

Orthopaedic Injury Patterns Related to Ice Skating, Inline Skating, and Roller Skating

A 20-Year Epidemiologic Analysis

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Background: Ice skating, inline skating, and roller skating are popular sports in the United States (US). Although they are similar, injuries incurred may be distinct and may have evolved over time.

Purpose: To characterize injuries related to ice skating, inline skating, and roller skating and track injury patterns over a 20-year period.

Study Design: Descriptive epidemiology study.

Methods: The current study utilized the National Electronic Injury Surveillance System, a database reporting consumer product-related injuries seen at emergency departments in the US. All ice skating, inline skating, and roller skating injuries between 2002 and 2021 were identified, and patient demographics, types of injury, and year of injury were compared between skating types.

Results: A total of 1,656,746 skating-related injuries were estimated nationally: 24% (403,791) for ice skating, 24% (400,172) for inline skating, and 52% (852,783) for roller skating. While the incidence of ice-skating- and roller-skating-related injuries decreased by 34.4% (from 22,490 in 2002-2004 to 14,758 in 2019-2021) and 29.6% (from 42,452 in 2002-2004 to 31,980 in 2019-2021), respectively, injuries related to inline skating decreased comparatively more, by 75.8% over the study period (from 48,097 in 2002-2004 to 11,662 in 2019-2021). Injuries occurred predominantly to the head/face/neck for ice skating ($n = 139,501$; 34.5% of injuries), whereas injuries occurred predominantly in the shoulder/arm/elbow/wrist for inline skating ($n = 212,088$, 53.0% of injuries) and roller skating ($n = 425,216$, 49.9% of injuries). Fracture was the most common injury type for all 3 skating types ($n = 614,853$, 37.1% of injuries), and the majority of fractures occurred in the upper extremity (shoulder/arm/elbow/wrist) for all 3 skating types ($n = 59,624$, 60.0% [ice skating]; $n = 69,197$, 41.2% [inline skating], and $n = 237,099$, 68.2% [roller skating]). Lower extremity (leg/knee/ankle) fractures were more common among ice skating ($n = 28,019$, 28.2%) and roller skating ($n = 82,094$, 23.6%) injuries compared with inline skating ($n = 21,391$, 12.7%).

Conclusion: In the current study, we found that fractures were the most common type of injury regardless of skating type but that the location of the injury/fracture varied by skating type.

Keywords: fracture; injury; skating

Ice skating, inline skating, and roller skating are popular pastimes and sports in the United States (US).^{3,4,14} Although related, the popularity and safety considerations of these different activities may not be the same and may have evolved over time.^{1,9} In particular, recent data have suggested increasing popularity of these activities.^{5,6} As

such, the injuries incurred with these activities is of current clinical interest.

One study examined a nationally representative sample of pediatric ice, roller, and inline skaters presenting to US emergency departments (EDs) between 1993 and 2003 and found that the majority of roller skating and inline skating injuries were upper extremity fractures and that head injuries were more common among ice-skating-related injuries.¹⁰ However, this study evaluated only pediatric patients. Other related studies have similarly focused only on pediatric populations.^{2,3,8,12,15-17} More recent studies examining injuries related to different types of skating

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in pediatric and adolescent populations have been retrospective, single-institution studies.¹¹ Overall, nationally representative, recent data examining epidemiologic features and injury patterns of various types of skating in adults and children are lacking in the literature, and this may be particularly important with regard to evolving technology and resultant changes in recommendations for equipment for different types of play.

The current study utilized the National Electronic Injury Surveillance System (NEISS), a consumer product-centered database. The database was used to characterize injuries related to skating and compare injury patterns related to ice skating, inline skating, and roller skating in the US over a 20-year period.

METHODS

Study Population

As this study utilized publicly available, deidentified data, our institutional review board determined it exempt from review. NEISS is a database developed by the US Consumer Product Safety Commission and was first released in 1972. It reports yearly consumer-product-related injuries seen at a select national sample of more than 100 EDs, and has been used to examine a wide variety of consumer-product-related injuries.^{7,13}

The NEISS database includes a selection of cases, which are assigned a sample weight based on a validated scale. Thus, the cases in the dataset are designed to be extrapolated to numbers representative of the national population. Cases include information regarding patient characteristics, dates, injury location, and injury type, as well as a short narrative describing the mechanism of injury and primary diagnosis. Coordinators at various hospitals collect and manage data. Hospital weights are used to extrapolate data to a national level based on reported weights for cases.¹⁸

NEISS data from 2002 to 2021 were used for the current study. Patients with an injury related to skating were queried using the unique NEISS coding for ice skating-, inline skating-, and roller skating-related injuries (NEISS injury diagnoses 3255, 3297, and 3216, respectively). Of note, injury related to ice skating did not include ice hockey injuries.

Statistical Analysis

Patient demographic information, injury location, and type were assessed for all patients identified to have

skating-related injuries and were reported as mean and standard deviation or as counts and percentages. Cases reported are the extrapolated national totals based on the number of cases and the estimated weight of each case reported in the dataset. Longitudinal trends in injuries over time for the various types of skating, as well as injury types, were examined by 3-year rolling averages. This timeframe was chosen to maintain granularity in the visualized trends while also minimizing the effect of a single year to isolate robust trends.

Data analysis was performed in Software for Statistics and Data Science (STATA) Version 16.0, and Prism 8. Data visualization was performed in Excel Version 16.63.1 (Microsoft). Chi-square and 2-way analysis of variance (ANOVA) analyses were utilized where appropriate. *P* values less than alpha of .05 were considered significant.

RESULTS

Study Population

From 2002 through 2021, a total of 1,656,746 patients with skating-related injuries were seen in EDs across the US according to the NEISS database. Of these injuries, ice skating accounted for 403,791 (24.4%), inline skating accounted for 400,172 (24.1%), and roller skating accounted for 852,783 (51.5%). Patient characteristics by skating type are shown in Table 1. There were significant differences among the 3 skating types in the mean age of patients with injuries and the proportion of injured patients who were at least 18 years old ($P < .0001$ for both). In terms of patient sex, ice skating and inline skating had a similar percentage of female patients (52.3% and 58.7%), but there were more female patients in the roller skating group compared with the other skating types (68.1%) ($P < .0001$).

Skating Injury Trends Over the Years

Overall, the total number of skating injuries has decreased from 2002 to 2021 (Figure 1). While the incidence of ice-skating- and roller-skating-related injuries decreased by 34.4% (from 22,490 in 2002-2004 to 14,758 in 2019-2021) and 29.6% (from 42,452 in 2002-2004 to 31,980 in 2019-2021) over the years, injuries related to inline skating decreased much more (from 48,097 in 2002-2004 to 11,662 in 2019-2021), with a 75.8% reduction over the study period.

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Ethical approval for this study was waived by Yale University.

TABLE 1
 Characteristics of Patients Presenting to EDs With Skating-Related Injuries From 2002 to 2021, by Discipline^a

Characteristic	Ice Skating (n = 403,791)	Inline Skating (n = 400,172)	Roller Skating (n = 852,783)	P ^b
Age, y	22.0 ± 16.5	19.8 ± 14.5	20.8 ± 16.1	<.0001
Age ≥18 y	169,272 (41.9)	154,009 (38.5)	320,557 (37.6)	<.0001
Sex				
Male	170,933 (47.7)	190,866 (42.3)	272,225 (31.9)	<.0001
Female	232,858 (52.3)	209,289 (57.7)	580,537 (68.1)	

^aData are reported as mean ± SD or n (%). ANOVA, analysis of variance; ED, emergency department.

^bStatistically significant differences were seen in age and sex among skating groups (P < .05, ANOVA or Pearson χ^2 test as appropriate).

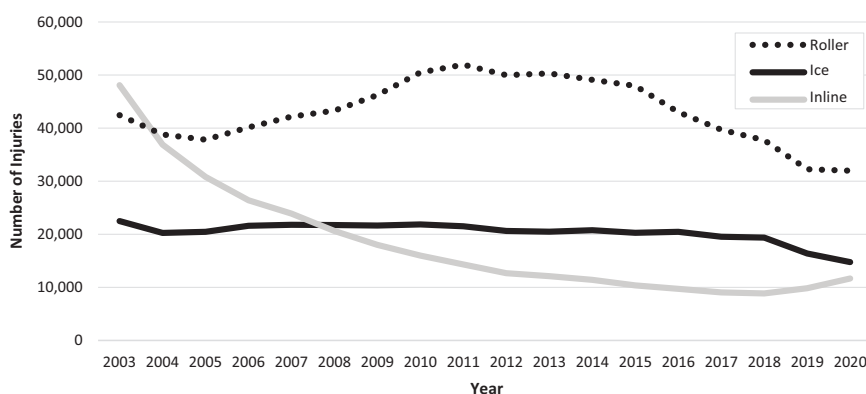


Figure 1. Number of skating-related injuries presenting to EDs from 2002 to 2021, by discipline. Data are shown as 3 year rolling averages. ED, emergency department.

Types of Injury Based on Skating Type

Anatomic sites of injury assessed for all types of skating are shown in Figure 2. For ice skating, the most common anatomic site of injury was the head, face, and neck (n = 139,501, 34.5% of ice skating injuries), followed by the shoulder, arm, and elbow (n = 58,062, 14.4% of ice skating injuries), then the wrist (n = 56,920, 14.1% of ice skating injuries). Lower extremity (leg, knee, or ankle) and trunk ice-skating-related injuries were less common. For roller and inline skating, the most common anatomic site of injury was the wrist, followed by the shoulder, arm, and elbow. In particular, we noted that 5.9% (n = 23,652) of patients presenting with ice-skating injuries were diagnosed with concussion compared with 1.2% (n = 4827) of inline skating and 1.5% (n = 12,842) of roller skating injuries.

The 3 skating types as assessed by injury type are shown in Figure 3. Fracture was the most common injury type overall (n = 614,853, 37.1% of total injuries). For ice skating, laceration was the second most common injury type (n = 84,424, 20.9%), followed by strain and sprain (n = 70,671, 17.5%). For roller and inline skating, the second most common injury type was strain and sprain (n = 215,618, 25.2%; and n = 81,607, 20.4%, respectively), followed by contusion and abrasion (n = 137,346, 16.1%; and n = 64,336, 16.1%, respectively).

The anatomic locations of all fractures according to skating type are shown in Figure 4. While upper extremity fractures (shoulder, arm, elbow) were the majority of fractures in all 3 disciplines (n = 59,624, 60.0%; n = 69,197, 41.2%; and n = 237,099, 68.2% for ice, inline, and roller skating, respectively), lower extremity (leg, knee, wrist) fractures were more common among roller skating (n = 82,094, 23.6%) and ice skating (n = 28,019, 28.2%) injuries compared with inline skating (n = 21,391, 12.7%).

DISCUSSION

In the current study, which utilized the NEISS database from 2002 to 2021, a total of 1,656,746 skating-related injuries were estimated nationally in ice skating (403,791, 24%), inline skating (400,172, 24%), and roller skating (852,783, 52%) over the 20-year period. Over one-third of patients with skating-related injuries were found to be 18 years and older (ice skating, 41.9%; inline skating, 38.5%; and roller skating, 37.6%). While fractures were the most common type of injury, anatomic location of both fractures and other injuries varied by discipline of skating. These findings indicate that all ages must be considered in assessing injury patterns over the year and that previous studies evaluating only pediatric patients may

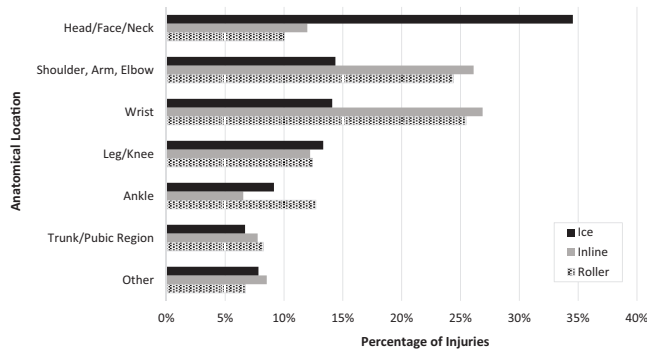


Figure 2. Anatomic location of skating-related injuries presenting to EDs from 2002 to 2021, by discipline. ED, emergency department.

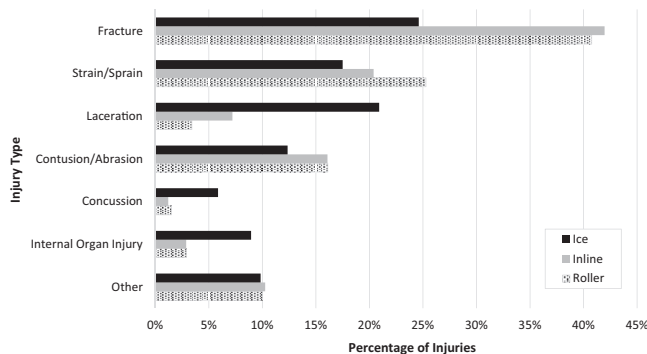


Figure 3. Injury type of skating related injuries presenting to EDs from 2002 to 2021, by discipline. ED, emergency department.

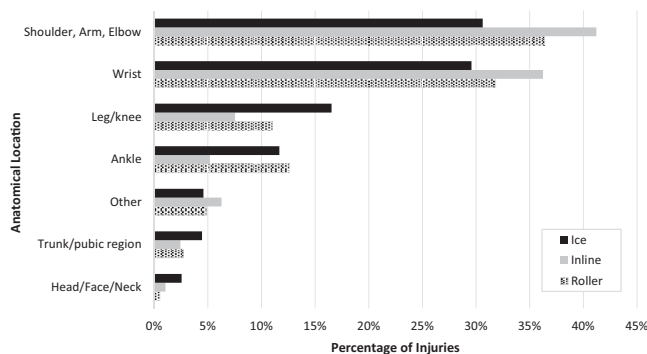


Figure 4. Anatomical location of skating related fractures presenting to EDs from 2002 to 2021, by discipline. ED, emergency department.

have not fully characterized a significant proportion of patients affected by skating-related injuries.

The yearly trends of skating injuries showed that, while the incidence of ice-skating- and roller-skating-related injuries decreased by 34.4% and 29.6% over the study period, injuries related to inline skating decreased much

more (75.8% reduction over the study period). For all 3 types of skating, these trends in injury mirror previously reported trends in increased participation,^{5,6} suggesting that trends in injury are related to trends in engagement in these activities and not modification or improvement of safety protocol or equipment being utilized. Further research to investigate areas for improvement of safety protocol or equipment being utilized for participants of these activities at all skill levels is warranted to better understand the national trends observed in this study.

In terms of anatomic region, ice-skating-related injuries differed from roller and inline skating, with head/face/neck injuries being the most common. In particular, we noted that 5.9% of patients presenting with ice skating injuries were diagnosed with concussion compared with 1.2% of inline skating and 1.5% of roller skating injuries. These data mirror those previously described in the pediatric population¹⁰; however, currently presented data provide expanded context for both most recent years and the full age spectrum. This has important implications with regard to both timely diagnosis of these injuries as well as recommendations to maximize safety for persons engaging in ice skating. In particular, headgear or helmets may be important safety gear for certain participants engaging in this activity to limit concussion risk.

On the other hand, upper extremity injuries (shoulder/arm/elbow/wrist) were most common for inline and roller skating. While these data are similar to those reported in the pediatric population,¹⁰ that this trend is also present among patients of all ages and, in more recent years, is an important consideration not only for recommendations to maximize safety protocol and equipment but also when evaluating patients presenting with acute injuries from these disciplines of skating compared with ice skating. That said equipment such as palm and elbow guards to try to limit these injuries is available commercially.

Fracture was the most common injury type for all skating types, with shoulder, arm, and elbow fractures being the most common. These data are consistent with previous research in the pediatric subpopulation that demonstrated a high rate of upper extremity fracture, particularly in patients presenting with roller and inline-skating-related injuries.¹⁰ Thus, a high index of suspicion for skating-related upper extremity fractures may be warranted in the acute setting amongst both adults and children to facilitate timely diagnosis and optimize care.

Limitations

There are limitations to the current study. Only injuries that presented to the ED are reported, and the total number of people skating each year (and therefore the overall injury rate among all participants) was not assessed. In addition, we were not able to assess injuries that may have presented to office or urgent care settings. Nonetheless, we believe that understanding skating injuries severe enough to present to the ED is valuable with regard to clinical decision-making in the acute setting and informs injury-prevention efforts. Furthermore, in-depth analysis

of the setting and mechanism of injury were not possible as analysis was limited to the data available in the NEISS dataset. Further research may seek to characterize whether recreational and less advanced skaters are more at risk of certain injury types versus others, although this was outside the scope of this study.

CONCLUSION

The current study characterizes trends in skating injury type and pattern in 3 different disciplines of skating, utilizing a large national database from 2002 to 2021. A significant number of skating-related injuries were estimated over a 20-year period, of which more than one-third of patients with skating-related injuries were older than 18 years. Fractures were the most common type of injury; however, anatomic location of both fractures and other injuries varied by discipline of skating. The data suggest that a significant number of skating-related injuries result in fractures, particularly of the upper extremity. These data may inform triaging and assist with prompt diagnosis of skating-related fractures. In addition, these data may inform recommendations for safety equipment for persons engaging in these activities and for best practices to minimize risk of injury in the recreational setting.

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