Industry-Related Injuries in the United States From 1998 to 2011

Characteristics, Trends, and Associated Health Care Costs

Delphine Solange Fontcha, MD, MSPH, Kiara Spooner, DrPH, MPH, Jason L. Salemi, PhD, MPH, Eknath Naik, MD, PhD, MSPH, Muktar H. Aliyu, MD, MPH, DrPH, Mulubrhan F. Mogos, PhD, Roger Zoorob, MD, MPH, and Hamisu M. Salihu, MD, PhD

Objective: To describe the trends, correlates, and healthcare costs associated with industry-related injuries across the United States between 1998 and 2011. **Methods:** A retrospective, cross-sectional analysis of hospital discharges was conducted using the National Inpatient Sample. We used the International Classification of Diseases, Ninth Revision, Clinical Modification codes to identify accidents occurring in industrial settings. Joinpoint regression modeling was used to analyze trends. **Results:** Most of the 357,716 inpatient hospitalizations were admissions from the emergency department (55%). Fractures were the most prevalent injuries (48.1%), whereas the lower and upper extremities were the most common injury sites (51.7%). The mean per admission cost of direct medical care was $12,849, with an overall downward trend in injuries during the study period. **Conclusions:** A comprehensive trend analysis of industry-related injuries is valuable to policymakers in formulating targeted strategies and allocating resources to address disparities at various levels.

Traumatic occupational injuries are common and pose a substantial economic burden to workers, employers, and society.[1] According to the latest US Bureau of Labor Statistics (BLS) data, more than 3 million occupational injuries and illnesses were reported in 2013.[2] Furthermore, with an estimated total cost of $250 billion in 2007, including direct medical costs of $67 billion and indirect costs of $183 billion (ie, lost wages and productivity)[3]—the importance of generating a more comprehensive understanding of the characteristics, contributing factors and health care–associated costs of occupational injuries and illnesses cannot be overstated.

Occupational injuries and illnesses are associated with numerous individual, social, and work-related risk factors, which are not always well understood. In the last two decades, many multiyear occupational injury studies have been conducted to identify associated risk factors,[4–9] to establish prevalence and incidence rates,[10–15] and to assess trends.[16–24] A number of studies have focused on sex disparities,[25–27] whereas others have examined socioeconomic status[5,11] and racial/ethnic differences in the occurrence of workplace injuries and illnesses.[24,28–30] In addition, some investigators have centered on occupational injuries within specific industries, such as agriculture,[12,20,28] mining,[31] underground coal mining,[13,19,32] solid waste,[33] retail merchandising,[9,14] and US correctional facilities.[34] Findings suggest that the rates, severity, and costs of occupational injuries can be attributed to a myriad of factors that place individuals at high risk for injuries,[4–35] including climate, workplace violence, accidents, and increased physical work/psychological demands.

Although not all are comprehensive or multiyear, several studies have also contributed insights on the estimated costs and economic burden of occupational injuries and illness in the United States.[3,17,35–40] For example, a recent analysis of hospital admissions data for 2006 found that the mean charges for work-related injuries, per admission, were $32,254; common diagnoses included orthopedic injuries (including amputations) to finger/hand (20.9%); and the most common procedure was fracture reduction (17.6%).[35] Even though the data derived from this and similar studies are of value, they do not typically drive decisions in occupational safety and health. Instead, most professionals in the field tend to rely and report on the national annual estimates provided by the BLS.[41] Yet, it has been established that the BLS data suffer from underreporting, with an estimated 33% to 69% in missed nonfatal occupational injuries.[42] Consequently, the reliance on BLS statistics by public and private decision makers underestimates the regularity of injuries and results in insufficient efforts and resources aimed at preventing and improving occupational safety.[41,42] Furthermore, without more comprehensive multiyear studies tracking the frequencies, trends, and outcomes of industrial injuries, particularly within population subgroups—it becomes difficult to assess change on a national scale.

Knowledge gained from a comprehensive investigation of industrial injuries serious enough to result in hospitalization will be useful to policymakers by enabling them to formulate targeted strategies and appropriately allocate limited resources. With that overarching objective in mind, the specific aims of this study were to (1) describe the frequency, prevalence, and trends of industry-related injuries in the United States from 1998 through 2011, (2) identify sociodemographic, behavioral, and hospital-level characteristics associated with disparities in rates and trends, and (3) evaluate the health care utilization, costs of direct medical care, and in-hospital mortality that is associated with various types of industry-related injuries.

METHODS

Study Population and Data Sources

We conducted a retrospective cross-sectional analysis of the 1998 to 2011 annual databases from the National Inpatient Sample (NIS). The NIS is part of the Healthcare and Cost and Utilization Project (HCUP), a federal-state-industry partnership sponsored by the Agency for Healthcare Research and Quality. To ensure a nationally representative sample, each year the NIS stratifies all nonfederal community hospitals into five groups on the basis of hospital-level characteristics, including ownership, the number of beds, geographic

From the Division of Preventative and Occupational Medicine, Department of Internal Medicine, Morsani College of Medicine (Dr Fontcha) and Department of Global Health, College of Public Health (Dr Naik), University of South Florida, Tampa; Department of Family and Community Medicine (Drs Spooner, Salemi, Zoorob, and Salihu), Baylor College of Medicine, Houston, Tex; Vanderbilt Institute for Global Health and Department of Health Policy (Dr Aliyu), Vanderbilt University, Nashville, Tenn, and Department of Community and Health Systems (Dr Mogos), School of Nursing, University of Indiana, Indianapolis.

This research was conducted within the framework of the University of South Florida's Occupational Medicine Residency program. This study was funded and supported by the Sunshine Educational Research Center (SERC), which is largely supported by a training grant from the National Institute for Occupational Safety and Health (NIOSH). The authors have no conflicts of interest.

Address correspondence to: Hamisu M. Salihu, MD, PhD, Department of Family and Community Medicine, Baylor College of Medicine, 3701 Kirby Dr, Ste 600, Houston, TX 77098 (Hamisu.Salihu@bcm.edu).

DOI: 10.1097/JOM.0000000000000481

region, location (rural/urban), and teaching status. A sample of hospitals (20%) is drawn from each group, and all inpatient discharges from sampled hospitals are included in the final database. During the study period, the NIS included data from approximately 8 million hospital stays each year and had more than 1000 hospitals in 45 states participating by 2010.[43] We excluded from this study population those discharge records in which the primary reason for admission was associated with pregnancy, childbirth, or the neonatal period. These maternal and neonatal stays were identified using major diagnostic categories 14 ("pregnancy, childbirth, and the puerperium") and 15 ("newborns and other neonates with conditions originating during the perinatal period") and using an HCUP-created variable NEOMAT, which labels discharges with neonatal and/or maternal diagnoses and procedures. Although these discharges represent nearly one quarter of all inpatient discharges in the United States, they are seldom at risk for industrial injuries and represent only 0.26% of all industrial injuries in our data.

Identifying and Characterizing Industry-Related Injuries

The International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) code E849.3 ("accidents occurring in industrial place and premises") was used to identify hospital admissions for occupational injuries and illnesses.[44] We further used ICD-9-CM codes to classify injuries on the basis of the type of injury (eg, fracture, dislocation, sprain/strain, internal injury, open wound, burn, and poisoning) and the anatomical location of the injury (eg, head, face, neck, trunk, and upper/lower extremities) (the Appendix). Discharge records may indicate more than one type of injury; therefore, although discharges are unduplicated at the level of the injury subtype, a discharge with multiple types of injuries may have been included in more than one type-specific analysis. In contrast, anatomical location of the injury was a variable with mutually exclusive categories, with a "multiple" group defining injuries involving more than one specified part of the body.

Study Variables

In addition to assessment of industry-related injuries in the entire population, we sought to describe the prevalence and trends of injuries by sociodemographic and hospital characteristics. We grouped patients' age in years into the following eight groups: less than 14, 14 to 17, 18 to 24, 25 to 34, 35 to 44, 45 to 54, 55 to 64, and 65 years or older. Race/ethnicity was based on self-report and first classified on the basis of ethnicity (Hispanic or non-Hispanic), with the non-Hispanic (NH) group further subdivided by race (white, black, or other). Median household income was estimated using zip code of residence and then ranked into quartiles by HCUP. The primary payer for the hospital stay was classified into government (Medicare/Medicaid), private (commercial carriers and private Health Maintenance Organizations [HMOs] and Preferred Provider Organizations [PPOs]), and other sources (including self-pay and no charge). We also investigated the timing (weekday vs weekend) and source of the admission (from the emergency room (ER), another hospital or other health care facility, court/law enforcement, and routine [physician/clinic referral]). Alcohol and drug use associated with the injury were captured using ICD-9-CM codes (the Appendix). We also considered several hospital characteristics, including location (urban vs rural) and US census region (Northeast, Midwest, South, or West).

We investigated short-term outcomes associated with industrial injuries. The patient's disposition at discharge from the inpatient stay was grouped into routine (eg, home), transfer to another hospital or health facility, home health care, left against medical advice, and died. Length of inpatient stay (LOS) served as both an indicator of health care utilization and a proxy for severity of complications. A prolonged hospitalization was defined as an LOS that met or exceeded the 95th percentile on the basis of the distribution among all industrial injuries (more than 13 days in our sample). Finally, we used total hospital charges reported for the patient's hospitalization to estimate the direct costs associated with medical care. The markup from what it costs a hospital to provide its services to what is ultimately charged varies significantly across hospitals, among different departments within the same hospital, and over time.[45,46] Therefore, to obtain a more accurate estimate, we converted reported charges to costs by (1) multiplying the total charges assigned to the hospitalization by a year and hospital-specific cost-to-charge ratio (CCR) obtained from HCUP; and (2) multiplying the amount from #1 by an HCUP-generated "adjustment factor" (AF), which attempts to account for interdepartmental variations in markup within each hospital.[47] The final formula for calculating the cost for each discharge record is as follows: *total cost = total charges × year and hospital-specific CCR × AF.*

Data Analysis

Descriptive statistics were used to provide estimates of the frequency and rate of industrial injuries overall and by injury type, as well as by individual and hospital-level characteristics. Because national estimates were desired, the inpatient discharges in our analyses were weighted to account for the complex sampling design of the NIS. Joinpoint regression was then used to characterize the overall temporal trend of injuries in industrial settings and to identify statistically significant changes in those trends throughout the study period.[48] Joinpoint regression fits trend data into the straight lines connected by "joinpoints." Each joinpoint in the final model corresponds to a significant increase or decrease in the trend, and an annual percentage change (APC) can be calculated to describe how the rate changes within each time interval.[49] The model also estimates the average annual percentage change, which describes the trend over the entire study period, even when there are significant changes in the trend over time.[48] Furthermore, because the NIS sampling design changed during the study period, we incorporated HCUP supplied NIS-Trends files for all trend analyses to ensure that trend weights and data elements were consistently defined over time.[50] We then estimated the mean, per discharge, LOS, the in-hospital mortality rate, and the direct medical costs associated with inpatient care across all industry-related injuries and by site and type of injury. We also calculated the total annual costs of medical care associated with inpatient admissions for industrial injuries in the United States. To account for inflation, all cost estimates were adjusted to 2011 dollars using the medical care component of the Consumer Price Index.[51]

Statistical analyses were performed with SAS software, version 9.4 (SAS Institute, Inc, Cary, NC) and the Joinpoint Regression Program, version 4.1.1.1.[48] All hypothesis tests (two-sided) and construction of confidence intervals assumed a 5% type I error rate. Because hospital-level CCR data were only available beginning in 2001, we restricted cost analyses to discharges for the period 2001 to 2011. This study was classified as exempt by the University of South Florida Institutional Review Board.

RESULTS

In the 14-year period between 1998 and 2011, there were an estimated 357,716 inpatient hospitalizations for injuries sustained in industrial settings in the United States, an average of more than 25,000 admissions per year. The most common types of injuries experienced in industrial places were fractures (48.1%), followed by open wounds (25.4%), internal or crushing injuries (19.6%), and contusions or superficial injuries (10.1%) (Table 1). Injuries involving a foreign body entering through an orifice (0.5%) and those involving poisoning (2.4%) were the rarest. The majority of anatomically isolated injuries involved the extremities (51.7%), followed by the trunk (9.1%) and head (9.1%). Multiple sites were affected

TABLE 1. Frequency and Distribution of Industry-Related Inpatient Hospitalizations, by Sociodemographic and Hospital Characteristics and by Type of Injury Diagnosed, Healthcare Cost and Utilization Project—Nationwide Inpatient Sample, 1998 to 2011*

	Major Types of Industrial Injuries†									
Characteristic	**Fracture** *N* (%)‡	**Open Wound** *N* (%)‡	**Internal or Crushing** *N* (%)‡	**Contusion or Superficial** *N* (%)‡	**Sprains and Strains** *N* (%)‡	**Burn** *N* (%)‡	**Dislocation** *N* (%)‡	**Physical/ Environmental** *N* (%)‡	**Poisoning** *N* (%)‡	**Foreign Body** *N* (%)‡
All	171,996 (48.1)	90,775 (25.4)	70,192 (19.6)	36,154 (10.1)	24,526 (6.9)	21,419 (6.0)	13,856 (3.9)	11,201 (3.1)	8,585 (2.4)	1,880 (0.5)
Age, yrs										
<14	904 (42.1)	311 (14.5)	329 (15.3)	291 (13.5)	5 (0.2)	137 (6.4)	5 (0.2)	166 (7.7)	169 (7.9)	89 (4.2)
14–17	958 (41.0)	803 (34.4)	552 (23.6)	230 (9.9)	60 (2.6)	275 (11.8)	82 (3.5)	52 (2.2)	164 (7.0)	19 (0.8)
18–24	17,438 (46.6)	13,969 (37.3)	9,929 (26.5)	3,598 (9.6)	1,645 (4.4)	3,068 (8.2)	1,257 (3.4)	987 (2.6)	866 (2.3)	248 (0.7)
25–34	33,449 (47.0))	22,636 (31.8)	15,970 (22.4)	6,949 (9.8)	4,135 (5.8)	5,210 (7.3)	3,213 (4.5)	2,090 (2.9)	1,432 (2.0)	390 (0.5)
35–44	40,158 (46.9)	22,041 (25.7)	16,899 (19.7)	8,444 (9.9)	6,501 (7.6)	5,667 (6.6)	3,930 (4.6)	2,460 (2.9)	2,095 (2.4)	372 (0.4)
45–54	38,534 (48.1))	17,892 (22.3)	14,869 (18.6)	8,107 (10.1)	6,548 (8.2)	4,477 (5.6)	3,325 (4.1)	2,358 (2.9)	1,944 (2.4)	370 (0.5)
55–64	24,581 (51.8))	8,938 (18.8)	8,322 (17.5)	4,944 (10.4)	4,235 (8.9)	1,980 (4.2)	1,486 (3.1)	1,602 (3.4)	1,059 (2.2)	219 (0.5)
65+	14,950 (51.0)	3,612 (12.3)	3,037 (10.4)	3,448 (11.8)	1,317 (4.5)	501 (1.7)	493 (1.7)	1,443 (4.9)	828 (2.8)	166 (0.6)
Sex										
Male	141,177 (48.5)	81,572 (28.0)	63,618 (21.8)	30,459 (10.5)	19,299 (6.6)	19,223 (6.6)	11,935 (4.1)	9,167 (3.1)	5,601 (1.9)	1,574 (0.5)
Female	28,477 (46.4)	7,706 (12.6)	5,936 (9.7)	5,428 (8.9)	5,013 (8.2)	2,040 (3.3)	1,790 (2.9)	1,985 (3.2)	2,928 (4.8)	286 (0.5)
Race/ethnicity										
NH-white	85,453 (47.9)	40,583 (22.7)	32,516 (18.2)	18,387 (10.3)	12,662 (7.1)	10,432 (5.8)	6,674 (3.7)	6,434 (3.6)	4,880 (2.7)	978 (0.5)
NH-black	9,222 (40.1)	5,689 (24.7)	4,359 (18.9)	1,885 (8.2)	1,855 (8.1)	1,430 (6.2)	952 (4.1)	897 (3.9)	768 (3.3)	104 (0.5)
Hispanic	32,852 (49.6)	21,264 (32.1)	15,195 (22.9)	6,781 (10.2)	3,948 (6.0)	4,227 (6.4)	2,642 (4.0)	1,766 (2.7)	1,273 (1.9)	420 (0.6)
Other	10,198 (48.0)	6,467 (30.4)	4,768 (22.4)	2,137 (10.0)	1,218 (5.7)	1,378 (6.5)	743 (3.5)	668 (3.1)	404 (1.9)	122 (0.6)
Missing	34,271 (49.8)	16,771 (24.4)	13,354 (19.4)	6,963 (10.1)	4,843 (7.0)	3,952 (5.7)	2,846 (4.1)	1,435 (2.1)	1,260 (1.8)	256 (0.4)
Household income										
Lowest quartile	43,101 (47.2)	23,848 (26.1)	17,951 (19.6)	8,740 (9.6)	5,992 (6.6)	5,605 (6.1)	3,520 (3.9)	3,199 (3.5)	2,233 (2.4)	506 (0.6)
2nd quartile	47,079 (48.7)	24,506 (25.4)	18,753 (19.4)	9,499 (9.8)	6,737 (7.0)	5,776 (6.0)	3,878 (4.0)	2,807 (2.9)	2,242 (2.3)	527 (0.5)
3rd quartile	43,931 (48.3)	22,727 (25.0)	18,120 (19.9)	9,606 (10.6)	6,544 (7.2)	5,492 (6.0)	3,763 (4.1)	2,717 (3.0)	2,088 (2.3)	441 (0.5)
Highest quartile	32,723 (48.2)	16,697 (24.6)	13,196 (19.4)	7,074 (10.4)	4,591 (6.8)	3,850 (5.7)	2,311 (3.4)	2,132 (3.1)	1,736 (2.6)	353 (0.5)
Primary payer										
Government	14,922 (40.8)	6,290 (17.2)	4,526 (12.4)	3,894 (10.6)	1,236 (3.4)	1,227 (3.4)	598 (1.6)	2,147 (5.9)	1,867 (5.1)	333 (0.9)
Private	30,754 (43.2)	16,536 (23.2)	12,763 (17.9)	7,948 (11.2)	5,270 (7.4)	3,569 (5.0)	2,428 (3.4)	2,669 (3.7)	2,898 (4.1)	409 (0.6)
Other	126,320 (50.5)	67,949 (27.2)	52,902 (21.2)	24,311 (9.7)	18,020 (7.2)	16,623 (6.7)	10,830 (4.3)	6,385 (2.6)	3,820 (1.5)	1,138 (0.5)
Source of admission										
Emergency room	106,144 (53.9)	60,140 (30.6)	44,810 (22.8)	23,255 (11.8)	10,615 (5.4)	8,517 (4.3)	6,466 (3.3)	6,150 (3.1)	5,120 (2.6)	996 (0.5)
Another hospital	3,520 (40.9)	1,506 (17.5)	1,654 (19.2)	490 (5.7)	212 (2.5)	1,893 (22.0)	247 (2.9)	245 (2.9)	147 (1.7)	43 (0.5)
Another health facility	1,617 (41.5)	979 (25.2)	648 (16.7)	144 (3.7)	326 (8.4)	517 (13.3)	139 (3.6)	46 (1.2)	96 (2.5)	10 (0.3)
Court/law enforcement	29 (26.0)	38 (34.4)	29 (26.2)	5 (4.1)	14 (13.0)	0 (0.0)	0 (0.0)	0 (0.0)	10 (9.1)	0 (0.0)
Routine/other	24,868 (34.4)	10,700 (14.8)	7,142 (9.9)	3,869 (5.4)	8,967 (12.4)	5,789 (8.0)	3,843 (5.3)	1,162 (1.6)	1,033 (1.4)	297 (0.4)

(*continues*)

TABLE 1. (*Continued*)

Characteristic	Major Types of Industrial Injuries†									
	Fracture *N* (%)‡	Open Wound *N* (%)‡	Internal or Crushing *N* (%)‡	Contusion or Superficial *N* (%)‡	Sprains and Strains *N* (%)‡	Burn *N* (%)‡	Dislocation *N* (%)‡	Physical/ Environmental *N* (%)‡	Poisoning *N* (%)‡	Foreign Body *N* (%)‡
Timing of admission										
Weekday	148,678 (48.4)	77,351 (25.2)	60,210 (19.6)	30,815 (10.0)	21,714 (7.1)	18,199 (5.9)	12,359 (4.0)	9,283 (3.0)	6,719 (2.2)	1,522 (0.5)
Weekend	23,054 (46.0)	13,223 (26.4)	9,908 (19.8)	5,296 (10.6)	2,801 (5.6)	3,179 (6.3)	1,481 (3.0)	1,912 (3.8)	1,840 (3.7)	353 (0.7)
Disposition upon discharge										
Died	1,255 (46.4)	425 (15.7)	1,099 (40.6)	243 (9.0)	5 (0.2)	346 (12.8)	39 (1.4)	450 (16.6)	73 (2.7)	48 (1.8)
Routine	130,379 (45.2)	79,237 (27.5)	57,299 (19.9)	29,333 (10.2)	21,388 (7.4)	16,929 (5.9)	11,093 (3.8)	8,350 (2.9)	6,886 (2.4)	1,521 (0.5)
Short-term hospital	3,333 (55.7)	1,186 (19.8)	1,281 (21.4)	668 (11.2)	223 (3.7)	405 (6.8)	304 (5.1)	298 (5.0)	224 (3.7)	27 (0.5)
Another type of facility	21,512 (71.8)	3,954 (13.2)	5,751 (19.2)	2,955 (9.9)	1,359 (4.5)	677 (2.3)	1,247 (4.2)	1,232 (4.1)	992 (3.3)	188 (0.6)
Home health care	14,615 (52.9)	5,143 (18.6)	4,137 (15.0)	2,435 (8.8)	1,416 (5.1)	2,928 (10.6)	1,074 (3.9)	699 (2.5)	160 (0.6)	77 (0.3)
Against medical advice	674 (24.7)	757 (27.7)	553 (20.3)	483 (17.7)	131 (4.8)	129 (4.7)	85 (3.1)	171 (6.3)	205 (7.5)	14 (0.5)
Indication of alcohol										
Yes	4,598 (40.5)	2,793 (24.6)	2,301 (20.3)	1,585 (14.0)	433 (3.8)	518 (4.6)	293 (2.6)	566 (5.0)	754 (6.6)	57 (0.5)
No	167,398 (48.3)	87,981 (25.4)	67,891 (19.6)	34,568 (10.0)	24,093 (7.0)	20,901 (6.0)	13,563 (3.9)	10,634 (3.1)	7,831 (2.3)	1,823 (0.5)
Indication of drugs										
Yes	2,699 (33.3)	1,742 (21.5)	1,286 (15.9)	902 (11.1)	320 (3.9)	481 (5.9)	170 (2.1)	439 (5.4)	1,211 (14.9)	56 (0.7)
No	169,296 (48.4)	89,032 (25.5)	68,905 (19.7)	35,252 (10.1)	24,206 (6.9)	20,939 (6.0)	13,686 (3.9)	10,762 (3.1)	7,374 (2.1)	1,824 (0.5)
Region										
Northeast	28,852 (47.1)	16,245 (26.5)	11,928 (19.5)	5,524 (9.0)	4,361 (7.1)	4,062 (6.6)	2,451 (4.0)	1,618 (2.6)	1,667 (2.7)	360 (0.6)
Midwest	34,055 (48.1)	16,726 (23.6)	13,691 (19.3)	7,750 (10.9)	5,203 (7.3)	4,693 (6.6)	3,025 (4.3)	2,320 (3.3)	1,712 (2.4)	269 (0.4)
South	44,585 (50.2	23,056 (26.0)	17,647 (19.9)	7,959 (9.0)	4,684 (5.3)	5,443 (6.1)	3,358 (3.8)	3,233 (3.6)	2,222 (2.5)	376 (0.4)
West	64,504 (47.1)	34,748 (25.4)	26,926 (19.7)	14,920 (10.9)	10,279 (7.5)	7,221 (5.3)	5,022 (3.7)	4,030 (2.9)	2,984 (2.2)	874 (0.6)
Location										
Urban	153,322 (48.4)	82,337 (26.0)	64,341 (20.3)	31,608 (10.0)	20,727 (6.5	19,990 (6.3)	12,494 (3.9)	9,444 (3.0)	7,375 (2.3)	1,670 (0.5)
Rural	17,737 (45.2)	8,025 (20.4)	5,421 (13.8)	4,305 (11.0)	3,708 (9.4)	1,174 (3.0)	1,236 (3.1)	1,640 (4.2)	1,142 (2.9)	200 (0.5)
Site of injury										
Head	10,305 (31.7)	12,340 (37.9)	11,299 (34.7)	5,445 (16.7)	32 (0.1)	1,258 (3.9)	1,041 (3.2)	505 (1.6)	248 (0.8)	914 (2.8)
Trunk	16,310 (50.3)	1,598 (4.9)	10,003 (30.8)	3,882 (12.0)	4,034 (12.4)	560 (1.7)	2,239 (6.9)	721 (2.2)	88 (0.3)	480 (1.5)
Extremity	111,968 (60.5)	61,776 (33.4)	29,828 (16.1)	10,159 (5.5)	14,928 (8.1)	9,997 (5.4)	7,258 (3.9)	1,883 (1.0)	199 (0.1)	76 (0.0)
Multiple	33,413 (65.5)	15,041 (29.5)	18,978 (37.2)	16,357 (32.1)	5,154 (10.1)	9,408 (18.4)	3,318 (6.5)	1,254 (2.5)	183 (0.4)	337 (0.7)
Unknown	0 (0.0)	20 (0.0)	83 (0.1)	311 (0.5)	379 (0.7)	196 (0.3)	0 (0.0)	6,837 (12.1)	7,867 (13.9)	73 (0.1)

*All hospital stays (discharge records) listed as being maternal or neonatal were excluded from this analysis, which constituted 0.26% of all discharges with an industry-related injury diagnosed.

†Discharge records may indicate more than 1 type of injury; therefore, although discharges are unduplicated at the level of the injury subtype, a discharge with multiple types of injuries may have been included in more than 1 type-specific analysis.

‡Percentages listed are row percentages, representing the proportions of all industry-related injuries within a particular characteristic subgroup that were diagnosed with each type of injury. Because a patient could be diagnosed with more than 1 type of injury during his or her hospitalization, frequencies may add to more than the total of all industry-related injuries and percentages may add to more than 100%.

in 14.3% of injuries, and the site of injury was undocumented on 15.9% of discharge records.

Frequency and Distribution of Industry-Related Injury Subtypes

Sociodemographic and hospital characteristics of the various types of industry-related injuries are further described in Table 1. The type of injury sustained was strongly associated with age. Fractures increased with increasing age, as did the proportion of injuries involving sprains and strains up to aged 64. Conversely, the likelihood of injuries involving burns tended to decrease with increasing age. Injuries involving poisoning were highest among age groups younger than 14 years and 14 to 17 years (7.9% and 7.0%, respectively) when compared with the entire sample (2.4%). Similarly, injuries in which a foreign body was digested and those due to physical/environmental factors were much more common among patients younger than 14 years. There were also notable differences in the type of injuries by sex. Injuries among men were more likely to involve open wound (28.0% vs 12.6%) and internal/crushing injures (21.8 vs 9.7%), whereas women experienced a higher proportion of injuries involving poisoning (4.8% vs 1.9%) and sprains/strains (8.2% vs 6.6%). As expected, when drug and alcohol use was documented, the proportion of injuries involving poisoning (14.9% and 6.6%) was higher than in the entire population (2.4%).

Prevalence of Industry-Related Injuries by Sociodemographic and Hospital Characteristics

The overall prevalence rate for industry-related injuries was 87.4 (95% confidence interval [CI], 82.1 to 92.7) per 100,000 nonmaternal/neonatal discharges (Table 2). The highest injury rates per 100,000 discharges were observed among patients with "other" (self-pay, charity, workers' compensation) insurance (668.7), patient's in the 18 to 24 and 25 to 34 age groups (305.4 and 293.8), and Hispanics (228.1). The injury rate among men (154.1) was more than five times higher than among women (27.9). Among those with known race/ethnicity, the high injury rate among Hispanics was more than four times higher than among NH-blacks (51.8) and nearly three times as high as among NH-whites (78.0). The rate of industrial injuries was higher on the weekday (92.8) than the weekend (64.2), and most hospitalizations followed a trip to the ER. We observed significant geographic variation in the prevalence of industry-related injuries across the United States, with significantly higher rates in the West (191.7), which was more than double the rate for any other region. Hospitals located in an urban setting not only cared for 89% of all industry-related injuries, but the rate of those injuries among all hospitalization was also 1.4 times higher in urban versus rural areas (90.7 vs 67.0) (Table 2).

Trends in Industry-Related Injuries

Among nonmaternal/neonatal discharges, the prevalence of industry-related injuries (per 100,000) in the United States has decreased approximately 1.4% each year (95% CI, −2.5 to −0.3), from a high of 102 in 1998 to 85 in 2011 (Fig. 1). The lowest injury rate during the study period (70) was observed in 2009. There was considerable variation in these trends by age of the injured person (Fig. 2). All age groups from 14 to 54 years experienced a significant decreasing in the industrial injury rate, with APCs ranging from −5.5% (95% CI, −9.7 to −1.1) for those 14 to 17 years old to −1.3% (95% CI, −2.5 to −0.1%) among 45 to 54 years old. Nevertheless, despite the low frequency relative to other age groups, the injury hospitalization rate for the youngest and oldest patients increased dramatically during the study period. For those patients 65 years and older the rate increased 8.9% annually (95% CI, 7.6 to 10.2); among those younger than 14 years, the APC was 4.7% (95% CI, 0.7 to 8.9).

Significant decreases in industry-related injuries were also observed in other population subgroups, most notably males (APC: −2.3%), Hispanics (APC: −3.8%), and other-NH (APC: − 3.4%). Those geographic regions with the highest overall rates of injuries also experienced the most significant decreasing trends. Hospitals in the western US and separately those in urban areas throughout the United States decreased 3.9% and 1.5%, respectively, per year. Women, however, did experience an annual 2% increase in industry-related injuries during the study period (Table 2).

Utilization, Mortality, and Direct Medical Costs of Industry-Related Injuries

Table 3 describes the LOS, direct costs of medical care, and in-hospital mortality associated with industry-related injuries. The mean LOS across all injury-related hospitalizations was 4.2 days (95% CI, 4.1 to 4.3), although 4.5% of hospitalizations exceeded 13 days in length. The in-hospital mortality rate associated with these injuries was 75.6 per 10,000, which is approximately one in-hospital death in every 132 admissions for industrial injuries. The mean cost of an inpatient admission following an industry-related injury from 2001 to 2011 was $12,849, and the overall costs of inpatient care for the study sample during this time frame exceeded $3.7 billion or $341 million annually.

Mean cost, LOS, and mortality differed dramatically depending on the type and anatomical location of the injury (Table 3). As expected, injuries that involved multiple areas of the body had the longest mean LOS (6.4 days), the highest risk of a prolonged hospital stay (10.6%), the highest mean cost of care ($22,361), and the second highest in-hospital mortality rate (193.3 per 10,000 hospitalizations). Head injuries were associated with the highest in-hospital mortality rate (230.5 per 10,000 hospitalizations). Although injuries to the extremities resulted in the shortest LOS (3.6 days) and the lowest mean cost ($10,497), they collectively accounted for the highest total cost ($142 million annually) compared with all other injury sites. Burns and injuries from physical/environmental exposures were associated with the highest mean LOS (7.4 and 6.2 days), the highest risk of prolonged stays (13.6% and 10.3%), high mean costs of care ($20,967 and $19,741), and high in-hospital mortality rates (1.6% and 4.0%). Nevertheless, considering the high prevalence of fractures, hospitalizations for injuries that included a fracture accounted for $186 million annually, over twice the cost associated with any other injury type.

DISCUSSION

In this study, a nationally representative sample of inpatient hospital discharge records was analyzed to describe the characteristics, trends, and outcomes associated with workplace injuries. Although the overall rate has been declining, approximately 25,500 workers were hospitalized in the United States each year between 1998 and 2011 due to injuries sustained in industrial settings. Of the four geographic regions defined for this study, the western United States had the highest proportion of admissions (38.3%), comparable with estimates reported in other studies.[35,39]

As expected, and consistent with findings in similar studies, the majority of patients in this analysis were primarily male (81.4%), between 25 and 54 years, and were admitted with injuries to the extremities.[35,39] The large share of males in the patient pool could be due to the distribution of tasks in most industrial settings being influenced by sex, with men more likely to be involved in physically demanding and risky tasks than women.[35,39] Nevertheless, it is also important to note that this study accounted only for the type of injuries that resulted in hospital admission. Additional research is needed to define sex differences in rates of workplace injuries that do not require hospitalization.

Comparable with other studies, we found that most patients with industry-related injuries were admitted after a visit to an emergency department (ED) or ER.[52–55] This was expected given the urgent need for care when most industry-related injuries take place.

TABLE 2. Prevalence and Trends of Industry-Related Inpatient Hospitalizations, by Selected Sociodemographic and Hospital Characteristics, Healthcare Cost and Utilization Project—Nationwide Inpatient Sample, 1998 to 2011

Characteristic	Annual Discharges*	Prevalence† (95% CI)	AAPC (95% CI)	Nature of Trend‡
All	25,551	87.4 (82.1, 92.7)	−1.4 (−2.5, −0.3)	↓
Age, yrs				
<14	154	9.8 (8.2, 11.4)	4.7 (0.7, 8.9)	↑
14–17	167	41.2 (35.5, 46.9)	−5.5 (−9.7, −1.1)	↓
18–24	2,674	305.4 (282.5, 328.3)	−5.4 (−7.0, −3.7)	↓
25–34	5,082	293.8 (272.8, 314.8)	−3.5 (−4.8, −2.2)	↓
35–44	6,115	211.3 (197.6, 225.0)	−2.7 (−3.8, −1.6)	↓
45–54	5,724	139.2 (131.0, 147.5)	−1.3 (−2.5, −0.1)	↓
55–64	3,388	77.2 (72.8, 81.5)	0.4 (−0.9, 1.6)	—
65+	2,095	15.9 (14.7, 17.0)	8.9 (7.6, 10.2)	↑
Sex				
Male	20,808	154.1 (144.1, 164.0)	−2.3 (−3.4, −1.2)	↓
Female	4,379	27.9 (26.4, 29.4)	2.0 (1.0, 3.1)	↑
Race/ethnicity				
NH-white	12,745	78.0 (72.9, 83.2)	−0.8 (−1.7, 0.2)	—
NH-black	1,643	51.8 (46.7, 57.0)	−2.1 (−4.1, 0.0)	—
Hispanic	4,730	228.1 (204.7, 251.6)	−3.8 (−5.8, −1.8)	↓
Other	1,519	134.2 (113.3, 155.1)	−3.4 (−5.5, −1.3)	↓
Missing	4,913	75.3 (66.2, 84.4)	−2.6 (−5.7, 0.6)	—
Household income				
Lowest quartile	6,529	78.3 (72.8, 83.9)	−1.3 (−2.9, 0.4)	—
2nd quartile	6,902	91.4 (85.4, 97.5)	−1.1 (−2.2, 0.0)	↓
3rd quartile	6,495	97.2 (90.3, 104.0)	−1.9 (−3.1, −0.6)	↓
Highest quartile	4,852	81.6 (74.7, 88.5)	−0.8 (−2.3, 0.7)	—
Primary payer				
Government	2,613	14.8 (13.7, 16.0)	8.2 (6.8, 9.6)	↑
Private	5,085	56.8 (52.5, 61.1)	−0.5 (−1.7, 0.7)	—
Other	17,853	668.7 (618.6, 718.8)	−4.0 (−5.3, −2.7)	↓
Source of admission				
Emergency room§	14,054	118.4 (109.9, 126.9)	2.4 (−2.3, 7.4)	—
Another hospital	615	67.3 (56.0, 78.5)	2.6 (0.3, 5.0)	↑
Another health facility	278	65.2 (41.7, 88.8)	−1.7 (−5.5, 2.3)	—
Court/law enforcement‖	8	25.9 (2.9, 48.9)	NA‖	NA‖
Routine/other	5,158	58.5 (53.1, 63.9)	0.8 (−1.5, 3.1)	—
Timing of admission				
Weekday	21,926	92.8 (87.1, 98.5)	−1.6 (−2.6, −0.5)	↓
Weekend	3,583	64.2 (60.2, 68.2)	0.0 (−1.2, 1.1)	—
Region				
Northeast	4,371	72.2 (61.1, 83.4)	0.8 (−1.3, 3.0)	—
Midwest	5,060	73.7 (64.9, 82.4)	−1.2 (−3.3, 0.9)	—
South	6,346	56.6 (49.4, 63.8)	0.2 (−1.9, 2.3)	—
West	9,774	191.7 (173.3, 210.1)	−3.9 (−5.5, −2.2)	↓
Location				
Urban	22,611	90.7 (84.6, 96.7)	−1.5 (−2.6, −0.4)	↓
Rural	2,803	67.0 (59.0, 75.0)	−1.2 (−3.9, 1.6)	—

*Calculated by determining the total number of inpatient hospitalizations (discharges) for industry-related injuries from 1998 to 2011 and dividing by the number of years (14).

†The prevalence rate is provided as the number of industry-related injuries per 100,000 inpatient discharges. Maternal and neonatal hospital stays are excluded from the numerator (0.26% of all hospitalizations for industry-related injuries) and denominator (23.5% of all inpatient hospitalizations).

‡If there was a statistically significant trend at the alpha = 5% level, an up or down arrow is used to reflect the direction of the trend; otherwise, a horizontal line is used to indicate no change.

§For industry-related injuries admitted from the emergency room, there was a statistically significant change in the rate. From 1998 to 2000 the annual percentage change (APC) was −9.2; from 2000 to 2009 the APC was 0.7; and from 2009 to 2011 the APC was 24.5. In no other subgroup was there a statistically significant change in the rate.

‖Because of zero counts for multiple years, a trend could not be estimated for industrial injuries admitted following court/law enforcement.

AAPC, average annual percent change; CI, confidence interval; NA, not available; NH, non-Hispanic.

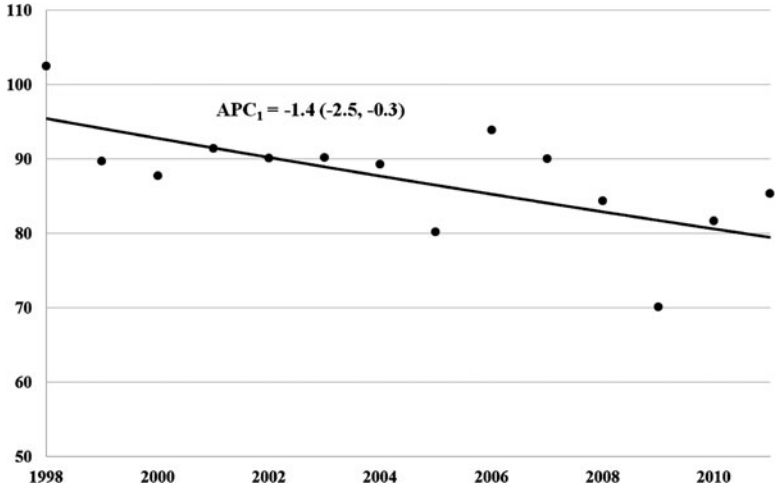

FIGURE 1. Trends in industry-related injuries among nonmaternal/neonatal inpatient discharges, Healthcare Cost and Utilization Project—Nationwide Inpatient Sample, 1998 to 2011. Note that, *x* axis: year of discharge; *y* axis: the number of industry-related injuries per 100,000 nonmaternal/neonatal inpatient discharges. APC, annual percentage change, point estimate (95% confidence interval). *Note:* circular markers indicate the observed annual rate, whereas the solid line represents the trend estimated by joinpoint regression.

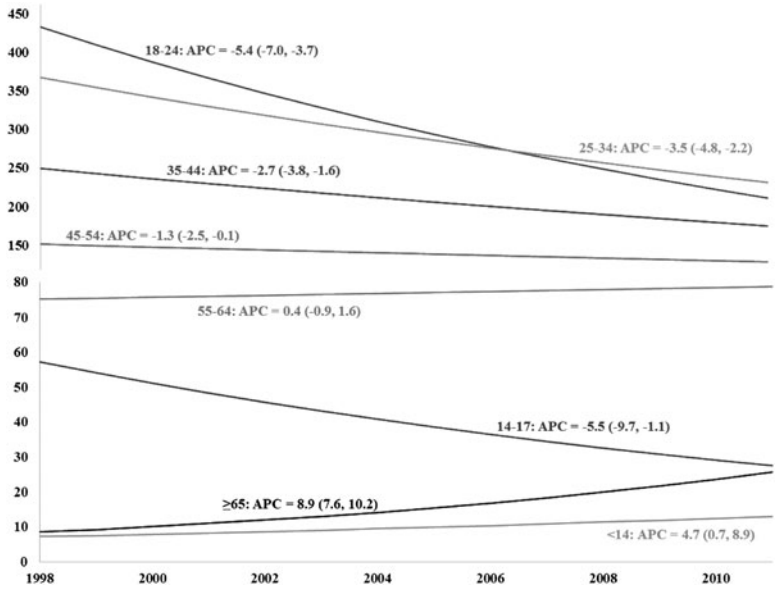

FIGURE 2. Age-specific trends in industry-related injuries among nonmaternal/neonatal inpatient discharges, Healthcare Cost and Utilization Project—Nationwide Inpatient Sample, 1998 to 2011. Note that, *x* axis: year of discharge; *y* axis: the number of industry-related injuries per 100,000 nonmaternal/neonatal inpatient discharges. The *y* axis is split between 80 and 150 to accommodate all age groups within a single figure. APC, annual percentage change, point estimate (95% confidence interval). *Note:* solid lines represent the trend estimated by joinpoint regression. All APCs are statistically significantly different from 0% (no change) except for the 55- to 64-year age group.

Yet, the prevalence of industry-related hospitalizations in this study is not comparable with studies that rely on databases, which focus exclusively on ED admissions, such as the National Electronic Injury Surveillance System.[52,56] These ED-based studies often report significantly higher prevalence rates but include extreme cases from minor injuries that do not result in hospitalization to those that are immediately lethal. Both ED- and inpatient-based studies miss injuries treated on workplace premises or at outpatient clinics and therefore underestimate the total health and economic burden associated with all industrial injuries. Nevertheless, it was the goal of this study to focus on serious injuries that require inpatient hospitalization, which are less studied but important contributors to short- and long-term morbidity and direct and indirect costs of care.

The overall downward trend in industry-related injuries was not consistent across sociodemographic population subgroups. For example, the APCs for the 65 years and older age group, Medicare/Medicaid, 14 years and younger age group, and women reflected 8.9%, 8.2%, 4.7%, and 2.0% yearly increases in the industrial injury rate. Consistent with prior research,[57–64] the increasing trend among the elderly population (older than 65 years) is a major finding in this analysis. Their rate, although second lowest among age groups, rose nearly 9% each year during the study period. This contrasts sharply from the general decreasing trend described among most other age groups. As Americans enjoy increasing quantity of life, with the average life expectancy hovering around more than 80 years,[65] it is to be expected that individuals will remain longer in the workforce.[58] Seniors are also more likely to suffer from vision and hearing impairments, which could increase their susceptibility to injuries.[66]

The similarities between the rising trends observed in the older and government payer groups may be ascribed to patients older than 65 years being very likely to be Medicare recipients. Given this premise, there is the need to devise a surveillance or monitoring system that could focus on this high-risk population. Equally important is the need to explore potentially effective interventions tailored to minimize workplace injury in the elderly. As for the increasing rates in the youngest group of workers, this may partially be explained by the accentuated number of youth entering the industry-related workforce to help support their families, as well as maturational (cognitive and physical) factors common in this age group.[40,67] Nevertheless, more research is needed on the potential role that age has in the injury type, severity, and site experienced by workers in industrial settings.

Another important finding is the increasing trends of industry-related hospitalizations observed among the women in the sample. We speculate that this observation could partially be explained by the upsurge in women's participation in the labor force, especially in high-risk areas traditionally dominated by men, such as heavy

TABLE 3. Hospitalization Utilization, Cost, and In-Hospital Mortality Associated With Industry-Related Injuries, by Site and Type of Injury, Healthcare Cost and Utilization Project—Nationwide Inpatient Sample, 1998 to 2011

	Frequency		Utilization			Direct Medical Cost	
Diagnostic Characteristic	Annual Discharges*	Prevalence† (95% CI)	Mean LOS (95% CI)	Prolonged‡ LOS	Mortality In-Hospital§	Mean‖	Total Annual‖
Overall	25,551	87.4 (82.1, 92.7)	4.2 (4.1, 4.3)	4.5%	75.6	12,849	341,306,584
Injury site							
Head	2,326	8.0 (7.4, 8.5)	3.9 (3.7, 4.0)	4.1%	230.5	12,914	31,503,887
Trunk	2,318	7.9 (7.4, 8.4)	4.5 (4.3, 4.6)	4.1%	83.1	13,098	30,704,943
Extremity	13,211	45.2 (42.2, 48.2)	3.6 (3.5, 3.7)	2.9%	11.5	10,497	142,437,643
Multiple	3,645	12.5 (11.2, 13.7)	6.4 (6.0, 6.7)	10.6%	193.3	22,361	85,057,537
Unknown	4,052	13.9 (12.9, 14.8)	4.2 (3.9, 4.4)	4.2%	85.9	11,712	51,602,575
Injury type¶							
Fracture	12,285	42.0 (39.4, 44.7)	4.5 (4.3, 4.6)	4.8%	73.0	14,574	186,450,107
Open wound	6,484	22.2 (20.2, 24.1)	3.7 (3.6, 3.9)	3.8%	46.9	11,893	78,949,005
Internal or crushing injury	5,014	17.1 (15.6, 18.7)	5.1 (4.9, 5.2)	7.1%	156.6	16,804	89,803,504
Contusion or superficial injury	2,582	8.8 (8.2, 9.5)	3.8 (3.7, 3.9)	3.1%	67.1	11,632	31,614,568
Sprains and strains	1,752	6.0 (5.6, 6.4)	3.0 (2.8, 3.1)	2.0%	1.9	10,162	17,098,744
Burn	1,530	5.2 (4.0, 6.4)	7.4 (6.7, 8.0)	13.6%	161.6	20,967	33,542,316
Dislocation	990	3.4 (3.1, 3.7)	4.4 (4.2, 4.7)	5.9%	28.0	16,647	16,653,470
Physical/environmental	800	2.7 (2.5, 2.9)	6.2 (5.4, 6.9)	10.3%	401.7	19,741	17,998,787
Poisoning	613	2.1 (1.9, 2.2)	3.1 (2.9, 3.3)	2.8%	85.2	7,659	5,146,969
Foreign body entering through orifice	134	0.5 (0.4, 0.5)	5.1 (4.0, 6.1)	9.4%	255.0	21,803	2,813,495

*Calculated by determining the total number of inpatient hospitalizations (discharges) for industry-related injuries from 1998 to 2011 and dividing by the number of years (14).

†The prevalence rate is provided as the number of industry-related injuries per 100,000 inpatient discharges. Maternal and neonatal hospital stays are excluded from the numerator (0.26% of all hospitalizations for industry-related injuries) and denominator (23.5% of all inpatient hospitalizations).

‡A prolonged length of hospital stay was defined as being greater than the 95th percentile of all hospitalizations in which an industry-related injury occurred (more than 13 days).

§Presented as the number of in-hospital deaths per 10,000 hospitalizations.

‖Cost analyses only performed from 2001 to 2011. Costs expressed in 2011 US dollars ($), represent third-party institutional inpatient hospitalization costs. Mean cost represents the mean, per discharge cost. The total annual cost was calculated by determining the total cost from 2001 to 2011 and dividing by the number of years in the cost analysis (11).

¶Discharge records may indicate more than 1 type of injury; therefore, although discharges are unduplicated at the level of the injury subtype, a discharge with multiple types of injuries may have been included in more than 1 type-specific analysis.

CI, confidence interval; LOS, length of stay.

manufacturing.[26] In addition, although we found that women were less likely than men to be injured, they were more than twice as likely to be hospitalized for poisoning injuries. This study also confirmed previous reports of higher rates of sprain/strain among women.[68] These observations may justify the need to offer sex-sensitive injury prevention strategies in industrial settings. Nevertheless, because this study was not designed to investigate the impact of sex across various types of industrial settings, more research is warranted to elicit explanations for sex-related disparities to formulate effective prevention measures for women working in industrial settings.

As anticipated, those with head and multiple-site injuries represented the most severe cases and, therefore, had the highest mean costs, in-hospital mortality, and prolonged stays, as did burns and physical/environmental injuries (eg, freezing, heat stroke, and electrocutions). On the contrary, most extremity injuries had the lowest mean cost per discharge ($10,497 per admission) and consequently the shortest average hospital stay (3.6 days). This lower cost and shorter stay can be attributed to the lower lethality associated with these injuries. Typically, injuries to the extremities do not impact vital organs and are easily detectable, accessible to prompt management, and non–life threatening. Yet, in spite of these factors, the frequency of extremity injuries still resulted in major costs for US hospitals during the study period (approximately $142 million per year).

It is also noteworthy that the average direct medical cost per admission (adjusted for inflation) for all admissions recorded between 2001 and 2011 in this study was $12,849, which is lower than the costs reported by other studies.[3,35] This cost difference could be due to several reasons. First, our methodology and span of years covered in this study may not necessarily allow for cost comparability with previous studies. In addition, one limitation of using secondary data is that some of the necessary variables may be absent for in-depth evaluation of trends and costs. The NIS data set does not collect data on indirect or intangible costs (eg, reduced productivity, disability, premature mortality, and absenteeism). Furthermore, the NIS identifies industry-related injuries using a single ICD-9-CM external cause-of-injury code with suboptimal accuracy and reliability[23,69,70] and is only capable of capturing cases in which the injured person seeks medical care and is admitted on an inpatient basis. Thus, this study underestimates the overall prevalence of these injuries as well as the total societal costs that can be attributed to lethal and major and minor nonlethal injuries that occur in the industrial setting. Finally, results of prevalence, trends, and cost analyses for any exposure or outcome, by race/ethnicity, using NIS data should be interpreted with caution because some states do not report race/ethnicity data in the discharges submitted to HCUP (approximately 25% missing race/ethnicity data in this study).

Despite limitations, the NIS database provided a large number of records to analyze. This allowed for a more representative national sample, increased power and precision for subgroup analyses. This study was also unique in that we analyzed data over a 14-year period, compared with other studies, which were limited to fewer or only 1 year. In addition, the uniqueness of the study extends to the cost and trends analysis methodology. As is often done with other conditions, the rate of industry-related injuries was being considered

with a denominator that included all inpatient hospitalizations in the United States. Nevertheless, maternal and neonatal hospitalizations are technically not "at risk" of an industry-related injury. Therefore, for this study, records with the indication of being maternal or neonatal were removed from the numerator and denominator hospitalizations. The process deleted 0.26% of all industry-related injuries and 23.5% of all inpatient hospitalizations. This ensures that rate estimation and trends were more reflective of true measures of industry-related injuries over time.

CONCLUSIONS

Results from this study suggest that variations in the rates and types of injuries exist by geographic region, age, sex, race/ethnicity, patient admission location (rural vs urban), income level, and payer. The findings may be a reflection of the recent reduction in occupational injuries through efforts led by the US Department of Labor, the Occupational Safety and Health Administration, and local government entities to enforce workplace safety rules and injury prevention programs.[71] Nevertheless, despite these efforts, occupational injuries, illnesses, and fatalities remain a major public health and economic concern in the United States and around the world. This creates a need for more research to understand the individual, social, and environmental-level risk factors associated with occupational injuries and illnesses. The findings from this study may be beneficial in the development, implementation, and evaluation of injury prevention policies and prevention programs.

REFERENCES

1. National Institute for Occupational Safety and Health. Workplace safety and health topics: traumatic occupational injuries. Available at: http://www.cdc.gov/niosh/injury/. Accessed November 18, 2014.
2. US Department of Labor, Bureau of Labor Statistics. Injuries, illnesses, and fatalities. Available at: http://www.bls.gov/iif/. Accessed December 4, 2014.
3. Leigh JP. Economic burden of occupational injury and illness in the United States. *Milbank Q*. 2011;89:728–772.
4. Amandus HE, Hendricks SA, Zahm D, et al. Convenience store robberies in selected metropolitan areas. Risk factors for employee injury. J Occup Environ Med. 1997;39:442–447.
5. Boyer J, Galizzi M, Cifuentes M, et al. Ergonomic and socioeconomic risk factors for hospital workers' compensation injury claims. *Am J Ind Med*. 2009;52:551–562.
6. Cantley LF, Galusha D, Cullen MR, et al. Does tinnitus, hearing asymmetry, or hearing loss predispose to occupational injury risk? *Int J Audiol*. 2015;54(suppl 1):S30–S36.
7. Helmkamp JC, Lincoln JE, Sestito J, Wood E, Birdsey J, Kiefer M. Risk factors, health behaviors, and injury among adults employed in the transportation, warehousing, and utilities super sector. *Am J Ind Med*. 2013;56:556–568.
8. Lipscomb HJ, Cameron W, Silverstein B. Back injuries among union carpenters in Washington State, 1989–2003. *Am J Ind Med*. 2008;51:463–474.
9. Gardner LI, Landsittel DP, Nelson NA. Risk factors for back injury in 31,076 retail merchandise store workers. *Am J Epidemiol*. 1999;150:825–833.
10. Mehler L, Beckman J, Badakhsh R, et al. Acute illness and injury from swimming pool disinfectants and other chemicals—United States, 2002–2008. *MMWR Morb Mortal Wkly Rep*. 2011;60:1343–1347.
11. d'Errico A, Punnett L, Cifuentes M, et al. Hospital injury rates in relation to socioeconomic status and working conditions. *Occup Environ Med*. 2007;64:325–333.
12. Earle-Richardson G, Jenkins PL, Slingerland DT, Mason C, Miles M, May JJ. Occupational injury and illness among migrant and seasonal farmworkers in New York State and Pennsylvania, 1997–1999: pilot study of a new surveillance method. *Am J Ind Med*. 2003;44:37–45.
13. Gallagher S, Moore S, Dempsey PG. An analysis of injury claims from low-seam coal mines. *J Safety Res*. 2009;40:233–237.
14. Peek-Asa C, Casteel C, Kraus JF, Whitten P. Employee and customer injury during violent crimes in retail and service businesses. *Am J Public Health*. 2006;96:1867–1872.
15. Tiesman HM, Konda S, Bell JL. The epidemiology of fatal occupational traumatic brain injury in the U.S. *Am J Prev Med*. 2011;41:61–67.
16. Bailer AJ, Stayner LT, Stout NA, Reed LD, Gilbert SJ. Trends in rates of occupational fatal injuries in the United States (1983–92). *Occup Environ Med*. 1998;55:485–489.
17. Bhushan A, Leigh JP. National trends in occupational injuries before and after 1992 and predictors of workers' compensation costs. *Public Health Rep*. 2011;126:625–634.
18. Castillo DN, Malit BD. Occupational injury deaths of 16 and 17 year olds in the US: trends and comparisons with older workers. *Inj Prev*. 1997;3:277–281.
19. Bockosh G, Fotta B, McKewan W. Employment, production and fatality trends in the U.S. coal mining industry. *Coal Age*. 2002;107:18–20.
20. Hendricks KJ, Hendricks SA. Changing farm injury trends by sex for youth living on U.S. farms, 1998–2006. *J Rural Health*. 2010;26:182–188.
21. Loomis D, Bena JF, Bailer AJ. Diversity of trends in occupational injury mortality in the United States, 1980–96. *Inj Prev*. 2003;9:9–14.
22. Pappas DM, Mark C. Roof and rib fall incident trends: a 10-year profile. In: *The National Institute for Occupational Safety and Health (NIOSH)*. Atlanta, GA: Centers for Disease Control and Prevention; 2008.
23. Sears JM, Bowman SM, Hogg-Johnson S, Shorter ZA. Occupational injury trends derived from trauma registry and hospital discharge records: lessons for surveillance and research. *J Occup Environ Med*. 2014;56:1067–1073.
24. Sears JM, Bowman SM, Silverstein BA. Trends in the disproportionate burden of work-related traumatic injuries sustained by Latinos. *J Occup Environ Med*. 2012;54:1239–1245.
25. Kelsh MA, Sahl JD. Sex differences in work-related injury rates among electric utility workers. *Am J Epidemiol*. 1996;143:1050–1058.
26. Taiwo OA, Cantley LF, Slade MD, et al. Sex differences in injury patterns among workers in heavy manufacturing. *Am J Epidemiol*. 2009;169:161–166.
27. Zwerling C, Sprince NL, Ryan J, Jones MP. Occupational injuries: comparing the rates of male and female postal workers. *Am J Epidemiol*. 1993;138:46–55.
28. McGwin G Jr, Enochs R, Roseman JM. Increased risk of agricultural injury among African-American farm workers from Alabama and Mississippi. *Am J Epidemiol*. 2000;152:640–650.
29. Pransky G, Moshenberg D, Benjamin K, Portillo S, Thackrey JL, Hill-Fotouhi C. Occupational risks and injuries in non-agricultural immigrant Latino workers. *Am J Ind Med*. 2002;42:117–123.
30. Xiang H, Shi J, Lu B, et al. Medical expenditures associated with nonfatal occupational injuries among immigrant and U.S.-born workers. *BMC Public Health.* 2012;12:678.
31. Hassi J, Gardner L, Hendricks S, Bell J. Occupational injuries in the mining industry and their association with statewide cold ambient temperatures in the USA. *Am J Ind Med*. 2000;38:49–58.
32. Asfaw A, Mark C, Pana-Cryan R. Profitability and occupational injuries in U.S. underground coal mines. *Accid Anal Prev*. 2013;50:778–786.
33. Olorunnishola OA, Kidd-Taylor A, Byrd L. Occupational injuries and illnesses in the solid waste industry: a call for action. *New Solut*. 2010;20:211–223.
34. Konda S, Reichard AA, Tiesman HM. Occupational injuries among U.S. correctional officers, 1999–2008. *J Safety Res*. 2012;43:181–186.
35. Lander L, Shah RK, Li Y, Mahalingam-Dhingra A, Smith LM, Sorock G. Healthcare cost usage for hospitalised injuries sustained in industrial settings in the USA. *Inj Prev*. 2013;19:112–118.
36. Leigh JP, Cone JE, Harrison R. Costs of occupational injuries and illnesses in California. *Prev Med*. 2001;32:393–406.
37. Leigh JP, Marcin JP. Workers' compensation benefits and shifting costs for occupational injury and illness. *J Occup Environ Med*. 2012;54:445–450.
38. Leigh JP, McCurdy SA, Schenker MB. Costs of occupational injuries in agriculture. *Public Health Rep*. 2001;116:235–248.
39. Leigh JP, Waehrer G, Miller TR, McCurdy SA. Costs differences across demographic groups and types of occupational injuries and illnesses. *Am J Ind Med*. 2006;49:845–853.
40. Zaloshnja E, Miller TR, Lawrence B. Incidence and cost of injury among youth in agricultural settings, United States, 2001–2006. *Pediatrics*. 2012;129:728–734.
41. Leigh JP, Du J, McCurdy SA. An estimate of the U.S. government's undercount of nonfatal occupational injuries and illnesses in agriculture. *Ann Epidemiol*. 2014;24:254–259.
42. Leigh JP, Marcin JP, Miller TR. An estimate of the U.S. Government's undercount of nonfatal occupational injuries. *J Occup Environ Med*. 2004;46:10–18.
43. Agency for Healthcare Research and Quality. The Healthcare Cost And Utilization Project overview. Available at: http://www.hcup-us.ahrq.gov/overview.jsp. Accessed December 4, 2014.
44. Centers for Disease Control and Prevention. Classification of diseases, functioning, and disability. Available at: http://www.cdc.gov/nchs/icd/icd9cm.htm. Accessed December 4, 2014.

45. Finkler SA. The distinction between cost and charges. *Ann Intern Med*. 1982;96:102–109.
46. Salemi JL, Comins MM, Chandler K, Mogos MF, Salihu HM. A practical approach for calculating reliable cost estimates from observational data: application to cost analyses in maternal and child health. *Appl Health Econ Health Policy*. 2013;11:343–357.
47. Sun Y, Friedman B. Tools for more accurate inpatient cost estimates with HCUP databases, 2009. Errata added October 25, 2012. HCUP methods series report # 2011–04. Agency for Healthcare Research and Quality. Available at: http://www.hcup-us.ahrq.gov/reports/methods/methods.jsp. Accessed November 18, 2014.
48. National Cancer Institute. Joinpoint Trend Analysis Software. Available at: http://surveillance.cancer.gov/joinpoint/. Accessed December 4, 2014.
49. Kim HJ, Fay MP, Feuer EJ, Midthune DN. Permutation tests for joinpoint regression with applications to cancer rates. *Stat Med*. 2000;19:335–351.
50. Houchens RL, Elixhauser A, Romano PS. How often are potential patient safety events present on admission? *Jt Comm J Qual Patient Saf*. 2008;34:154–163.
51. US Department of Labor, Bureau of Labor Statistics. Consumer Price Index: all urban consumers—(CPI-U), 2012. Available at: http://www.bls.gov/data/. Accessed December 18, 2014.
52. Centers for Disease Control and Prevention. Nonfatal occupational injuries and illnesses treated in hospital emergency departments—United States, 1998. *MMWR Morb Mortal Wkly Rep*. 2001;50:313–317.
53. Centers for Disease Control and Prevention. Nonfatal occupational injuries and illnesses among workers treated in hospital emergency departments—United States, 2003. *MMWR Morb Mortal Wkly Rep*. 2006;55:449–452.
54. Jackson LL. Non-fatal occupational injuries and illnesses treated in hospital emergency departments in the United States. *Inj Prev*. 2001;7:i21–i26.
55. Layne LA, Pollack KM. Nonfatal occupational injuries from slips, trips, and falls among older workers treated in hospital emergency departments, United States 1998. *Am J Ind Med*. 2004;46:32–41.
56. Centers for Disease Control and Prevention. Nonfatal occupational injuries and illnesses—United States, 2004. *MMWR Morb Mortal Wkly Rep*. 2007;56:393–397.
57. Centers for Disease Control and Prevention. Work-related roadway crashes—United States, 1992–2002. *MMWR Morb Mortal Wkly Rep*. 2004;53:260–264.
58. Hartley D, Biddle EA. Will risks to older workers change in the 21st century? *Hum Ecol Risk Assess*. 2001;7:1885–1894.
59. Massachusetts Department of Public Health. Fatal injuries at work: Massachusetts fatality update, 2003–2004. Available at: http://www.mass.gov/eohhs/docs/dph/occupational-health/alert/cfoi-update-03-04.pdf. Accessed March 11, 2015.
60. Kisner SM, Pratt SG. Occupational injury fatalities among older workers in the United States, 1980–1994. *Am J Ind Med*. 1999;S1:24–25.
61. Layne LA, Landen DD. A descriptive analysis of nonfatal occupational injuries to older workers, using a national probability sample of hospital emergency departments. *J Occup Environ Med*. 1997;39:855–865.
62. Locklin C, Lackovic M. Work-related hospitalizations in Louisiana: a review of Louisiana hospital inpatient discharge data for 10 years (1998–2007). Available at: http://www.cdc.gov/niosh/nioshtic-2/20042478.html. Accessed March 11, 2015.
63. Marsh SM, Layne LA. Fatal injuries to civilian workers in the United States, 1980–1995 (national and state profiles). Available at: http://www.cdc.gov/niosh/docs/2001-129/. Accessed March 11, 2015.
64. Pratt SG, Kisner SM, Helmkamp JC. Machinery-related occupational fatalities in the United States, 1980 to 1989. *J Occup Environ Med*. 1996;38:70–76.
65. Xu JQ, Kochanek KD, Murphy SL, Arias E.*Mortality in the United States, 2012*. NCHS data brief, no 168. Hyattsville, MD: National Center for Health Statistics. Available at: http://www.cdc.gov/nchs/data/databriefs/db168.htm. Accessed January 20, 2015.
66. Palmer KT, D'Angelo S, Harris EC, Linaker C, Coggon D. Sensory impairments, problems of balance and accidental injury at work: a case-control study. *Occup Environ Med*. 2015;72:195–199.
67. Breslin C, Koehoorn M, Smith P, Manno M. Age related differences in work injuries and permanent impairment: a comparison of workers' compensation claims among adolescents, young adults, and adults. *Occup Environ Med*. 2003;60:e10.
68. Islam SS, Velilla AM, Doyle EJ, Ducatman AM. Gender differences in work-related injury/illness: analysis of workers compensation claims. *Am J Ind Med*. 2001;39:84–91.
69. Sears JM, Bowman SM, Hogg-Johnson S, Shorter ZA. Linkage and concordance of trauma registry and hospital discharge records: lessons for occupational injury surveillance and research. *J Occup Environ Med*. 2014;56:878–885.
70. Alamgir H, Koehoorn M, Ostry A, Tompa E, Demers P. An evaluation of hospital discharge records as a tool for serious work related injury surveillance. *Occup Environ Med*. 2006;63:290–296.
71. Occupational Safety and Health Administration. Injury and Illness Prevention Programs White Paper—January 2012. Available at: https://www.osha.gov/dsg/InjuryIllnessPreventionProgramsWhitePaper.html. Accessed December 4, 2014.

APPENDIX

International Classification of Diseases, Ninth Edition, Clinical Modification (ICD-9-CM) Diagnosis Codes Used to Identify and Classify Industry-Related Hospital Discharge Records

Injury Type	Description	ICD-9-CM Code or Range
Fracture	Fracture of skull	(800–804)
	Spine and trunk	(805–809)
	Upper limb	(810–819)
	Lower limb	(820–829)
Dislocation	Dislocation	(830–839)
Sprains and strains	Sprains and strains of joints and adjacent muscles	(840–848)
Internal or crushing injury	Intracranial, excluding those with skull fracture	(850–854)
	Chest, abdomen, and pelvis	(860–869)
	Injury to blood vessels	(900–904)
	Crushing injury	(925–929)
	Injury to nerves and spinal cord	(950–957)
Open wound	Head, neck, and trunk	(870–879)
	Upper limb	(880–887)
	Lower limb	(890–897)
Contusion or superficial injury	Superficial injury	(910–919)
	Contusion with intact skin surface	(920–924)

(*continues*)

APPENDIX (*Continued*)

Injury Type	Description	ICD-9-CM Code or Range
Foreign body entering through orifice	Effects of foreign body entering through orifice	(930–939)
	Inhalation and ingestion of food causing obstruction of respiratory tract or suffocation	(E911)
	Inhalation and ingestion of other object causing obstruction of respiratory tract or suffocation	(E912)
	Accidental mechanical suffocation	(E913)
	Foreign body accidentally entering eye and adnexa	(E914)
	Foreign body accidentally entering other surface	(E915)
Burns	Burns	(940–949)
	Injury by burns or fire, undetermined whether accidentally or purposely inflicted	(E988.1)
	Injury by scald, undetermined whether accidentally or purposely inflicted	(E988.2)
Poisoning	Poisoning by drugs, medicinal and biological substances	(960–979)
	Toxic effects of substances chiefly nonmedicinal as to source	(980–989
	Accidental poisoning by drugs, medicinal substances, and biologicals	(E850-E858)
	Accidental poisoning by other solid and liquid substances, gases, and vapors	(E860-E869)
	Poisoning by solid or liquid substances undetermined whether	(E980)
	accidentally or purposely inflicted	(E980)
	Poisoning by other gases undetermined whether accidentally or purposely inflicted	(E982)
Physical/environmental (other and unspecified effects of external cause)	Radiation	(990)
	Cold	(991)
	Heat/light	(992)
	Air pressure	(993)
	Other	(994)
	NEC	(995)
	Prickly heat disorders of sweat glands	(705.1)
	Asphyxia and hypoxemia	(799.0)
	Injury by extremes of cold, undetermined whether accidentally or purposely inflicted	(E988.3)
	Injury by electrocution, undetermined whether accidentally or purposely inflicted	(E988.4)
Anatomical location	**Description**	**ICD-9-CM Code or Range**
Head, face, and neck	Fracture of skull	(800–804)
	Closed fracture of cervical vertebra with and w/o spinal cord injury	(805.0, 806.0)
	Open fracture of cervical vertebra with and w/o spinal cord injury	(805.1, 806.1)
	Dislocation of jaw	(830)
	Dislocation of cervical vertebra	(839.0–1)
	Sprain of septal cartilage of nose	(848.0)
	Sprain of jaw	(848.1)
	Sprain of thyroid region	(848.2)
	Intracranial injury, excluding those with skull fracture	(850–854)
	Open wound of ocular adnexa, eyeball, ear, head, neck	(870–874)
	Injury to blood vessels of head and neck	(900)
	Superficial injury of face neck and scalp	(910)
	Superficial injury of eye and adnexa	(918)
	Contusion of face, scalp, and neck	(920)
	Contusion of eye and adnexa	(921)
	Crushing injury of face scalp and neck	(925)
	Foreign body on external eye	(930)
	Foreign body on ear	(931)
	Foreign body on nose	(932)
	Foreign body on larynx	(933)
	Burn confined to eye and adnexa	(940)
	Burn confined to face, head, and neck	(941)
	Burn confined to mouth and pharynx	(947.0)
	Injury to optic nerve and pathways	(950)
	Injury to other cranial nerve(s)	(951)
	Injury to cervical spinal cord	(952.0)
	Injury to cervical nerve root	(953.0)

(*continues*)

APPENDIX (*Continued*)

Anatomical location	Description	ICD-9-CM Code or Range
	Injury to superficial nerves of head and neck	(957.0)
	Other and unspecified injury to head face and neck	(959.0)
Trunk	Closed/open fracture of dorsal (thoracic) vertebra with and w/o spinal cord injury	(805.2–3, 806.2–3)
	Closed/open fracture of lumbar vertebra with and w/o spinal cord injury	(805.4–5, 806.4–5)
	Closed/open fracture of sacrum and coccyx with and w/o spinal cord injury	(805.6–7, 806.6–7)
	Closed fracture of unspecified vertebral column with and w/o spinal cord injury	(805.8–9, 806.8–9)
	Fracture of rib(s), sternum, larynx, and trachea	(807)
	Fracture of pelvis	(808)
	Fracture of bones of trunk	(809)
	Dislocation of thoracic, lumbar, other vertebra, sternum	(839.2–7)
	Sprains and strains of sacroiliac region	(846)
	Sprains and strains of other and unspecified parts of back	(847)
	Sprain of septal cartilage of ribs	(848.3)
	Sprain of sternum	(848.4)
	Sprain of pelvis	(848.5)
	Internal Injury of chest, abdomen, and pelvis	(860–869)
	Open wound of chest, back, buttock, genital organs	(875–878)
	Open wound of breast	(879.0–1)
	Open wound of abdominal wall	(879.2–5)
	Open wound of other parts of trunk	(879.6–7)
	Injury to blood vessels of thorax	(901)
	Injury to blood vessels of abdomen and pelvis	(902)
	Superficial injury of trunk	(911)
	Contusion of trunk	(922)
	Crushing injury of trunk	(926)
	Foreign body in trachea bronchus and lung	(934)
	Foreign body in esophagus and stomach	(935)
	Foreign body in intestine and colon	(936)
	Foreign body in anus and rectum	(937)
	Foreign body in digestive system unspecified	(938)
	Foreign body in genitourinary tract	(939)
	Foreign body in burn of trunk	(942)
	Foreign body in larynx, trachea, and lung	(947.1)
	Foreign body in esophagus	(947.2)
	Foreign body in gastrointestinal tract	(947.3)
	Foreign body in vagina and uterus	(947.8)
	Injury to dorsal/thoracic, lumbar, and other sites of spinal cord	(952.1–4, 8–9)
	Injury to nerve root, other than cervical and brachial plexus	(953.1–3, 5, 8–9)
	Injury to other nerve(s) of trunk	(954)
	Other and unspecified injury to trunk	(959.1)
Upper extremity	Fracture of upper limb	(810–819)
	Dislocation of shoulder, elbow, wrist, finger	(831–834)
	Sprains and strains of shoulder and upper arm	(840)
	Sprains and strains of elbow and forearm	(841)
	Sprains and strains of wrist and hand	(842)
	Open wound of upper limb	(880–887)
	Injury to blood vessels of upper extremity	(903)
	Superficial injury of shoulder and upper arm	(912)
	Superficial injury of elbow forearm and wrist	(913)
	Superficial injury of hand	(914)
	Superficial injury of fingers	(915)
	Contusion of upper limb	(923)
	Crushing injury of upper limb	(927)
	Burn of upper limb	(943)
	Burn of wrist and hand	(944)

(*continues*)

APPENDIX (*Continued*)

Anatomical location	Description	ICD-9-CM Code or Range
	Injury to brachial plexus	(953.4)
	Injury to peripheral nerve(s) of shoulder girdle and upper limb	(955)
	Injury to shoulder and upper arm	(959.2)
	Injury to elbow, forearm, and wrist	(959.3)
	Injury to hand	(959.4)
	Injury to finger	(959.5)
Lower extremity	Fracture of lower limb	(820–829)
	Dislocation of hip, knee, ankle, foot	(835–838)
	Sprains and strains of hip and thigh	(843)
	Sprains and strains of knee and leg	(844)
	Sprains and strains of ankle and foot	(845)
	Open wound of lower limb	(890–897)
	Injury to blood vessels of lower extremity	(904.0–8)
	Superficial injury of hip thigh leg and ankle	(916)
	Superficial injury of foot and toe	(917)
	Contusion of lower limb	(924.0–5)
	Crushing injury of lower limb	(928)
	Burn of lower limb	(945)
	Injury to peripheral nerve(s) of pelvic girdle and lower limb	(956)
	Injury to hip and thigh	(959.6)
	Injury to knee, leg, ankle, and foot	(959.7)