experiencing declines. The total number of claims per year declined 30% from 2012 (9880) to 2019 (6916). This varied by state, with the majority (72%) experiencing declines. The overall claim rate also declined of 25% from 2012 (4.40) to 2019 (3.28), with 78% of states having declines.

The number of lost-time nonfatal claims also declined, but to a lesser degree, 19% from 2012 (3636) to 2019 (2952), with 72% of states having declines. The rate of lost-time nonfatal claims declined 13.5% from 2012 (1.62) to 2019 (1.40), with 72% of states showing declines.

The total mining-related WC costs (Table 2) during this 8-year period were over $2B ($2,325,206,206). Medical-only claims represented 59.4% of the claims by count, but only 3.3% of costs. Lost-time nonfatal claims represented 40.2% of the claims by count, but 90.2% of costs. Lost-time fatal claims represented 0.3% of the claims by count, but 6.4% of costs.

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TABLE 7. Mining-Related Claim Counts, Rates, and Costs*** by Part of Body for MSHA Injury/Illness Data and NCCI Claims, 2012–2019

Part of Body	MSHA Injury/Illness Count 2012–2019* (% of Total)	MSHA Count Rate**	NCCI Claim Count 2012–2019 (% of Total)	NCCI Claim Rate**	Total Cost 2012–2019 (% of Total)	Indemnity Cost 2012–2019	Indemnity Cost % of Total Cost	Medical Cost 2012–2019	Medical Cost % of Total Cost
Upper extremities	13,686 (38.3%)	1.14	21,083 (32.3%)	1.23	$485,951,767 (20.9%)	$255,288,190	52.5%	$230,663,576	47.5%
Trunk	7,333 (20.5%)	0.61	16,137 (24.7%)	0.94	$821,467,289 (35.3%)	$547,228,780	66.6%	$274,238,508	33.4%
Lower extremities	7,117 (19.9%)	0.59	11,938 (18.3%)	0.70	$343,669,421 (14.8%)	$172,396,612	50.2%	$171,272,809	49.8%
Head	4,722 (13.2%)	0.39	9,472 (14.5%)	0.55	$179,741,108 (7.7%)	$103,945,671	57.8%	$75,795,436	42.2%
Multiple body parts	1,667 (4.7%)	0.14	3,924 (6.0%)	0.23	$306,092,560 (13.2%)	$182,194,380	59.5%	$123,898,181	40.5%
Neck, including throat	679 (1.9%)	0.06	1,850 (2.8%)	0.11	$126,946,771 (5.5%)	$67,196,192	52.9%	$59,750,580	47.1%
Body systems	532 (1.5%)	0.04	599 (0.9%)	0.03	$55,514,839 (2.4%)	$40,518,007	73.0%	$14,996,832	27.0%
Nonclassifiable	NR	NR	216 (0.3%)	0.01	$5,822,019 (0.3%)	$4,781,655	82.1%	$1,040,364	17.9%
Other body parts	11 (<0.01%)	<0.01	NR	NR	NR	NR	NR	NR	NR
Total	35,747	2.96	65,220	3.80	$2,325,206,206	$1,373,549,488	59.1%	$951,656,718	40.9%

NR means "not reported" and indicates fewer than five case counts.

*For the 35 NCCI states, excludes contractors and office workers.

**Rate per 100 workers.

***All costs in this table include both paid and reserves.

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Table 3 provides mining-related costs per WC claim for 2012–2015. Costs differed dramatically by claim severity type. Mean cost per medical-only claim was $1925 (median, $798). Mean cost per lost-time nonfatal claim was $79,798 (median, $27,368). Mean cost per lost-time fatal claim was $683,944 (median, $511,704).

Annual MSHA count and rate data for the 35 NCCI states from 2012 to 2019 are provided in Table 4. During this period, the estimated number of FTEs declined 12% with 40% of states experiencing declines, and there was an annual average of 150,778 FTE mine workers. In the same period, an average of 4468 injuries/illnesses were reported. Most states (85%) had decreasing or steady counts and rates. The number of all reported injuries/illnesses per year declined 30% from 2012 (5436) to 2019 (3840). The rate of all injuries/illnesses declined 20% from 2012 (3.26) to 2019 (2.61). The count and rates for medical-only and of lost-time nonfatal claims also declined with similar trends as the overall injury/illness data.

Event/Exposure

Table 5 presents NCCI mining-related WC claim counts, rates, and costs by event/exposure, along with MSHA data on injury counts and rates by event/exposure. Nearly 39% of the WC claims by count had an event/exposure classified as contact with objects and equipment, representing 30% of total costs. This was followed by overexertion and bodily reaction with 27% of claims by count and 24% of costs. Across all event/exposure types, 59% of costs were due to indemnity payments and 41% due to medical payments. Indemnity payments as a share of total claim cost varied by event/exposure type, ranging up to 69% of all costs for exposure to harmful substances or environments claims.

The distribution of injuries/illnesses by event/exposure in the MSHA data was similar to the distribution in the NCCI data, with nearly 39% classified as contact with objects and equipment and 27% classified as overexertion/bodily reaction, 8% classified as exposure to harmful substances and 2.4% classified as other/not classified. The 25% classified in MSHA data as falls, slips, and trips was much larger than the 14% found in the NCCI claims. While transportation incidents, violence, and fires and explosions only made up 5% of the NCCI claims, note that the injury classification scheme used in the MSHA data did not use these injury categories. This means that injuries that might have belonged to these categories were instead classified elsewhere.

Table 6 presents NCCI mining-related WC claim counts and costs by event/exposure by claim severity type. Claim counts and costs varied considerably by event/exposure and claim severity. Among medical-only claims, contact with objects and equipment led with 47% of claims by count and 43% of costs, followed by overexertion/bodily reaction (23% of claims; 22% of costs) and falls, slips, and trips (14% of claims; 16% of costs). Fires and explosions represented the highest cost per medical-only claim ($5243 mean, $663 median) followed by transportation incidents ($3536 mean, $923 median), and falls, slips, and trips ($2350 mean, $805 median).

Among lost-time nonfatal claims, overexertion and bodily reaction led with 32% of claims by count and 26% of costs, followed by contact with objects and equipment (26% of claims; 28% of costs) and exposure to harmful substances or environments (16% of claims; 18% of costs). Fires and explosions again represented the highest cost per lost-time nonfatal claims ($139,152 mean, $38,603 median) followed by transportation incidents ($119,287 mean, $36,572 median) and exposure to harmful substances or environments ($90,175 mean, $23,363 median).

Among lost-time fatal claims, contact with objects and equipment led with 35% of lost-time fatal claims by count and 38% of costs, followed by transportation incidents (29% of claims; 30% of costs) and exposure to harmful substances or environments (11% of claims; 8% of costs). Fires and explosions again represented the highest cost per lost-time fatal claims ($1,598,373 mean, $1,337,700 median) followed by contact with objects and equipment ($791,419 mean, $655,252 median) and falls, slips, and trips ($621,710 mean, $460,923 median).

Part of Body

Table 7 presents NCCI mining-related WC claim counts, rates, and costs by part of body, along with MSHA data on injury counts and rates by part of body. A total of 32% of the WC claims had a part of body classified as upper extremities, representing 21% of total costs. This was followed by trunk with 25% of claims and 35% of costs. Indemnity payments varied by part of body, ranging up to 72% of all costs for body systems claims. The distribution of injuries/illness by part of body in the MSHA data was similar to the NCCI data. Upper extremities made up 39% of the MSHA data, followed by trunk (21%) and lower extremities (20%).

Table 8 presents NCCI mining-related WC claim counts and costs by part of body by claim severity type. Claim counts and costs varied considerably by part of body and claim severity. Among medical-only claims, upper extremities led with 36% of claims by count and 34% of costs, followed by trunk (21% of claims; 20% of costs) and lower extremities (19% of claims; 16% of costs). Neck, including throat represented the highest cost per medical-only claim ($3443 mean, $1359 median) followed by multiple body parts ($3027 mean, $1345 median), and body systems ($2825 mean, $1181 median).

Among lost-time nonfatal claims, trunk led with 31% of claims by count and 37% of costs, followed by Upper Extremities (27% of claims; 22% of costs) and Lower Extremities (18% of claims; 16% of costs). Neck, including Throat again represented the highest cost per Lost-time nonfatal claim ($141,782 mean, $47,355 median) followed by Trunk ($101,579 mean, $28,443 median) and body systems ($97,561 mean, $33,764 median).

Among lost-time fatal claims, multiple body parts led with 40% of claims by count and 45% of costs, followed by trunk (24% of claims; 21% of costs) and body systems (21% of claims; 19% of costs). Among body part claims with at least 5 claims, multiple body parts represented the highest cost per lost-time fatal claim ($777,448 mean, $625,308 median) followed by trunk ($644,254 mean, $506,718 median) and Body Systems ($572,383 mean, $413,302 median).

Nature of injury

Table 9 presents NCCI WC claim counts, rates, and costs by nature of injury, along with MSHA data on injury counts and rates by nature of injury. A total of 35% of the WC claims had a nature of injury classified as traumatic injuries to muscles, tendons, ligaments, and joints, representing 32% of total costs. This was followed by surface wounds and bruises with 16% of claims and 5% of costs. Indemnity payments varied by part of body, ranging up to 81% of all costs for nervous system and sense organs diseases. The classification for nature of injury in the MSHA data generally followed the same pattern as the nature of injury reported in the NCCI data, with 34% classified as traumatic injuries to muscles, tendons, ligaments, and joints, 22% classified as open wounds, 15% classified as traumatic injuries to bones, nerves, spinal cord, and 10% classified as surface wounds and bruises.

Table 10 presents NCCI mining-related WC claim counts and costs by nature of injury by claim severity type. Claim counts and costs varied considerably by nature and claim severity. Among medical-only claims, traumatic injuries to muscles, tendons, ligaments, and joints led with 34% of claims by count and 34% of costs, followed by surface wounds and bruises (23% of claims; 18% of costs) and open wounds (18% of claims; 15% of costs). Circulatory system diseases represented the highest cost per medical-only claim ($5074 mean, $2351 median) followed by intracranial injuries ($4363 mean, $2040 median), and traumatic injuries to bones, nerves, spinal cord ($3847 mean, $1585 median).

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TABLE 8. NCCI Mining-Related Claim Counts and Costs** by Part of Body by Claim Severity Type, *Continued on next page*

	Medical-Only Claims				Lost-Time Nonfatal Claims		
Part of Body	Count 2012–2019	Medical Cost 2012–2019	Mean Claim Cost*** 2012–2015	Median Claim Cost*** 2012–2015	Count 2012–2019	Total Cost 2012–2019	Mean Claim Cost*** 2012–2015
Upper extremities	13,983 (36.1%)	$26,162,494 (33.9%)	$1,813	$861	7,098 (27.1%)	$457,879,854 (21.9%)	$63,106
Trunk	7,955 (20.5%)	$15,631,355 (20.2%)	$1,930	$685	8,129 (31.0%)	$773,375,925 (36.7%)	$101,579
Lower extremities	7,221 (18.6%)	$12,721,730 (16.5%)	$1,750	$787	4,716 (18.0%)	$329,739,314 (15.7%)	$70,140
Head	6,207 (16.0%)	$12,366,658 (16.0%)	$1,885	$717	3,244 (12.4%)	$155,065,999 (7.4%)	$43,939
Multiple body parts	1,765 (4.6%)	$5,486,427 (7.1%)	$3,027	$1,345	2,069 (7.9%)	$232,438,069 (11.2%)	$92,174
Neck, including throat	1,049 (2.7%)	$3,435,170 (4.4%)	$3,443	$1,359	799 (3.0%)	$122,094,220 (5.8%)	$141,782
Body systems	424 (1.1%)	$999,862 (1.3%)	$2,825	$1,181	129 (0.5%)	$25,788,456 (1.3%)	$97,561
Nonclassifiable	168 (0.4%)	$465,476 (0.6%)	$2,354	$857	40 (0.2%)	$1,151,709 (0.1%)	$33,155
Other body parts	NR	NR	NR	NR	NR	NR	NR
Total	38,773	$77,269,603 (100%)	$1,952	$820	26,224 (100%)	$2,097,533,545 (100.0%)	$79,798

NR means "not reported" and indicates fewer than five case counts.

**All costs in this table include both paid and reserves.

**All costs in this table include both paid and reserves.

Among lost-time nonfatal claims, traumatic injuries to muscles, tendons, ligaments, and joints led with 36% of claims by count and 35% of costs, followed by respiratory system diseases (13% of claims; 16% of costs) and traumatic injuries to bones, nerves, spinal cord (12% of claims; 14% of costs). Mental disorders and syndromes represented the highest cost per lost-time nonfatal claim ($154,508 mean, $56,330 median) followed by multiple traumatic injuries and disorders ($141,299 mean, $37,549 median), intracranial injuries ($108,285 mean, $37,869 median), and circulatory system diseases ($106,837 mean, $41,014 median).

Among lost-time fatal claims, traumatic injuries and disorders, unspecified with 33% of lost-time fatal claims by count and 43% of costs, followed by other traumatic injuries and disorders (26% of claims; 25% of costs) and multiple traumatic injuries and disorders (22% of claims; 18% of costs). Among nature claims with at least five claims, traumatic injuries and disorders, unspecified represent the highest cost per lost-time nonfatal claim ($926,505 mean, $806,271 median), followed by other traumatic injuries and disorders ($768,395 mean, $712,591 median) and multiple traumatic injuries and disorders ($493,234 mean, $407,052 median).

DISCUSSION

Comparisons of NCCI Mining-Related Claims to MSHA Injury/Illness Cases

From 2012 to 2019, there were 35,747 MSHA cases compared with 65,220 NCCI claims for mining-related class codes in the same states (82% higher in the NCCI data). During this period, the total case rate for MSHA was 2.96 per 100 workers, while the NCCI claim rate (based on payroll) for the same states was 3.80 per 100 workers (28% higher). The MSHA number of annual full-time equivalent miners employed from 2012 to 2019 averaged 150,778. The NCCI estimated annual mining-related employees from 2012 to 2019 for the same states averaged 42% higher at 214,676. This differed by state and year. This difference was driven in part by Texas, for which there are 15,432 average annual employees in 2012–2019 according to MSHA and 94,777 NCCI estimated mining-related employees. Excluding Texas, the numbers are closer with 135,345 (MSHA) versus 119,899 (NCCI), which is a −11% difference.

The large difference between the NCCI mining-related cases, estimated employment from payroll and MSHA cases and reported employment data was unexpected. A previous study comparing WC to MSHA data in Illinois for 2001–2013 found that MSHA had 1.5 times the reported injuries/illnesses as the Illinois WC program and only 23% of the WC cases were captured by the MSHA Part 50 program.[13]

These differences between NCCI and MSHA data could be due to several factors. Clearly, the large difference in number of cases is in part due to the larger FTE employee count estimated from the NCCI payroll data. The NCCI class codes that we have chosen to represent mining-related claims represent a somewhat different population than does the MSHA data because NCCI class codes do not exactly map to NAICS industry codes. Rather, class codes are often a mix of occupation and industry. This is an inherent limitation of using class codes to identify specific industries. Therefore, the chosen mining-related class codes may have captured some occupations not directly included within MSHA data.

Class codes also affect how office workers and contract workers are categorized. Because of how data are collected and coded, we were able to exclude office workers from both MSHA and NCCI data. However, while we can easily exclude contract workers from MSHA data, they may be included in NCCI data. The NCCI data only includes data for workers required to be covered by WC and in many cases excludes independent contractors. The NCCI data may still include specialist contractors who perform specific tasks at mine sites if their work was classified using the chosen mining-related class codes.

By contrast, contractors do not report hours by state to MSHA. MSHA collects much less information from contractor employers than operator employers, yet contractor employees make up 30% of the mining workforce.[1] We do know for all states, contract miners account for approximately 10% to 15% of nonfatal lost time injuries and have an average injury rate of about 1 per 100 FTEs, which is much lower than mine operators.[1] If we were able to include contractors in the MSHA rate calculations, it is likely the rates would decrease.

The MSHA data also only captures "on-site" injuries and excludes off site injuries/employees. This could be another reason why MSHA captures fewer injury cases and employee counts. A driver delivering material to a customer or off-site location would not be captured by MSHA but could be captured by NCCI's class codes.

TABLE 8. NCCI Mining-Related Claim Counts and Costs** by Part of Body by Claim Severity Type, *Continued*

Lost-Time Nonfatal Claims			Lost-Time Fatal Claims					
Median Claim Cost*** 2012–2015	Indemnity Cost 2012–2019	Medical Cost 2012–2019	Count 2012–2019	Total Cost 2012–2019	Mean Claim Cost*** 2012–2015	Median Claim Cost*** 2012–2015	Indemnity Cost 2012–2019	Medical Cost 2012–2019
$30,688	$253,382,282	$204,497,571	NR	NR	NR	NR	NR	NR
$28,443	$516,822,820	$256,553,105	53 (23.8%)	$32,460,009 (21.1%)	$644,254	$506,718	$30,405,960	$2,054,049
$26,880	$171,197,803	$158,541,512	NR	NR	NR	NR	NR	NR
$9,522	$92,069,347	$62,996,652	21 (9.4%)	$12,308,451 (8.2%)	$478,132	$312,895	$11,876,324	$432,127
$30,916	$116,860,371	$115,577,698	90 (40.4%)	$68,168,065 (45.3%)	$777,448	$625,308	$65,334,009	$2,834,056
$47,355	$65,781,687	$56,312,533	NR	NR	NR	NR	NR	NR
$33,764	$12,495,260	$13,293,195	46 (20.6%)	$28,726,522 (19.4%)	$572,383	$413,302	$28,022,747	$703,775
$14,950	$657,346	$494,363	8 (3.6%)	$4,204,834 (2.9%)	$774,688	$674,642	$4,124,309	$80,525
NR	NR	NR	NR	NR	NR	NR	NR	NR
$26,191	$1,229,266,916	$868,266,629	223 (100%)	$150,403,058 (100%)	$683,944	$517,652	$144,282,572	$6,120,486

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Another factor is related to denominator information—MSHA rates were calculated using hours reported by mines while WC claim rates were calculated by dividing NCCI payroll information by OEWS median wages. We used OEWS median wages for all mining occupations since mining wages in BLS data were right skewed, as they included the most highly paid, white-collar workers, which are not included in the mining related class codes. If wages are overestimated, there would be fewer miners which would lead to overestimating injury rates in the NCCI data. The OEWS wage information and WC payroll reports also differ slightly in inclusion criteria as payroll can include some overtime.

Moreover, the NCCI data generally does not include mines that self-insure, meaning that the mine would provide its own WC insurance coverage independently and not obtain coverage through a private insurance company or state fund. While mining-specific information on self-insurance is unavailable, for all industries, self-insured employers represented approximately 25% of WC benefits paid in the United States from 2016 to 2020.[17] This suggests an even larger discrepancy between the MSHA and NCCI data, because if the NCCI data were to include self-insured employers, the injury counts and FTE estimates from NCCI would exceed those from MSHA by a much greater amount.

In addition, not all injury/illness cases are reported to WC. We would expect MSHA to have a higher number of reported injuries because not all injuries reported to MSHA are reportable to WC and not all mines have WC insurance. The Illinois study also pointed out that the MSHA data did not capture 66% of the WC cases. A majority of mining-related injuries and illnesses that were severe enough to result in a WC claim were not captured by MSHA.[13] The MSHA data underreports mining related illnesses and chronic injuries,[10,31,32] which is likely also true for the NCCI data. Table 9 supports this statement as respiratory diseases, nervous system diseases, and cumulative disorders (including carpal tunnel syndrome) had higher percents of total NCCI claims than the same categories had as percents of total MSHA cases.

The proportions by OIICS event/exposure were highly correlated in the NCCI and MSHA datasets, but there were several noticeable differences. Falls, slips, and trips represented 25% of MSHA cases compared with 14% of NCCI claims. The MSHA data had a lower percentage (7.7%) of exposure to harmful substances or environmental compared with NCCI (10.2%). These differences could be due to limitations with the crosswalk between WCIO codes and OIICS codes. The MSHA's categories for part of body and nature of injury did seem to match well to their OIICS counterparts, but not all the OIICS event/exposure values matched with values of MSHA's event/exposure variable. The MSHA data does not have separate event/exposure codes for *Fires and Explosions, Violence, or Transportation Incidents*—and as previously noted above, MSHA does not include off-site driving.

Cross-walking the MSHA data to OIICS nature of injury, part of body, and event/exposure was validated by comparing to the BLS "Case and Demographic Characteristic for Work-related Injuries and Illnesses involving Days Away from Work" resource tables for each year from 2012 to 2019. After matching the inclusion criteria, the pattern and distributions of counts and rates for OIICS event/exposure (BLS tables R4 and R8), part of body (BLS tables R2 and R6), and nature of injury (BLS tables R1 and R5) were very similar. The BLS data did not have any cases with OIICS event/exposure of *Fires and Explosions* nor *Violence and Oher Injuries by Person or Animals* and only 20 cases of *Transportation Incidents* for 2017 and 2018. The BLS nature of injury tables only included seven of the 20 natures of injury OIICS groupings developed from the WCIO codes. Even with the limited comparisons, the distributions were similar, except for *Open Wounds* and *Other* categories, but it is likely the BLS *Other* category captured all the other OIICS nature of injury variables.

Both MSHA and NCCI data point to declining mining-related injury counts and rates in most states. However, some individual states did experience increases. The same general types of injuries continue to drive overall frequency, pointing to the need for continued prevention improvements.

Cost Data

These analyses indicate a high financial burden of mining-related injuries and illnesses, totaling $2.325 billion in WC costs from 2012 to 2019. The NCCI data generally does not include self-insured employers, so this is just a partial impact for the mining industry.

Costs differed dramatically by claim severity type, providing insights into prevention strategies. Medical-only claims represented almost 60% of the claims by count, but only 3% of costs. Lost-time nonfatal claims represented 40% of the claims by count, but 90% of costs,

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TABLE 9. Mining-Related Claim Counts, Rates, and Costs*** by Nature of Injury for MSHA Injury/Illness data and NCCI Claims, 2012–2019.

Nature of Injury Grouping	MSHA Injury/Illness Count 2012–2019* (% of Total)	MSHA Rate**	NCCI Claim Count 2012–2019 (% of Total)	NCCI Claim Rate**	Total Cost** 2012–2019 (% of Total)	Indemnity Cost 2012–2019	Indemnity Cost (% of Total Cost)	Medical Cost 2012–2019	Medical Cost (% of Total Cost)
Traumatic injuries to muscles, tendons, ligaments, joints, etc (includes dislocations and sprain/strain)	12,109 (33.9%)	1.00	22,589 (34.6%)	1.32	$754,041,731 (32.4%)	$442,432,294	58.7%	$311,609,437	41.3%
Surface wounds and bruises (contusions)	3,402 (9.5%)	0.28	10,526 (16.1%)	0.61	$125,547,970 (5.4%)	$64,326,323	51.2%	$61,221,647	48.8%
Open wounds (cuts, lacerations, punctures, amputations)	7,959 (22.3%)	0.66	8,718 (13.4%)	0.51	$124,296,531 (5.3%)	$48,240,508	38.8%	$76,056,023	61.2%
Traumatic injuries to bones, nerves, spinal cord (includes bone fractures)	5,482 (15.3%)	0.45	4,862 (7.5%)	0.28	$309,896,877 (13.3%)	$141,004,481	45.5%	$168,892,396	54.5%
All other specific injuries, not elsewhere classified	1,636 (4.6%)	0.14	4,526 (6.9%)	0.26	$216,386,855 (9.3%)	$142,944,558	66.1%	$73,442,297	33.9%
Respiratory system diseases (includes black lung, asbestosis, silicosis, etc)	1,093 (3.1%)	0.09	4,515 (6.9%)	0.26	$355,304,967 (15.3%)	$280,159,627	78.9%	$75,145,339	21.1%
Nervous system and sense organs diseases (includes hearing loss)	658 (1.8%)	0.06	2,565 (3.9%)	0.15	$43,942,649 (1.9%)	$35,578,897	81.0%	$8,363,752	19.0%
Other traumatic injuries and disorders (crushing, dermatitis, electric shock, asphyxiation)	690 (1.9%)	0.06	1,646 (2.5%)	0.10	$123,710,762 (5.3%)	$61,567,219	49.8%	$62,143,543	50.2%
Multiple physical injuries	366 (1.0%)	0.03	1,566 (2.4%)	0.09	$141,311,217 (6.1%)	$83,014,405	58.7%	$58,296,813	41.3%
Burns (scalds)	1055 (3.0%)	0.09	1,271 (1.9%)	0.07	$33,770,942 (1.5%)	$11,189,391	33.1%	$22,581,551	66.9%
Other disease/cumulative injury (including radiation)	38 (0.1%)	—	789 (1.2%)	0.05	$39,850,778 (1.7%)	$29,740,546	74.6%	$10,110,232	25.4%
Carpal tunnel syndrome	NR	NR	332 (0.5%)	0.02	$17,216,183 (0.7%)	$10,666,621	62.0%	$6,549,562	38.0%
Intracranial injuries (includes concussions)	190 (0.5%)	0.02	318 (0.5%)	0.02	$13,374,146 (0.6%)	$7,192,146	53.8%	$6,182,000	46.2%
No physical injury (includes symptoms, contact lenses, artificial appliance, syncope)	552 (1.5%)	0.05	316 (0.5%)	0.02	$5,694,616 (0.2%)	$3,939,278	69.2%	$1,755,337	30.8%
Effects of environmental conditions	221 (0.6%)	0.02	276 (0.4%)	0.02	$1,036,896 (0.0%)	$154,548	14.9%	$882,348	85.1%
Infections (contagious, bacterial, etc)	92 (0.3%)	0.01	167 (0.3%)	0.01	$5,331,138 (0.2%)	$1,723,718	32.3%	$3,607,420	67.7%
Poisoning (systemic, absorption of toxic substances)	204 (0.6%)	0.02	130 (0.2%)	0.01	$3,434,089 (0.1%)	$2,691,390	78.4%	$742,699	21.6%
Circulatory system diseases (includes myocardial infarctions)	NR	—	76 (0.1%)	0.00	$5,206,989 (0.2%)	$3,461,908	66.5%	$1,745,081	33.5%
Mental disorders and syndromes	NR	—	30 (<0.1%)	0.00	$5,156,119 (0.2%)	$2,993,777	58.1%	$2,162,341	41.9%
Total	35,747	2.96	65,220	3.80	$2,325,206,206	$1,373,549,488	59.1%	$951,656,718	40.9%

NR means "not reported" and indicates fewer than five case counts.

*For the 35 NCCI states, excludes contractors and office workers.

**Rate per 100 workers.

***All costs in this table include both paid and reserves.

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TABLE 10. NCCI Mining-Related Claim Counts and Costs by Nature by Claim Severity Type, *Continued on next page*

	Medical-Only Claims				Lost-Time Nonfatal Claims		
Nature of Injury Grouping	**Count 2012–2019**	**Medical Cost 2012–2019**	**Mean Claim Cost*** 2012–2015**	**Median Claim Cost*** 2012–2015**	**Count 2012–2019**	**Total Cost** 2012–2019**	**Mean Claim Cost*** 2012–2015**
Traumatic injuries to muscles, tendons, ligaments, joints, etc (includes dislocations and sprain/strain)	13,021 (33.6%)	$26,312,645 (34.1%)	$2,052	$871	9,564 (36.5%)	$725,622,180 (34.6%)	$77,762
Surface wounds and bruises (contusions)	8,735 (22.5%)	$13,861,166 (17.9%)	$1,547	$675	1,791 (6.8%)	$111,686,803 (5.3%)	$59,565
Open wounds (cuts, lacerations, punctures, amputations)	7,089 (18.3%)	$11,591,355 (15.0%)	$1,585	$890	1,627 (6.2%)	$112,060,205 (5.3%)	$74,187
Traumatic injuries to bones, nerves, spinal cord (includes bone fractures)	1,792 (4.6%)	$7,060,116 (9.1%)	$3,847	$1,585	3,064 (11.7%)	$299,263,747 (14.3%)	$96,468
All other specific injuries, not elsewhere classified	2,943 (7.6%)	$6,066,470 (7.9%)	$1,807	$680	1,509 (5.8%)	$145,149,945 (6.9%)	$90,497
Respiratory system diseases (includes black lung, asbestosis, silicosis, etc.)	1,011 (2.6%)	$1,473,104 (1.9%)	$1,561	$229	3,482 (13.3%)	$344,721,070 (16.4%)	$107,447
Nervous system and sense organs diseases (includes hearing loss)	328 (0.8%)	$1,366,704 (1.8%)	$3,781	$1,489	2,237 (8.5%)	$42,575,945 (2.0%)	$20,074
Other traumatic injuries and disorders (crushing, dermatitis, electric shock, asphyxiation)	1,012 (2.6%)	$1,888,792 (2.4%)	$1,854	$926	577 (2.2%)	$83,499,069 (4.0%)	$73,723
Multiple physical injuries	748 (1.9%)	$2,839,233 (3.7%)	$4,019	$1,501	769 (2.9%)	$111,498,615 (5.3%)	$141,299
Burns (scalds)	967 (2.5%)	$1,731,109 (2.2%)	$1,522	$649	303 (1.2%)	$31,119,537 (1.5%)	$88,103
Other disease/cumulative injury (including radiation)	121 (0.3%)	$216,178 (0.3%)	$1,657	$932	667 (2.5%)	$39,583,445 (1.9%)	$62,828
Carpal tunnel syndrome	67 (0.2%)	$285,564 (0.4%)	$3,349	$2,152	265 (1.0%)	$16,930,619 (0.8%)	$59,036
Intracranial injuries (includes concussions)	186 (0.5%)	$811,161 (1.0%)	$4,363	$2,040	131 (0.5%)	$12,289,332 (0.6%)	$108,285
No physical injury (includes symptoms, contact lenses, artificial appliance, syncope)	255 (0.7%)	$423,029 (0.5%)	$1,277	$601	59 (0.2%)	$5,147,541 (0.2%)	$48,530
Effects of environmental conditions	248 (0.6%)	$685,273 (0.9%)	$3,443	$1,794	28 (0.1%)	$351,623 (0.0%)	$14,576
Infections (contagious, bacterial, etc.)	113 (0.3%)	$175,867 (0.2%)	$1,148	$497	54 (0.2%)	$5,155,271 (0.2%)	$87,528
Poisoning (systemic, absorption of toxic substances)	103 (0.3%)	$353,432 (0.5%)	$3,038	$825	25 (0.1%)	$1,485,020 (0.1%)	$73,162
Circulatory system diseases (includes myocardial infarctions)	27 (0.1%)	$118,000 (0.2%)	$5,074	$2,351	48 (0.2%)	$4,186,080 (0.2%)	$106,837
Mental disorders and syndromes	7 (<0.1%)	$10,405 (0.0%)	$780	$592	23 (0.1%)	$5,145,714 (0.2%)	$154,508
Total	38,773 (100.0%)	$77,269,603 (100.0%)	$1,952	$842	26,224	$2,097,533,545 (100.0%)	$79,798

NR means "not reported" and indicates fewer than five case counts.

**All costs in this table include both paid and reserves.

***Mean and median cost per claim based on 2012–2015 data only.

while lost-time fatal claims represented 0.3% of the claims by count, but 6.4% of costs. This is consistent with prior studies that have shown the vast majority of total WC costs for states and large organizations are due to a relatively small number of particularly high cost claims.[33,34] All injuries/illnesses must be prevented, but additional focus must be applied to those with the most severe outcomes. Relatively minor cases can also become more severe without early reporting and proper medical treatment. The cost and severity of claims varied by event/exposure, part of body, and nature of injury.

Among medical-only claims, the mean cost per claim was $1952 (median $798). Contact with objects and equipment was by far the primary event/exposure (47% of claims; 43% of costs) driving medical-only claims. This was followed by overexertion and bodily reaction (23% of claims; 22% of costs) and falls, slips, and trips (14% of claims; 16% of costs). The majority of these injuries were traumatic injuries to muscles, tendons, ligaments, and joints (34% of claims; 34% of costs) or surface wounds and bruises (23% of claims; 18% of costs) and open wounds (18% of claims; 15% of costs). Most medical-only claims involved the upper extremities (36% of claims; 34% of costs), trunk (21% of claims; 20% of costs), or lower extremities (19% of claims; 16% of costs).

Among lost-time nonfatal claims, the mean cost per lost-time nonfatal claim was $79,798 (median $27,368), which was more than 40 times the cost per medical-only claim. In contrast to medical-only claims, the main event/exposure for lost-time nonfatal claims was overexertion and bodily reaction (32% of claims; 26% of costs), followed by contact with objects and equipment (26% of claims; 28% of costs). Exposure to harmful substances or environments was the leading event/exposure, representing 16% of claims (18% of costs) of lost-time nonfatal compared with only 6.5% of medical-only claims. Like medical-only claims, falls, slips, and trips remained a main driver of lost-time nonfatal claims (15% of claims; 15% of costs). Among lost-time nonfatal claims, claim natures were still dominated by traumatic injuries to muscles, tendons, ligaments, and joints (36% of claims; 35% of costs) and traumatic injuries to bones, nerves, spinal cord (12% of claims; 14% of costs), but respiratory system diseases (13% of claims; 16% of costs) became a greater part of the case nature of injury mix. The main part of body changed to trunk injuries

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TABLE 10. NCCI Mining-Related Claim Counts and Costs by Nature by Claim Severity Type, *Continued*

Lost-Time Nonfatal Claims			Lost-Time Fatal Claims					
Median Claim Cost*** 2012–2015	Indemnity Cost 2012–2019	Medical Cost 2012–2019	Count 2012–2019	Total Cost** 2012–2019	Mean Claim Cost*** 2012–2015	Median Claim Cost*** 2012–2015	Indemnity Cost 2012–2019	Medical Cost 2012–2019
$33,805	$440,367,842	$285,254,339	NR	NR	NR	NR	NR	NR
$18,792	$64,326,323	$47,360,481	NR	NR	NR	NR	NR	NR
$16,419	$47,616,341	$64,443,863	NR	NR	NR	NR	NR	NR
$33,510	$138,061,759	$161,201,988	6 (2.7%)	$3,573,014 (2.4%)	$411,174	$372,707	$2,942,723	$630,291
$32,362	$78,577,256	$66,572,689	74 (33.2%)	$65,170,440 (43.3%)	$926,505	$806,271	$64,367,302	$803,137
$27,077	$271,655,913	$73,065,157	22 (9.9%)	$9,110,793 (6.1%)	$450,344	$300,068	$8,503,715	$607,078
$8,394	$35,578,897	$6,997,048	NR	$0 (0.0%)	NA	$0	$0	$0
$22,606	$25,045,319	$58,453,750	57 (25.6%)	$38,322,901 (25.5%)	$768,395	$712,591	$36,521,900	$1,801,001
$37,549	$57,432,153	$54,066,462	49 (22.0%)	$26,973,369 (17.9%)	$493,234	$407,052	$25,582,251	$1,391,118
$12,237	$10,925,994	$20,193,543	NR	NR	NR	NR	NR	NR
$31,422	$29,690,061	$9,893,384	NR	NR	NR	NR	NR	NR
$48,525	$10,666,621	$6,263,998	NR	NR	NR	NR	NR	NR
$37,869	$6,920,376	$5,368,956	NR	NR	NR	NR	NR	NR
$10,909	$3,815,233	$1,332,308	NR	NR	NR	NR	NR	NR
$11,803	$154,548	$197,075	NR	NR	NR	NR	NR	NR
$33,294	$1,723,718	$3,431,553	NR	NR	NR	NR	NR	NR
$31,036	$1,096,647	$388,373	NR	NR	NR	NR	NR	NR
$41,014	$2,565,145	$1,620,935	NR	NR	NR	NR	NR	NR
$56,330	$2,993,777	$2,151,936	NR	NR	NR	NR	NR	NR
$28,265	$1,229,266,916	$868,266,629	223 (100.0%)	$150,403,058 (100.0%)	$683,944	$594,760	$144,282,572	$6,120,486

(31% of claims; 37% of costs), followed by upper extremities (27% of claims; 22% of costs) and lower extremities (18% of claims; 16% of costs).

Among lost-time fatal claims, the mean cost per lost-time fatal claim was $683,944 (median $511,704), which was 350 times the cost per medical-only claim and 9 times the cost per lost-time nonfatal claim. Like lost-time nonfatal claims, the main event/exposure for lost-Time Fatal claims was contact with objects and equipment (35% of claims; 38% of costs). However, a new main driver for lost-time fatal claims was transportation incidents (29% of claims; 30% of costs) followed by exposure to harmful substances or environments (11% of claims; 8% of costs). Claim natures of injury were dominated by different types of traumatic injuries including traumatic injuries and disorders, unspecified (33% of claims; 43% of costs), and other traumatic injuries and disorders (26% of claims; 25% of costs). Lost-time fatal claims also tended to involve multiple traumatic injuries and disorders (22% of claims; 18% of costs). Unlike medical-only and lost-time nonfatal claims that tended to be associated with specific parts of the body, lost-time fatal claims were associated most with multiple body parts (40% of claims; 45% of costs) and body systems (21% of claims; 19% of costs). The specific part of body associated most with fatalities was the trunk (24% of claims; 21% of costs), which includes the spine.

Limitations

There were limitations associated with this study. The use of WC data for occupational injury/illness surveillance has several general limitations, which include underreporting, especially for work-related illnesses,[11,12,35] and state WC differences in reporting requirements for WCIO injury codes, compensability, and lost-time definitions.[21] Other limitations specific to this analysis are that the NCCI dataset did not include WC claims from self-insured employers, such that findings may not be generalized to all mining employers. In addition, NCCI class codes for mining-related work may not correspond exactly to MSHA and NIOSH data that use mining industry NAICS codes. Furthermore, the methods used for estimating FTEs from the NCCI payroll data differed from MSHA FTE estimates. MSHA based its FTE estimates on direct reports from employers, while FTEs associated with the NCCI data were based on dividing total payroll taken from employer

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reports to WC insurers by the annual median mining wage estimates from OEWS data. Furthermore, worker pay is not calculated in exactly the same way in OEWS and WC payroll reports. The comparison to MSHA and NIOSH mining state data are also limited because contract workers are excluded from MSHA data, even though contractors represent 30% of the mining workforce. In addition, both NCCI and MSHA data had to be cross walked to the BLS OIICS system and MSHA data did not easily match to OIICS event/exposure codes, especially for fires/explosions and transportations, which limited comparisons.

Strengths

There are also several strengths associated with this study. Although other studies evaluated mining claims in single states, we utilized NCCI WC data from 35 states to perform the largest analysis to date of WC claims, counts, and costs among a mining-related population. The main contribution of this work is to provide detailed medical and indemnity cost estimates associated with various injury categories as defined by the OIICS part of body, nature of injury, and event/exposure codes for the mining industry. These costs can be used to understand how costs differ dramatically by levels of severity (medical-only, lost-time nonfatal, lost-time fatal) and injury event/exposure, nature, and part of body. The NIOSH worked previously to provide similar costs in partnership with the Ohio WC Bureau using a smaller dataset and develop the *Safety Pays in Mining* web application.[34] As next steps, we plan to utilize the larger NCCI dataset from the current analysis to update the *Safety Pays in Mining* web application.

CONCLUSIONS

This study demonstrated that WC data could be used to augment traditional MSHA data to summarize the frequency and cost of mining-related injuries in 35 states. Despite differences in covered populations, injury classification systems and analysis methods, both mining-related WC claim counts and MSHA case counts declined 30% from 2012 to 2019 while claim/case rates declined 25% and 20% under each system respectively. After matching the inclusion criteria, the pattern and distributions of counts and rates for OIICS event/exposure, part of body, and nature of injury were fairly similar in both datasets. Contact with object and equipment and overexertion/bodily reaction, and falls, slips, and trips were leading events/exposures, while upper extremities, trunk and lower extremities were the most frequent parts of body injured in both datasets. There was a huge difference in the number of injuries identified in each dataset, and while the data sources are not comparable, additional investigation is warranted. Traumatic injuries to muscles, tendons, ligaments, and joints were the leading nature of injury in both datasets. Although claim count and rates declined, the WC data indicated a high financial burden of mining-related injuries and illnesses, totaling $2.325 billion in WC costs from 2012 to 2019. Costs were particularly concentrated in more severe claims, as medical-only claims represented 59.4% of the claims by count, but only 3.3% of costs. Costs varied greatly by injury cause, nature, part of body, and severity. These data can be used by insurers and occupational clinicians to focus workplace and medical care improvements on the most costly and disabling cases within mining-related operations.

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