Injury Patterns in Weightlifting: An Epidemiological Analysis of Emergency Visits (2014–2023)

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ABSTRACT

BACKGROUND: Limited research exists on the impact of the pandemic on weightlifting injury trends. The objective of this study was to analyze weightlifting injury trends across age and gender, comparing pre-COVID, COVID, and post-COVID periods to provide long-term data that can inform national injury prevention strategies. We hypothesize that there was a temporary dip in weightlifting injuries during COVID and a resurgence in injury rates post-COVID that could contribute to an increase in specific injury types, particularly among young males, which may reflect inadequate reconditioning.

METHODS: Data was obtained from the Consumer Product Safety Commission's National Electronic Injury Surveillance System database for weightlifting injuries presented to United States (US) Emergency Departments from 2014 to 2023. Chi-square analyses, linear regressions, ANOVA, and Z-tests were used for data analysis.

RESULTS: From 2014 to 2023, there were an estimated 767,174 weightlifting-related injuries nationally. A 34.95% reduction in injury incidence occurred during the COVID period compared to pre-COVID, followed by a 47.19% increase post-COVID. Strains and sprains were the most common injuries, with incidence rates dropping 43.81% during COVID compared to pre-COVID levels and increasing 27.87% post-COVID.

CONCLUSION: There is a need for targeted injury prevention strategies, with consideration for psychosocial factors that impact younger populations.

LEVEL OF EVIDENCE: Level 3

KEYWORDS: Weightlifting; Injury; COVID; Trends; Emergency

INTRODUCTION

Weightlifting, a form of resistance training involving free and fixed weights, has become increasingly popular as a means to enhance muscle strength, endurance, and hypertrophy.[1-3] In 2020, the CDC reported that 35.2% of men and 26.9% of women aged 18 or older engaged in muscle-strengthening activities at least twice weekly.[4]

Despite well-documented mental and physical benefits,[5-7] weightlifting carries inherent injury risks.[8-10] From 1990 to 2007, US emergency departments treated an estimated 970,801 weight training-related injuries nationwide.[11] These injuries ranged from acute events such as strains and lacerations to chronic overuse syndromes. Previous studies have identified the lower back and shoulder as common injury sites, with exercises like squats, deadlifts, and bench presses frequently implicated.[1,12]

While existing research has explored weightlifting injuries in specific populations or body regions,[13,14] a comprehensive analysis of recent trends across all age groups is lacking. Kerr et al examined weight-training-related injuries from 1990 to 2007.[11] During this period, Kerr et al found the most common weight-training injury diagnosis in US emergency departments was sprains/strains and patients were commonly younger (average age 27.6) and male (82.3%),[11] but the landscape of fitness and emergency care has evolved significantly since then. Moreover, the COVID-19 pandemic, beginning in January 2020, has impacted both weightlifting practices and healthcare utilization patterns.[15-17]

This study aims to provide the first epidemiological analysis of weightlifting-related injuries across all age groups treated in US emergency departments from 2014 to 2023. Injury rates before, during, and after the COVID-19 pandemic years are analyzed. Additionally, the study aims to update and expand upon previous findings regarding age and gender trends in weightlifting injuries. We hypothesize that weightlifting injuries temporarily declined during the COVID-19 pandemic, followed by a rebound afterward, with a greater rise in certain injury types—especially among young males—possibly due to insufficient physical reconditioning. By analyzing long-term trends and patterns of musculoskeletal injuries directly attributed to weightlifting, future safety protocols and clinicians in injury prevention and treatment strategies can be informed.

METHODS

Data were obtained from the US Consumer Product Safety Commission's (CPSC) National Electronic Injury Surveillance System (NEISS) database. The CPSC-trained coders from a nationally representative, stratified probability sample of 100 US hospitals with at least six beds and a 24-hour emergency department (ED) service reviewed ED records

daily, inputting demographic, injury, and treatment information into the NEISS database. The CPSC applies statistical weights to the NEISS sample data to calculate national estimates of the number of injuries treated in all EDs across the United States.

Data from weight-training-related injuries (product code 3265) captured by NEISS from January 1, 2014, to December 31, 2023, were evaluated (N = 25,785). Injury case narratives were reviewed to ensure only injuries specifically related to weight training were included in the sample. Injuries not directly associated with weight training were excluded (N=6794) and patients without complete data (N=6) were also excluded resulting in (N=18985).

Variables of interest included age, gender, date of injury (by year), body region injured, injury diagnosis, disposition, and type of exercise (e.g., bench press, deadlift, bicep curl). The 26 CPSC body region codes were categorized into eight body regions consistent with previous NEISS research head (including eyes, ears, face, mouth, and neck), upper trunk (including shoulders), lower trunk (including pubic region), hand, foot, arm, leg, and other (e.g., internal injuries). The CPSC diagnosis codes were categorized into nine diagnoses: strain/sprain, fracture, contusions, abrasions, lacerations, nerve damage, dislocation, internal injury, crushing, hematoma, and other (concussion, avulsion, amputation, hemorrhage, dental injury, poisoning, foreign body, derma/conjunct, puncture, thermal burns).

Data analyses were conducted using Python *statsmodels* and *scipy* library while adjusting for sample weights and the stratified survey design, as recommended by the CPSC for NEISS data to produce national injury estimates. Chi-square analyses, linear regressions, ANOVA, and Z-tests were performed, with $p<.05$ considered statistically significant.

RESULTS

Injury Rates

From 2014 through 2023, there were an estimated total of 18,985 weightlifting-related injuries recorded in the NEISS database, representing a national estimate of 767,174 injuries. The annual number of injuries fluctuated between 1,297 and 2,141 from 2014 to 2019 [**Table 1**]. However, there was a notable decrease to 1,297 injuries in 2020 due to the COVID-19 pandemic, representing a 34.95% reduction. This was followed by a gradual recovery in subsequent years, reaching 2,126 injuries in 2023.

Demographics

Among the injured, 79.21% were male (15,038 cases) and 20.79% were female (3,947 cases), with national estimates of 602,220 and 164,954 injuries respectively [**Table 1**]. Of patients with specified race, there were 36.74% White patients and 18.25% Black patients representing 6,975 injuries and 3,464 injuries [**Table 1**].

Table 1. Weight-Training-Related Injuries and Demographics

Characteristic	Number (N=18985)	National Estimates
Gender		
Male	15,038 (79.21%)	602220
Female	3947 (20.79%)	164954
<13	150 (0.79%)	4478
13–18	3543 (18.66%)	128339
19–34	8356 (44.01%)	338517
3 –49	4107 (21.63%)	172499
50–64	2032 (10.70%)	86121
65+	797 (4.20%)	37219
Race		
Not Specified	7270 (38.29%)	280609
White	6975 (36.74%)	305608
Black/African American	3464 (18.25%)	131501
Other	829 (4.37%)	34192
Asian	364 (1.92%)	11118
American Indian/ Alaska Native	46 (0.24%)	2440
Native Hawaiian/ Pacific Islander	37 (0.19%)	1706
Yearly Injuries		
2014	2074 (10.92%)	78784
2015	1982 (10.44%)	81169
2016	2106 (11.09%)	89929
2017	2141 (11.28%)	88461
2018	1838 (9.68%)	76627
2019	1820 (9.59%)	74254
2020	1297 (6.83%)	50287
2021	1743 (9.18%)	66101
2022	1858 (9.79%)	77419
2023	2126 (11.20%)	84142

Overall Injury Incidence

There was a significant reduction in the overall incidence of weightlifting-related injuries during the COVID period (2020) compared to the pre-COVID period (2014–2019). Specifically, there was a 34.95% reduction in the incidence rate of all injuries ($p<0.001$), dropping from an annual mean incidence of 1,993 injuries per year in pre-COVID years compared to 1,297 injuries in 2020 [**Figure 1**]. The post-COVID period (2021-2023) showed a recovery trend, with injury rates increasing 47.19% compared to the COVID period to a mean annual incidence of 1,909 injuries per year but remaining 4.24% below pre-COVID levels ($p<0.001$).

Injury Types

Among specific injury types, strain and sprains were the most common at 7,199 cases [**Table 2**]. The mean incidence rates for strains and sprains were reduced significantly during

the COVID period, dropping 43.83% from an annual mean incidence of 826 to 464 (p<0.001) compared to pre-COVID levels. In the post-COVID period, these injuries showed partial recovery back to pre-COVID levels at an annual mean incidence of 593, but still 28.17% below pre COVID levels (p<0.001).

The mean annual incidence of contusions and abrasions, crushing, and fractures all dropped from the pre-COVID years during the COVID years (p<0.05). In the post-COVID period the incidence of each injury has increased at varying rates. Contusions and abrasions as well as dislocations have not returned to pre-COVID levels. However, fractures, internal injuries, lacerations, nerve damage, other injuries and unspecified injuries have surpassed (p<0.05) pre-COVID levels [**Table 2**].

The most common type of injury that was specified for males and females were strains/sprains. The rates of fractures and contusions for males were 5.9% and 5.0% compared to 6.9% and 7.2% for females.

Figure 1. Weightlifting injuries by gender from 2014–2023
The estimated annual number of weightlifting-related injuries treated in United States emergency departments from 2014 to 2023, stratified by gender (male and female) and total cases are visualized. The data show a significant reduction in injuries during the COVID-19 period (2020) compared to pre-COVID years (2014–2019), followed by a notable increase post-COVID (2021–2023). Linear regression models (R^2 values and p-values provided) indicate trends in injury rates, with males accounting for the majority of cases. Statistical significance (p<0.001) is noted for the differences between pre-COVID, COVID, and post-COVID periods.

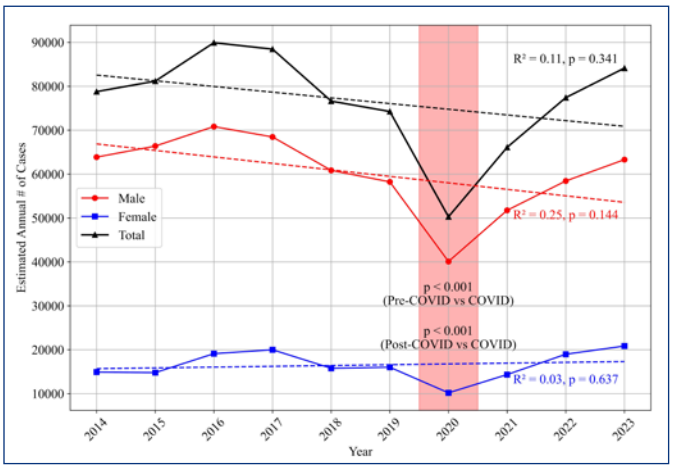

Figure 2. Weightlifting injuries by age group from 2014–2023
The estimated annual number of weightlifting-related injuries across different age groups treated in United States emergency departments from 2014 to 2023 is visualized. The data highlight a significant decline in injuries during the COVID-19 period (2020) compared to pre-COVID years (2014–2019), followed by a gradual recovery in the post-COVID period (2021–2023). The trends demonstrate varying injury rates among age groups, with young adults (19–34 years) consistently experiencing the highest number of injuries.

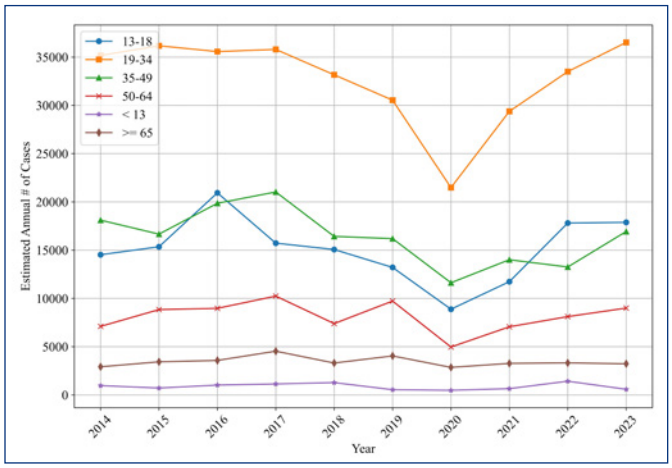

Table 2. Injuries Per Year by Diagnosis, Broken Down by Time Period

	Pre-COVID (2014–2019)	COVID (2020)	Post-COVID (2021–2023)	Totals (%)	p-value Pre-COVID to COVID	p-value COVID to Post-COVID	p-value Pre-COVID to Post-COVID
Contusions/Abrasions	111.83	53	101.67	1029 (5.42)	p = 0.026	p = 0.078	p = 0.460
Crushing	15.83	18	18.33	168 (0.88)	p = 0.040	p = 0.223	p = 0.299
Dislocation	39.00	34	34.33	371 (1.95)	p = 0.130	p = 0.068	p = 0.509
Fracture	109.83	92	137.67	1164 (6.13)	p = 0.023	p = 0.929	p < 0.001*
Hematoma	8.33	10	10.67	92 (0.48)	p = 0.114	p = 0.487	p = 0.242
Internal Injury	28.00	22	37.67	303 (1.60)	p = 0.474	p = 0.587	p = 0.006
Laceration	64.17	46	73.00	650 (3.42)	p = 0.582	p = 0.695	p = 0.042
Nerve Damage	41.00	38	52.00	440 (2.32)	p = 0.050	p = 0.753	p = 0.006
Strain/Sprain	825.83	464	593.33	7199 (37.92)	p < 0.001*	p = 0.001*	p < 0.001*
Other	21.17	21	29.00	235 (1.24)	p = 0.094	p = 0.889	p = 0.011
Not Specified	728.50	499	821.33	7334 (38.63)	p = 0.181	p = 0.003	p < 0.001*
Total	1993.49	1297	1909.00	18985			

*Significant at p<0.05 with Bonferroni Correction

Table 3. Injuries by body region

Location	Male (N=15038)	Female (N=3947)	p-value	Total Number (N=18985)	National Estimates
Upper Trunk	5405 (35.94%)	1287 (32.61%)	p* < 0.001	6692 (35.25%)	274331
Lower Trunk	3872 (25.75%)	867 (21.97%)	p* < 0.001	4739 (24.96%)	190732
Hand	1607 (10.69%)	406 (10.29%)	p = 0.4856	2013 (10.60%)	78140
Head	1384 (9.20%)	462 (11.71%)	p* < 0.001	1846 (9.73%)	74351
Arm	1259 (8.37%)	279 (7.07%)	p = 0.0083	1538 (8.10%)	63293
Foot	667 (4.44%)	341 (8.64%)	p* < 0.001	1008 (5.31%)	39407
Leg	683 (4.54%)	271 (6.87%)	p* < 0.001	954 (5.03%)	39100
Other	161 (1.07%)	34 (0.86%)	p = 0.2839	195 (1.03%)	7818

*Significant at p<0.05 with Bonferroni Correction

Strains/sprains were also the most common type of injury across age groups. These injuries were followed by fractures (18%) and lacerations (16%) in the <13 group. Fractures (4.5–9.4%) and contusions (3.5–9.1%) were the most common following strains/sprains for the remaining age groups.

Body Regions

Injuries by body region showed distinct patterns across the entire study period from 2014 to 2023. The upper trunk was the most affected area, accounting for 6,692 injuries, which represented approximately 35% of all reported cases [**Table 3**]. This was followed by lower trunk injuries, with 4,740 cases (25% of total), hand injuries with 2,015 cases (11%), and head injuries at 1,847 cases (10%) [**Table 3**].

Comparisons between males and females revealed that males were more likely (p<0.05) to sustain upper trunk and lower trunk injuries [**Table 3**]. However, females were more likely (p<0.05) to sustain head, foot, and leg injuries [**Table 3**].

There were significant variations in distribution of the body region of injury by age group. Notably, as age group increased there was an increase in upper trunk injuries [**Table 4**]. Lower trunk injuries peaked in the 19–34 age group [**Table 4**].

Table 4. Injuries by age group

Location	<13 (%)	13–18 (%)	19–34 (%)	35–49 (%)	50–64 (%)	65+ (%)	p–value
Upper Trunk	28 (18.67)	1006 (28.39)	2904 (34.75)	1552 (37.79)	853 (41.98)	349 (43.79)	p < 0.001*
Lower Trunk	21 (14.00)	684 (19.31)	2344 (28.05)	1102 (26.83)	459 (22.59)	129 (16.19)	p < 0.001*
Hand	44 (29.33)	567 (16.00)	868 (10.39)	330 (8.04)	132 (6.50)	72 (9.03)	p < 0.001*
Head	25 (16.67)	410 (11.57)	784 (9.38)	340 (8.28)	196 (9.65)	91 (11.42)	p < 0.001*
Arm	10 (6.67)	304 (8.58)	583 (6.98)	368 (8.96)	193 (9.50)	80 (10.04)	p < 0.001*
Foot	16 (10.67)	271 (7.65)	455 (5.45)	174 (4.24)	70 (3.44)	22 (2.76)	p < 0.001*
Leg	6 (4.00)	262 (7.39)	322 (3.85)	204 (4.97)	110 (5.41)	50 (6.27)	p < 0.001*
Other	0 (0.00)	39 (1.10)	96 (1.15)	37 (0.90)	19 (0.94)	4 (0.50)	p = 0.3121
Total	150	3543	8356	4107	2032	797	

*Significant at p<0.05 with Bonferroni Correction

Comparisons by Age Group

Weightlifting injuries showed similar trends across all age groups when comparing pre-COVID, COVID, and post-COVID periods. Injuries were significantly decreased during the COVID year followed by a gradual increase [**Figure 2**]. All reported changes were statistically significant (p<0.001).

The 19-34 age group experienced the highest number of injuries throughout the study period [**Table 1**]. During the COVID year, this group saw a substantial reduction in injuries compared to the pre-COVID average. In the post-COVID period, injuries increased and in 2023 reached close to pre-COVID levels [**Figure 2**]. The 13–18 and 35–49 age group also experienced a decrease in injuries during the COVID year, followed by an increase post-COVID, though still below pre-COVID levels [**Figure 2**]. The under-13 age group showed the smallest relative changes and the smallest number of injures during the study period.

Older age groups (35–49, 50–64, and 65+) followed similar patterns, with substantial decreases during the COVID year and partial recoveries post-COVID [**Figure 2**]. However, their post-COVID injury rates remained below pre-COVID levels.

DISCUSSION

This study evaluated weight-training-related injuries across all age groups of the general population treated at US emergency departments from 2014 to 2023. The epidemiological analysis of weightlifting injuries by age, gender, injury type, and exercise type build on previous work.[11,13] Understanding the change in weightlifting injury over the last decade provides useful information in designing targeted injury prevention efforts.

From 2014 to 2023 the rate of emergency department visits due to weightlifting injuries has overall remained constant. The limited increase stands in contrast to prior studies that have reported a larger increase in weightlifting injuries.[11,14,18] The overall plateau in weightlifting injuries likely stems from the COVID-19 pandemic. There was a significant decrease from the pre-COVID period (2014–2019) to COVID (2020) in weightlifting injuries. A decrease in weightlifting

and overall activity was common during the COVID-19 pandemic because of a lack of access to sports facilities,[19-21] which corresponds to the finding that most weightlifting injuries happened in the setting of sports. Notably, the decrease in COVID-19 exercise resulted in a long-term lowering of physical fitness from a decrease in activity.[22-24] While the rate of injury has increased over the last three years as individuals resume weightlifting, a slower increase in the rate of injury will likely continue. Additional interventions to reduce injury should be made as more people return to weightlifting. These findings support the hypothesis that injury rates overall temporarily declined during COVID and saw a resurgence in the post-COVID period as facilities reopened and people returned or started weightlifting without adequate conditioning. Moreover, we found that the specific injury types varied in the amount decreased during COVID and the amount increased during the post-COVID period.

The analysis in this study found a similar plateau of injury rates across age groups from 2014 to 2023 as previous findings for adolescents.[13] The COVID-19-associated dip was seen across most age groups. However, the proportion of injuries for those younger than 13 remained constant, likely because of an already low number of cases and due to random chance rather than consistent weightlifting. Young adults aged 19-34 composed the highest number (44%) of all weightlifting injuries in line with our hypothesis and previous findings.[18] Individuals aged between 13 to 18 and 35 to 49 also had a high proportion of injuries. Possible reasons include improper form due to lack of experience, overuse, and lifting heavier than what the athlete should be safely lifting. These populations may be susceptible to societal and psychosocial factors that could push the athlete towards overtraining, overlifting, and injury. Factors such as body dysmorphia, social media influence, performance pressure, and peer comparison can significantly contribute to maladaptive training behaviors.[25-28] Adolescents and young adults therefore represent an age group that should be targeted to reduce injuries as exercise-based injury prevention programs show success.[29-31] Those older than the age of 50 had a low proportion of injuries. The decline in injury with age likely reflects a decrease in activity, an increase in knowledge of safe lifting, and a decline in more injury-prone exercises.

Males had 79% of the number of injuries from 2014 to 2023 compared to females. The findings confirm our hypothesis and previous work that injuries from weightlifting continue to be male dominated.[11,13,14] This difference may be due to gender-based stigma for weightlifting, resulting in fewer women engaging in this form of exercise. In fact, females report more accounts of weight-related stigma which decreases motivation to exercise and levels of physical activity.[32,33] Weight training among women should be destigmatized, as it has proven that weight training helps prevent metabolic syndrome, reduces body fat, improves metabolic rate, and reduces the risk of osteoporosis.[6,34,35] Head, foot, and leg injuries were more common among women compared to men, suggesting the importance of education on proper technique and the use of weights.

LIMITATIONS

This study has several limitations, most of which are related to its retrospective nature and use of the NEISS database. The NEISS database does not consistently provide information about the type of exercise that resulted in injury. This information was provided in the narrative section, which was free response and varied in level of detail. The NEISS database also has a code for "weightlifting," but this code didn't ensure the injury was associated with strength training. Additionally, the NEISS database didn't account for chronic sequelae of weightlifting, which accounts for many weightlifting injuries. The inclusion of chronic weightlifting injuries would provide a more comprehensive estimate of injury prevalence. The NEISS database didn't include patients who presented to the urgent care first, leading to an underestimation of injury prevalence. Furthermore, retrospective data collection limited our ability to analyze confounding risks and allowed for selection bias.

CONCLUSION

This study reveals stable weightlifting injury rates from 2014 to 2023, with a significant pandemic-related dip and subsequent recovery. Key findings include the predominance of injuries among males and young adults, the prevalence of core body injuries, and the high injury rates associated with common exercises like squats and bench presses. To reduce injury risk, we recommend implementing proper warm-up routines, emphasizing correct form and technique, starting with lighter weights, using spotters, and ensuring safe equipment and environments. Education on these practices should be tailored to different age groups and gender especially to address the increased injury rate among adolescents and young adults. Future research should focus on prospective studies to better understand causal relationships and long-term outcomes of weightlifting injuries. Additionally, efforts to promote safe weightlifting practices among women and older adults could help balance participation and reduce injury risks across demographics.

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Ethical Approval

Ethical approval is not applicable for this article

Disclosures

None

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