

# Pediatric Hoverboard and Skateboard Injuries

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abstract

**OBJECTIVES:** To investigate the characteristics of hoverboard injuries compared with skateboard injuries in children presenting to US emergency departments (EDs).

**METHODS:** Data regarding hoverboard and skateboard injuries in children <18 years of age were obtained from the National Electronic Injury Surveillance System for calendar years 2015 and 2016. Data included demographics, body regions injured, and ED disposition.

**RESULTS:** There were an estimated 26 854 hoverboard and 121 398 skateboard injuries treated in US EDs between 2015 and 2016. The mean and median ages for hoverboard and skateboard injuries were 11 and 13 years, respectively. In both groups, boys were more commonly injured. The majority of hoverboard injuries occurred at home, whereas skateboard injuries occurred on the street. The wrists were the most common injured body part, and fractures were the most common diagnosis in both groups. The majority of patients in both groups were discharged from the hospital. Approximately 3% of the patients with skateboard injuries and hoverboard injuries were admitted to the hospital.

**CONCLUSIONS:** The distribution of injuries among hoverboard riders and skateboarders was similar. Fractures, contusions, and sprains and/or strains were the most common types of injuries in both riders. However, there was a higher number of sprains and/or strains in skateboarders when compared with hoverboard users. This difference may be attributed to the way users ride these boards. Fractures were the most common reason for hospital admission for both toys. By elucidating the characteristics of hoverboard injuries, preventive measures can be implemented to decrease the incidence of these injuries as well as ED visits.

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**WHAT'S KNOWN ON THIS SUBJECT:** Hoverboards are a new toy among children. Hoverboards are known to spontaneously catch fire and cause a wide array of injuries. However, little research has been conducted regarding hoverboard injuries and how to counsel parents appropriately.

**WHAT THIS STUDY ADDS:** In this study, we use nationally representative data to investigate various characteristics of hoverboard injuries and skateboard injuries in children to better counsel parents. We highlight the importance of helmet use, wrist pad use, and parental supervision.

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Hoverboards (also known as self-balancing, 2-wheeled boards) have experienced rapid popularity since their introduction to the US consumer market in 2015. As the demand for hoverboards spiked that year, US consumers were able to purchase hoverboards from multiple manufacturers that did not undergo quality or safety inspections before sale.<sup>1</sup> By the last quarter of 2015, the Consumer Product Safety Commission (CPSC) had received reports of users with dangerous injuries presenting to emergency departments (EDs), including burns from spontaneous fires from malfunctioning hoverboard batteries, as detailed in the press.<sup>2</sup> As a result, the CPSC began investigating hoverboard injuries, and many airlines, university campuses, and public roads banned hoverboard use.<sup>3</sup> Hoverboards, which are structurally similar to skateboards, have attracted media attention, but little research has been conducted to investigate hoverboard injuries. Researchers in recent studies have investigated skateboard injuries in children and suggested preventive measures to increase patient safety.<sup>4</sup> The CPSC's National Electronic Injury Surveillance System (NEISS) database contains a wealth of information regarding users with various injuries related to consumer products (ie, hoverboard injuries) who present to US hospital EDs across the nation. Our purpose in this study is to use the nationally representative data from the NEISS database to investigate the characteristics and epidemiology of hoverboard injuries in the pediatric population and compare them with those of skateboard injuries. We aim to elucidate the types of injuries that occur to help direct injury prevention efforts and advise families.

## METHODS

### Data Source

The CPSC monitors injuries in US EDs through the NEISS database.

The NEISS database, which was established in calendar year 1972, has undergone various revisions in its sampling frame during 1978, 1990, and 1997 and is a stratified sample of ~100 hospital EDs in the United States. The data in the NEISS are selected from hospitals with at least 6 beds and that operate for 24 hours per day in the United States and its territories. Hospitals that participate in the NEISS database submit data extracted from patients' medical records in their EDs. These records are then reviewed by professional NEISS coders. The data uploaded are also associated with a consumer product. A coordinator assigns a consumer product code for each injury. In addition, other characteristics of the patients' injuries are recorded in the database, including a free-text narrative of an injury by the physician in the ED. NEISS coders review all of the information. The NEISS coders receive detailed training to decrease the variability in data collection. Previous studies have revealed the NEISS database's accuracy in identifying injuries.<sup>4-6</sup>

The NEISS database is updated frequently and allows for the estimation of the epidemiology of injury-related ED visits. Hoverboard (product code: 5042) and skateboard (product code: 1333) injuries in children <18 years of age were retrospectively analyzed from calendar years 2015 and 2016 by using the NEISS database.<sup>7</sup> Product code 5042 in the NEISS database includes a group of products (powered scooters and/or skateboards) that includes hoverboards. The analyzed data from the NEISS database included patient age, sex, injured body part, type of injury, ED disposition, and locale of injury. In addition, a short narrative written by the attending physician in the ED regarding the injury is included in each case.

### Data Analysis

The data were analyzed by using the SAS University Edition (SAS Institute, Inc, Cary, NC) survey procedure PROC SURVEYFREQ function. This accounted for the NEISS database's complex statistical design. Sample weights from the NEISS database were used in all analyses to extrapolate national estimates. Relationships were examined by using  $\chi^2$  tests and by calculating relative risk (RR) with 95% confidence intervals (CIs). A *P* value of <.05 was considered statistically significant.

### Study Variables

Cases were categorized on the basis of injury type, ED disposition, locale of the injury, and injured body part. NEISS database categories for injury types included the following: (1) fracture, (2) contusion, and (3) sprain and/or strain. Injury types that did not represent at least 5% of the total injuries were assigned to the category "other." NEISS database categories for the patient's disposition from the ED included the following: (1) treated and released, (2) hospitalized (admitted, transferred to another hospital, or held for observation), and (3) left the ED against medical advice or without being completely evaluated. NEISS database categories for the locale of the injury included the following: (1) home, (2) public street and/or highway, and (3) place of recreation (eg, school). NEISS database categories for injured body part included the following: (1) head, (2) wrist, (3) forearm, and (4) ankle. Body parts that were injured that did not represent at least 5% of the total injuries were assigned to the category "other."

### Ethical Considerations

This study received institutional review board exemption.

## RESULTS

There were an estimated 26 854 hoverboard injuries during 2015 and 2016 (95% CI 20 462–33 246); summarized in Table 1). The mean and median age was 11 years. The number of hoverboard injuries peaked at ~12 years of age (Fig 1). Boys accounted for 52% of all injuries. Of the number of recorded cases detailing race (56% of the total number of injuries), white users accounted for the majority of injuries (39%). Of the hoverboard cases detailing the locale of the injury, 66% occurred at home.

The most common injuries were fractures (40%), contusions (17%), and strains and/or sprains (13%). There were 3 burns in the study cohort. Two patients sustained injuries from riding a hoverboard in the kitchen and colliding with a stove of boiling water. The other patient developed a friction burn after his or her finger was run over by a hoverboard. The most common body parts injured were the wrist (19%), forearm (14%), and head (14%). The ankles were the most commonly sprained body part (RR = 11.8; 95% CI 10.8–12.9). The majority of patients were treated in the ED and discharged from the hospital (95%). A small number of patients (<1%) left the ED without being completely evaluated by a medical provider. Head injuries accounted for 14% of all admissions to the hospital.

There were ~121 398 (95% CI 88 788–154 008) skateboard injuries in calendar years 2015 and 2016 (Table 2). The mean and median age of skateboard injuries was 13 years. The number of injuries increased with age (Fig 1). Of the skateboard cases detailing the locale of the injury, 52% occurred on the street. The most common body part injured was the wrist (15%). Fractures accounted for 32% of all injuries. The ankles were the most commonly sprained body part (RR = 3.33; 95% CI 3.26–3.40). The majority of

**TABLE 1** Hoverboard Injuries in Children <18 Years of Age Presenting to the ED During Calendar Years 2015 and 2016

Characteristic	Sample Count, <i>n</i>	National Estimate, <i>N</i>	95% CI	Percentage of Total, %
Total injuries	849	26 854	20 462–33 246	100
Year				
2015	215	7662	4658–10 666	29
2016	634	19 192	13 550–24 834	71
Sex				
Male	451	13 872	10 321–17 423	52
Female	397	12 978	9278–16 678	48
Locale of injury				
Home	227	9903	8906–17 448	34
School	0	0	<sup>a</sup>	0
Street and/or highway	68	3065	<sup>a</sup>	11
Other public property	41	1229	<sup>a</sup>	5
Park	15	346	<sup>a</sup>	1
Unknown	496	13 177	9601–18 143	49
Body part				
Wrist	132	5045	3546–6544	19
Head	135	3861	<sup>a</sup>	14
Forearm	142	3674	<sup>a</sup>	14
Ankle	56	1894	<sup>a</sup>	7
Other <sup>b</sup>	384	12 375	<sup>a</sup>	46
Diagnosis				
Fracture	334	10 630	7976–13 284	40
Contusion	143	4470	2878–6062	17
Sprain and/or strain	100	3382	<sup>a</sup>	13
Other <sup>c</sup>	272	8367	<sup>a</sup>	30
Disposition				
Treat and release	805	25 765	19 309–32 221	96
Admit	33	687	<sup>a</sup>	3
Left before complete evaluation or AMA	6	179	<sup>a</sup>	<1
Observation	1	5	<sup>a</sup>	<1
Transfer	3	214	<sup>a</sup>	<1

AMA, against medical advice.

<sup>a</sup> Estimates of <1200 or with a coefficient of variation >33% are unstable and unreliable to calculate a CI.

<sup>b</sup> Injured body parts representing <5% of the total injuries were assigned to the category “other.”

<sup>c</sup> Diagnoses representing <5% of the total injuries were assigned to the category “other.”

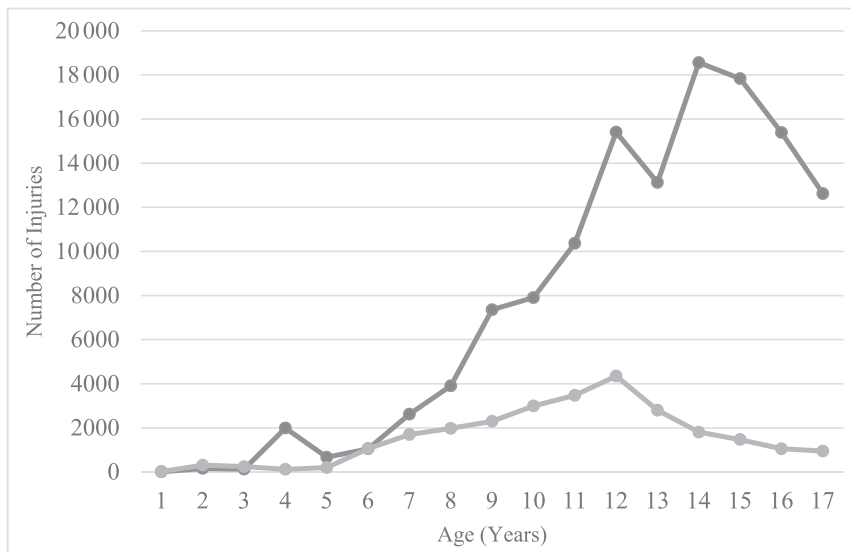
injuries were treated in the ED and patients were discharged from the hospital (96%). Approximately 3% of those with skateboard injuries were admitted to the hospital for further management. Head injuries accounted for 35% of all admissions to the hospital.

The forearm and wrist had the highest frequency of fractures when compared with other body parts in those with hoverboard injuries (RR = 1.15; 95% CI 1.12–1.18) and skateboard injuries (RR = 3.52; 95% CI 3.47–3.58) presenting to the ED. Fractures accounted for the largest number of hospital admissions when compared with other injury types from hoverboards (RR = 9.06; 95%

CI 8.80–9.32) and skateboards (RR = 3.50; 95% CI 3.29–3.73).

## DISCUSSION

During 2015 and 2016, there were 26 854 hoverboard injuries and 121 398 skateboard injuries in children <18 years of age. The mean and median age of hoverboard riders was lower than that of skateboard riders. The number of users with hoverboard injuries presenting to the ED peaked at 12 years of age, whereas the number of users with skateboard injuries presenting to the ED increased with age. This may be due to the increased risk-seeking behaviors and/or lack of



**FIGURE 1** Users with hoverboard injuries (light gray) and skateboard injuries (dark gray) presenting to the ED in 2015 and 2016, stratified by age (in years).

**TABLE 2** Skateboard Injuries in Children <18 Years of Age Presenting to the ED During Calendar Years 2015 and 2016

Characteristic	Sample Count, <i>n</i>	National Estimate, <i>N</i>	95% CI	Percentage of Total, %
Total injuries	3212	121 398	88 788–154 008	100
Year				
2015	1606	64 562	43 050–86 074	53
2016	1523	56 836	32 329–81 344	47
Sex				
Male	2492	98 752	71 176–126 328	76
Female	720	30 371	24 790–35 952	24
Locale of injury				
Home	332	13 230	10 341–16 119	10
School	16	629	<sup>a</sup>	<1
Street and/or highway	598	40 097	<sup>a</sup>	31
Other public property	222	7712	<sup>a</sup>	6
Park	394	15 592	<sup>a</sup>	12
Unknown	1650	51 863	32 823–70 903	40
Body part				
Wrist	410	19 484	13 002–25 966	15
Head	110	15 880	11 575–20 185	12
Forearm	438	12 907	9621–16 193	10
Ankle	318	14 745	10 189–19 301	11
Other <sup>b</sup>	1936	66 112	<sup>a</sup>	52
Diagnosis				
Fracture	1114	40 877	30 689–51 065	32
Contusion	532	23 081	17 951–28 211	18
Sprain and/or strain	602	28 355	21 163–35 547	22
Other <sup>c</sup>	964	36 789	<sup>a</sup>	29
Disposition				
Treat and release	2982	123 358	92 177–154 539	96
Admit	190	3930	2602–5258	3
Left before complete evaluation or AMA	18	936	<sup>a</sup>	1
Observation	4	21	<sup>a</sup>	<1

AMA, against medical advice.

<sup>a</sup> Estimates of <1200 or with a coefficient of variation >33% are unstable and unreliable to calculate a CI.

<sup>b</sup> Injured body parts representing <5% of the total injuries were assigned to the category “other.”

<sup>c</sup> Diagnoses representing <5% of the total injuries were assigned to the category “other.”

parental supervision seen with older children. The ratio of male to female skateboarders who presented to the ED after sustaining an injury was ~3:1 compared with that of hoverboard riders, which was ~1:1. It is unclear why boys comprised a larger proportion of injuries when presenting to the ED for skateboard use compared with hoverboard use. The majority of skateboard injuries occurred on the street (52%), whereas the majority of hoverboard injuries occurred at home (66%). This can be attributable to the ease of riding hoverboards at home, whereas skateboards require a hard surface (ie, asphalt).

The distribution of injuries among hoverboard riders and skateboarders was similar. Fractures, contusions, and sprains and/or strains were the most common types of injuries in both types of users. However, there was a higher number of sprains and/or strains in skateboarders compared with hoverboard users. This difference may be attributed to the way users ride these boards. Skateboarders can grind rails, flip the board (ie, kickflip) and ollie, or jump off obstacles. In comparison, hoverboard riders primarily use it as a ride-on toy (ie, around the home or outside), with less room for recreational tricks because of the innate design of the product. This may explain why the majority of sprains and/or strains occurred around the ankle in skateboarders, likely occurring during performing tricks with the board. This may also explain why hoverboard riders injured their wrists more often, which likely occurred after falling off the toy.

Contrary to recent news articles describing hoverboards spontaneously catching fire, in this cohort, no injuries were observed from this mechanism. Three patients were burned; however, the burns were not associated with device malfunction.

A limitation of these data is not knowing whether patients were wearing protective gear. A case series of 5 hoverboard injuries revealed that none of the patients in the study were wearing protective gear.<sup>4</sup> In this cohort, head and wrist injuries accounted for >25% of all those with hoverboard and skateboard injuries presenting to the ED. Fourteen percent of all admissions from hoverboard injuries and 35% of all admissions from skateboard injuries presenting to the ED were due to head injuries. The head was also the second most common body part injured by both toys. Although it is unclear whether these patients were wearing protective gear, a helmet and wrist pads may decrease the frequency of head and wrist injuries in hoverboard riders and skateboarders.

In this study, 40% of skateboard injuries and 49% of hoverboard

injuries in the database did not have a documented locale of the injury. Another limitation of this study and source of potential bias is not knowing where a large percentage of skateboard and hoverboard injuries occurred. Lastly, the data from product code 5042 in the NEISS database include a group of toys (ie, hoverboards and powered scooters and skateboards). Thus, it is difficult to draw conclusions regarding solely hoverboard injuries from this product code.

## CONCLUSIONS

This study reveals that the wrist, head, and forearm were the most common injured body parts in children presenting to the ED with hoverboard and skateboard injuries. Fractures were the most

common diagnosis made in the ED resulting from hoverboard and skateboard injuries. Head injuries and fractures were a common cause of admission to the hospital. Most hoverboard injuries occurred at home, and most skateboard injuries occurred on the street. By elucidating the characteristics of hoverboard and skateboard injuries in children, preventive measures can be implemented to decrease the incidence of injuries and the frequency of ED visits.

## ABBREVIATIONS

CI: confidence interval  
CPSC: Consumer Product Safety Commission  
ED: emergency department  
NEISS: National Electronic Injury Surveillance System  
RR: relative risk

**POTENTIAL CONFLICT OF INTEREST:** The authors have indicated they have no potential conflicts of interest to disclose.

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