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Workplace-related musculoskeletal injury trends in the United States from 1992 to 2018☆

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ABSTRACT

Introduction: The purpose of our study is to assess workplace-related musculoskeletal (wrMSK) injury trends by utilizing Bureau of Labor Statistics (BLS) data. We hypothesize that trunk injuries are the most commonly reported, injuries occur most frequently in the manufacturing sector, and that injury type occurrence differs according to body region affected.

Methods: This study assessed wrMSK injury data provided by the BLS from 1992 to 2018. The three main body regions analyzed were lower extremity (LE), upper extremity (UE), and trunk. Injury data was also assessed by industrial sector (Agriculture, Manufacturing, Healthcare, and Construction) and injury type (fractures, multiple injuries, sprains/strains/tears, tendonitis, cuts/lacerations, pain/soreness, and bruises). Negative binomial regression and pairwise comparisons with a Benjamini-Hochberg adjustment were utilized to compare calculated incidence rate ratios for wrMSK injuries. Exponentiated beta estimates were used to calculate the estimated annual percent changes of wrMSK injuries within each industrial sector.

Results: Occurrence of wrMSK injuries from 1992 to 2018 was significantly lower for LE when compared to both upper extremity and trunk ($p < 0.001$). Manufacturing is shown to be the industry with the most wrMSK injuries in each of UE, LE, and trunk. wrMSK injuries were shown to decrease in each industrial sector over the timespan assessed, with the greatest percent change occurring in the manufacturing sector. Lacerations and tendonitis were the most common diagnosis types in UE, while pain/soreness and strains/sprains/tears were most common in trunk and bruises were most common in LE.

Discussion: From 1992 to 2018, trunk injuries were the most frequently occurring wrMSK injury, but not to a significantly higher degree than upper extremity injuries. wrMSK injury types that may require orthopedic surgical care affect specific body regions to different degrees, with cuts/lacerations and tendonitis most commonly affecting the upper extremity. Thus, it appears that wrMSK injuries in the upper extremity are of particular importance from an orthopedic care perspective.

Introduction

In the United States as of 2018, there were approximately 155 million Americans employed [1]. From the healthcare perspective, one of the most critical aspects to understand regarding the workforce as a whole is the injuries that occur on the job. Workplace injuries have previously been shown to be quite common, and in 2018 over 70 million production days were lost due to work injuries [2]. According to the National Safety Council, the most common causes of workplace-related injuries are overexertion, contact with objects and equipment, and slips, trips and falls [2]. Of all workplace-related injuries, over half require days off from work [3]. In particular, musculoskeletal injuries account for around one third of all job-related injuries [4].

With a substantial proportion of workplace-related injuries being musculoskeletal in nature, understanding the trends of these injuries provides vital information not only for the government but also health systems and hospitals as well. Previous studies have indicated a reduction in overall workplace-related musculoskeletal (wrMSK) injury rates and provided different explanations for such trends, such as workers shifting to less hazardous industries and alterations in the of Occupational Safety and Health Administration (OSHA) reporting guidelines [5–7]. Of particular importance

☆ Since this study utilized publicly available database information, an exemption was granted by our Institutional Review Board office.

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are changes in OSHA guidelines that have been instituted in the time since the organization's advent in 1970 [5,8]. Within the last 25 years, two major changes occurred: (1) in 1995 reporting requirements for employers were transitioned to electronic reporting, and (2) in 2002 OSHA implemented a change in the record-keeping rules that resulted in a more strict definition regarding which injuries are considered recordable [5,9]. These changes in reporting requirements have been cited as a contributing factor to the large reduction in annual injuries that occurred both in 1995 and 2002 and in subsequent years [5]. Taking into account these changes in employer injury reporting requirements, it remains unclear whether these decreases in wrMSK injuries are industry specific or related to other factors such as specific body regions. In 2016, the Bureau of Labor Statistic's *The Economic Daily* report discussed data on work-related back injuries, which was demonstrated to be the most frequent wrMSK injury [10]. However, further investigation is merited in order to fully assess the distribution of wrMSK injuries over the past decades and determine any trends.

The primary objective of our study is to compare wrMSK injury rates by body region including trunk, upper extremity (UE), and lower extremity (LE) injuries by utilizing nationwide injury data from the Bureau of Labor Statistics (BLS) from 1992 to 2018. Additional secondary objectives will include analyzing wrMSK injuries according to (1) industrial sectors outlined by the BLS and (2) injury types. We hypothesize that (a) trunk injuries are still the most commonly reported wrMSK injury, (b) wrMSK injuries occur most frequently in the manufacturing sector, and that (c) wrMSK injury type occurrence differs significantly according to body region affected.

Materials and methods

Study design and participants

The Bureau of Labor Statistics (BLS), a division of the United States Department of Labor, supports nationally, publicly available databases containing labor and economic statistics. Workplace-related injury occurrence data was collected from the respective BLS databases for the years 1992 to 2018. The BLS uses OSHA injury data which defines nonfatal workplace-related injuries as injuries or illnesses resulting from events or exposures occurring in the workplace. Specifically, injuries that meet any of the following criteria are included in the OSHA/BLS injury data: (a) any workplace-related injury or illness that results in loss of consciousness, days away from work, restricted work, or transfer to another job, (b) any workplace-related injury or illness requiring medical treatment beyond first aid, and (c) any workplace-related diagnosed case of cancer, chronic irreversible diseases, fractured or cracked bones/teeth, and punctured eardrums [11,12]. For the purposes of our study, only musculoskeletal injuries within the aforementioned three criteria from the BLS databases were considered in analysis. Since this study utilized publicly available database information, an exemption was granted by our Institutional Review Board office.

The three main wrMSK injury body regions analyzed in this study were lower extremity (LE), upper extremity (UE), and trunk. Injuries in the LE region include damage to thigh, leg, and foot. The UE region contains injuries to the shoulder, arm, forearm, and hand. Lastly, the trunk region includes back and abdominal injuries. Injury data was also assessed according to industry of occupation, which included the following sectors: (1) Agriculture, (2) Manufacturing, (3) Healthcare, and (4) Construction. A second comparison was made according to type of injury, which included: (1) fractures, (2) bruises, (3) sprains/strains/tears, (4) tendonitis, (5) cuts/lacerations, (6) pain/soreness, and (7) multiple injuries.

Statistical analysis

Negative binomial regression was applied to obtain incidence rate ratios for wrMSK injuries with 95% confidence intervals according to body region (UE, LE, or Trunk), industrial sectors (Agriculture, Manufacturing, Healthcare, and Construction), and injury type (Fractures, Tendonitis, Sprains/strains/tears, multiple injuries, cuts and lacerations, pain/soreness, and bruises). To conduct pairwise comparisons for calculated incidence rate ratios, a Benjamini-Hochberg adjustment was applied to the p-values to control the type I error rate. Exponentiated beta estimates from models where body region injured is the dependent variable and year is the independent variable were used to calculate the estimated annual percent change within each industrial sector along with 95% confidence interval. Calculated *p*-values smaller than 0.05 were considered statistically significant. All analyses are performed using SAS 9.4 (SAS Institute Inc, Cary, NC, USA).

Results

Overall wrMSK injury occurrence in major industrial sectors from 1992 to 2018 for the following body regions were tabulated: UE (5278,166 cases, 36.5% of total wrMSK injuries), LE (3296,547 cases, 22.8% of total wrMSK injuries), and trunk (5855,312 cases, 40.6% of total wrMSK injuries) (Fig. 1). When taking into account the average yearly employed labor force over this time span (138,284,148 workers per year), there are 1.41 UE injuries per 1000 employed people, 0.88 LE injuries per 1000 employed people, and 1.57 trunk injuries per 1000 employed people [13]. Overall wrMSK injury occurrence over this time range was significantly lower for LE when compared to both UE and trunk respectively ($p < 0.001$). Although no statistically significant difference was found between UE and trunk injuries during the time span, the overall number of trunk injuries was higher.

When looking at the overall number of wrMSK injuries by body region and workplace sector, the manufacturing sector is shown to account for the most UE, LE, and trunk injuries (Table 1). In the manufacturing sector, LE injury occurrence was shown to be significantly lower than UE and trunk injury occurrences respectively ($p < 0.001$) (Fig. 2a). No significant difference was observed between UE and trunk injury occurrence in manufacturing. For the healthcare sector, trunk injury occurrence was shown to be the highest, followed by UE and then LE ($p < 0.001$) (Fig. 2b). For both the construction and agriculture sectors, no significant differences in wrMSK injury occurrence were observed when comparing between the trunk, LE, and UE regions.

When comparing the occurrence of UE and LE injuries across industrial sectors from 1992 to 2018, significant differences were determined for all sectors except when directly comparing the construction and healthcare sectors (Fig. 3a and b, $p < 0.001$). Upon analyzing trunk injury occurrence across industrial sectors from 1992 to 2018, significant differences were determined between all sectors (Fig. 3c, $p < 0.01$). The manufacturing sector showed the most significant annual percentage decreases in wrMSK injuries for each body region examined, while the healthcare sector showed the least significant decreases for all body regions (Table 2). When assessing the annual percentage change of wrMSK injury occurrence in specific body regions stratified by industrial sector, the greatest annual percent decrease occurred in the trunk injury category within manufacturing (9.59% annual decrease) while the smallest percent change was in the UE category within healthcare (1.08% annual decrease) (Table 2).

When comparing the occurrence of injury types by body region from 1992 to 2018, significant differences were determined for

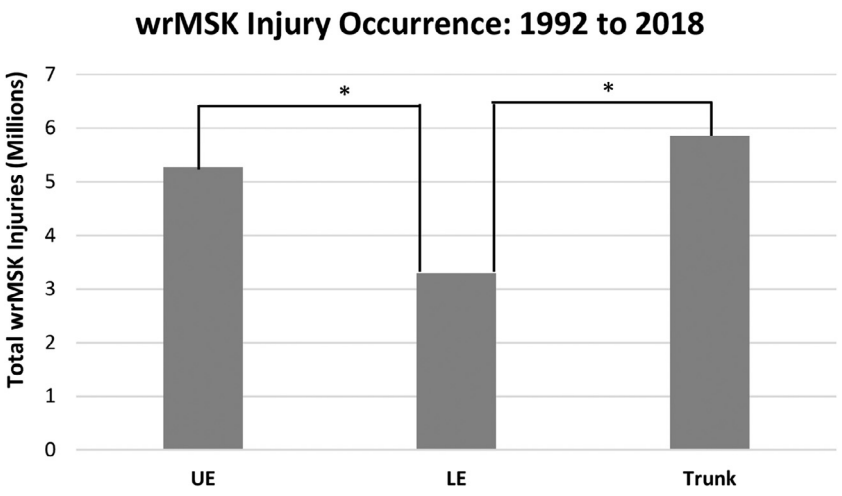
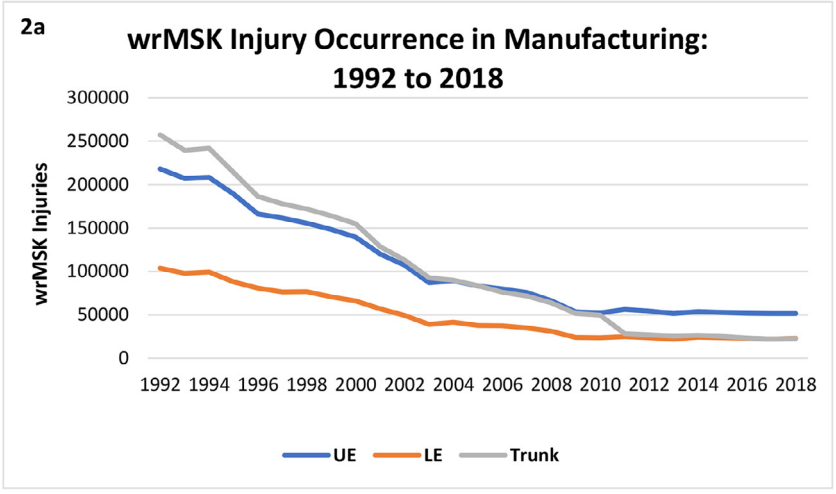


Fig. 1. wrMSK injury occurrence over the 1992 to 2018 time range was significantly lower for LE when compared to both UE and trunk respectively ($p < 0.001$).

Table 1
Mean and standard deviation for wrMSK injuries stratified by body region affected and industrial sector.

Industry	UE	LE	Trunk
Agriculture ($N = 27$)	7546 (3261)	6168 (2367)	7000 (4062)
Construction ($N = 27$)	40,059 (12,068)	32,646 (12,332)	38,543 (18,393)
Healthcare ($N = 27$)	43,015 (5376)	34,352 (4730)	66,522 (19,882)
Manufacturing ($N = 27$)	104,868 (57,120)	48,928 (27,925)	104,798 (77,578)



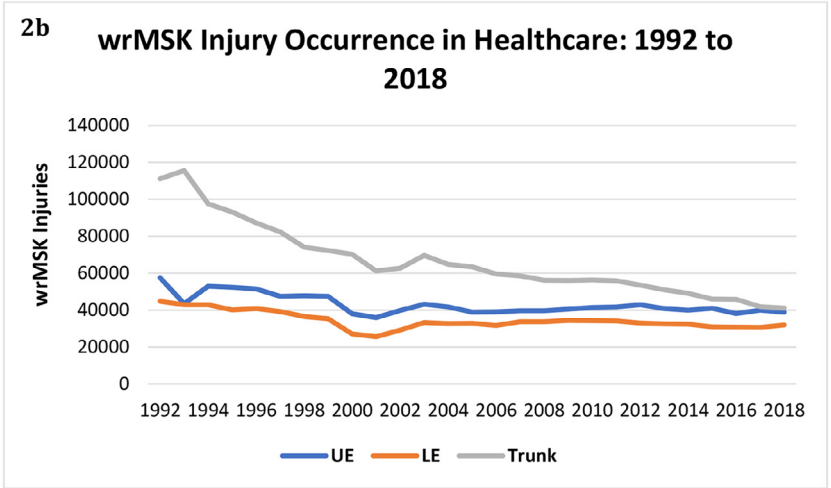


Fig. 2. a: In the manufacturing sector, LE injury occurrence was shown to be significantly lower than UE and trunk injury occurrences respectively ($p < 0.001$). **b:** For the healthcare sector, trunk injury occurrence was shown to be the highest, followed by UE and then LE ($p < 0.001$).

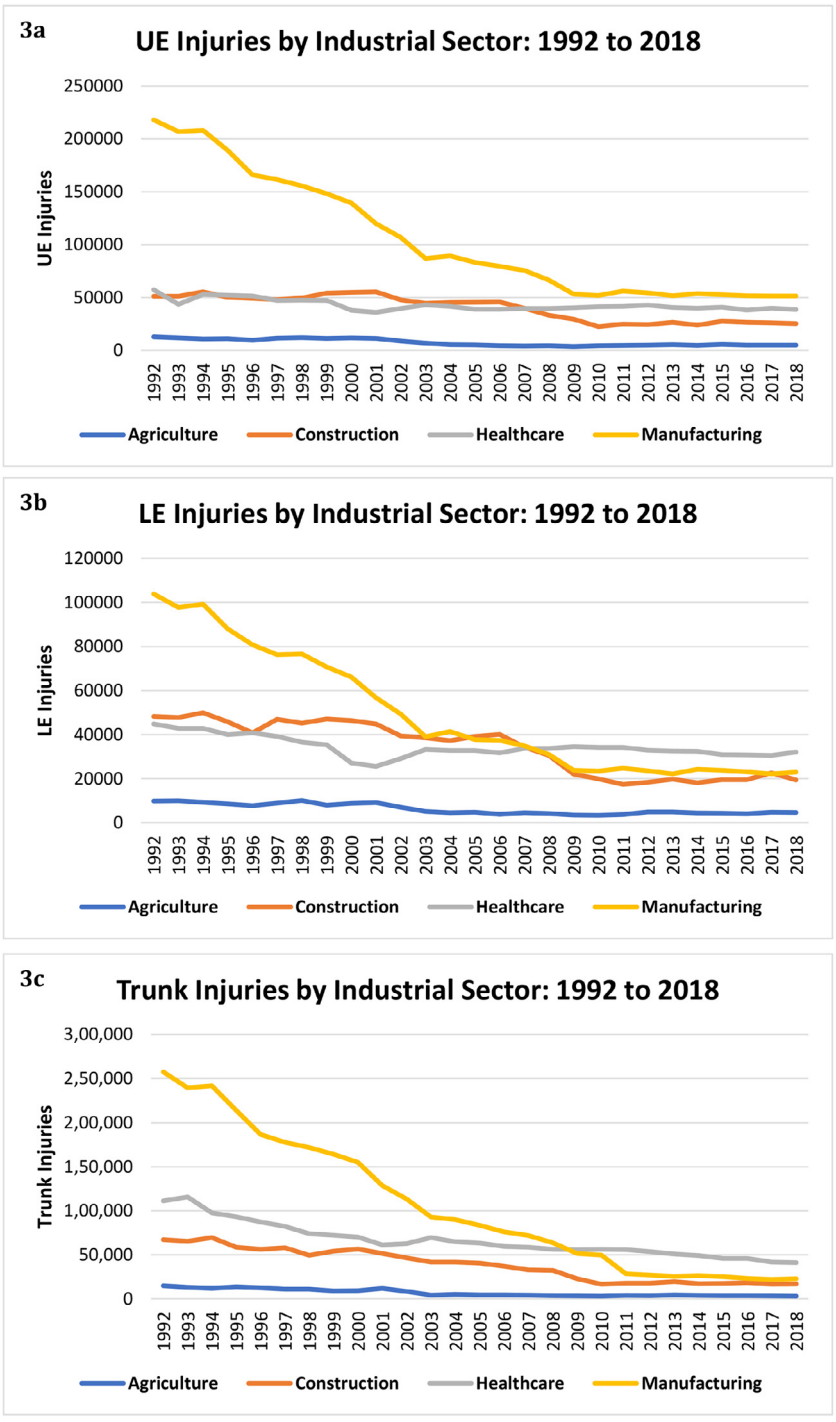


Fig. 3. a,b: For UE and LE injury occurrence from 1992 to 2018, significant differences were determined between all sectors except when directly comparing the construction and healthcare sectors ($p < 0.001$). **c:** Trunk injury occurrence differed significantly across all industrial sectors ($p < 0.01$).

Table 2
Estimated annual percentage wrMSK change with 95% confidence interval from 1992 to 2018 for wrMSK injuries stratified by body region affected and industrial sector.

Industry	UE	LE	Trunk
Agriculture	−4.68 (−4.73, −4.62)	−4.09 (−4.15, −4.03)	−6.76 (−6.82, −6.70)
Construction	−3.42 (−3.45, −3.40)	−3.55 (−3.58, −3.52)	−5.91 (−5.94, −5.89)
Healthcare	−1.08 (−1.10, −1.06)	−1.09 (−1.11, −1.06)	−3.49 (−3.50, −3.47)
Manufacturing	−6.60 (−6.62, −6.59)	−6.95 (−6.98, −6.93)	−9.59 (−9.60, −9.57)
All	−4.61 (−4.62, −4.60)	−4.19 (−4.20, −4.17)	−6.83 (−6.84, −6.82)

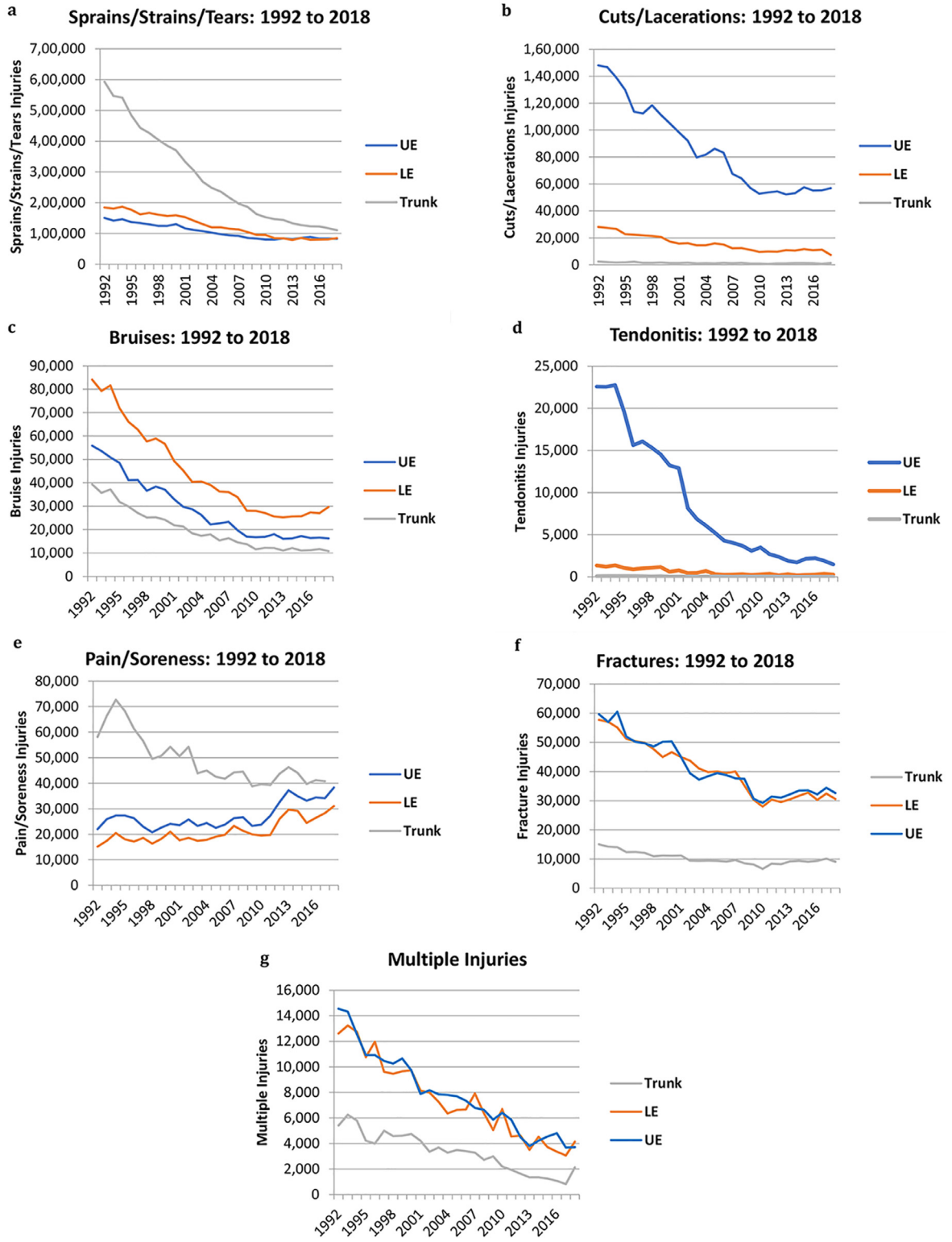


Fig. 4. a–e: When comparing the occurrence of injury types by body region from 1992 to 2018, significant differences were determined for the following injury types: sprains/strains/tears, cuts/lacerations, bruises, tendonitis, and pain/soreness ($p < 0.001$). **f-g:** Trunk occurrence was significantly lower than UE and LE occurrence for fractures and multiple injuries respectively ($p < 0.001$).

the following injury types: sprains/strains/tears, cuts/lacerations, bruises, tendonitis, and pain/soreness (Fig. 4a–e, $p < 0.001$). Cuts/lacerations and tendonitis were the most common injury types in UE, while pain/soreness and strains/sprains/tears were most common in trunk and bruises were most common in LE. For fractures and multiple injuries, trunk occurrence was significantly lower than UE and LE occurrence respectively (Fig. 4f–g, $p < 0.001$).

Discussion

As hypothesized, the BLS database analysis shows that the most common wrMSK injuries by total number between 1992 and 2018 are trunk injuries (40.6% of wrMSK injuries), followed by upper extremity (36.5% of wrMSK injuries) and then lower extremity (22.8% of wrMSK injuries). However, there was no significant difference between the year by year occurrence of upper extremity and trunk injuries over this timespan. While the manufacturing sector was shown to have the most wrMSK injuries in each body region analyzed, it also demonstrated the largest industry-specific annual percentage decrease in wrMSK injury occurrences. Additionally, lacerations/cuts and tendonitis were the most common wrMSK injury types in UE, pain/soreness and strains/sprains/tears were most common in trunk, and bruises were most common in LE. Fractures and multiple injuries were least common in the trunk region.

A University of Connecticut study analyzed the incidence and trends of UE injuries from 1995 to 2001 within the of Connecticut by looking at state-specific BLS data [14]. The Connecticut-specific BLS data showed a decrease in UE injuries between 1995 and 1997 (4220 to 3305) followed by a sharp increase in 2000 (3827) and another decrease in 2001 (3220). Comparatively, our study shows a 4.61% decrease in UE injury occurrence from 1992 to 2018 according to national BLS data, with no increases in any year within the 1995–2001 timespan. While our study assessed wrMSK injury national trends in different industries ranging from manufacturing to healthcare, the Connecticut-specific study didn't analyze the state's industry-specific wrMSK injury data. Therefore, it is possible that the different trends observed between the aforementioned study's Connecticut-specific BLS UE injury data and our analysis of national BLS UE injury data may be due to the state of Connecticut having a different industrial composition than the nation as a whole.

A second study conducted by the National Institute for Occupational Safety and Health (NIOSH) assessed data from the National Health Interview Survey Arthritis supplements in 2006, 2009, and 2014 [15]. This report focused on wrMSK injuries of the upper extremity. Of the various occupations sampled, construction workers were estimated to have the highest number of UE injuries, followed by agricultural, manufacturing, and then healthcare workers. The BLS data assessed in our study shows that the manufacturing sector is the most common source of UE injury for all years and the agricultural sector is the least common. These contrasting trends in reported injuries could be explained by differences in industrial sector classification. For example, the NIOSH study defined the healthcare sector as "Healthcare Practitioners and Technical Support Occupations", while the healthcare sector in our study only included healthcare BLS injury data and not any other groups such as "Technical Support Occupations". Though the other industrial sectors analyzed in both studies were more similarly defined, differences in which specific occupations were included in each sector potentially explains contrasting findings between the studies.

A third study assessed worker compensation data from 1999 to 2013 to estimate the occurrence of wrMSK disorders within the state of Washington [16]. When looking at the specific industrial sectors assessed in our study, the highest incidence of wrMSK claims are within the manufacturing sector followed by healthcare, construction, and agriculture, respectively. The authors estimate that the overall workplace-related claim rates declined by an estimated annual 5.4% in Washington state from 1999 to 2013. Our data similarly indicates that wrMSK injuries are most frequent in the manufacturing sector and least frequent in the agriculture sector, and furthermore shows a comparable annual decline in wrMSK injuries (between 1.08% and 9.59% annually depending on the injury category) on a national level.

One limitation in this study would be that injury data presented by the BLS databases is obtained by the Occupational Safety and Health Administration (OSHA), which relies on employer reported injury data. This may allow for improper reporting of various workplace-related injuries. However, OSHA continues to monitor and update rulings in order to mitigate employer misreporting of injuries as indicated by the Final Rule change in 2016 [17]. A second limitation would be how the definition of a workplace-related injury by the BLS and OSHA is restricted to those injuries as defined by specific criteria (listed in "Methods"), and there is potential for an injury to not fit these criteria and therefore not be reported [11]. This may result in an underestimation in the total number of injuries for some categorization of types of injuries. However, this is likely to affect all industrial sectors equally, which suggests overall consistency in the injury data we have analyzed in our study. Another limitation would be the lack of demographic-sorted injury data in the BLS databases, rendering it not possible to make comparisons based on factors such as gender and age. Regardless, we still feel that our study provides valuable broad insights into overall injury trends, and that further studies potentially using data from sources other than the BLS would be more suitable for assessing these specific demographic variables. Lastly, differences in state to state regulations regarding workplace-related injury data may result in disparities between the national BLS data and state specific data. However, many states have adopted reporting guidelines that are similar or identical to those outlined by OSHA, which mitigates against significant differences between BLS data and state trends [12,18].

Conclusion

From 1992 to 2018, trunk injuries were the most frequently occurring wrMSK injury, but not to a significantly higher degree than upper extremity injuries. Occurrence of all wrMSK injury types in the manufacturing, construction, healthcare, and agriculture sectors decreased within this time period, with the largest decreases observed in the manufacturing sector. wrMSK injury types that may require orthopedic surgical care affect specific body regions to different degrees. Cuts/lacerations and tendonitis were shown to most commonly affect the upper extremity, while fractures similarly affected both the upper and lower extremities. Based on this study, it appears that upper extremity injuries are of particular importance in wrMSK injuries.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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