



Safety on the slopes: ski versus snowboard injuries in children treated at United States trauma centers[☆]



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ABSTRACT

Purpose: Skiing and snowboarding are popular winter sports. The purpose of this study was to determine differences in injury patterns and severity between children participating in these sports treated at trauma centers in the United States.

Methods: Ski and snowboard injuries in children <15 identified from the 2011–2015 National Trauma Data Bank were compared using *t* tests, chi squared tests, and multivariable analyses. Time trends were evaluated using the Cochran Armitage trend test.

Results: We identified 1613 injured snowboarders and 1655 skiers. Snowboarders were older (12 vs. 11 years, $p < .001$) and more likely to be male (84 vs. 68%, $p < .001$). The proportion of ski to snowboard injuries increased over time ($p < .001$). Skiers had greater median ISS than snowboarders (5 vs. 4, $p < .001$) but similar severe injuries $ISS \geq 16$ (9 vs. 8%, $p = .31$). Head injuries were more frequent among snowboarders (26 vs. 23%, $p = .013$). Helmet use was greater in skiers (46 vs. 34%, $p < .001$). Skiers were more likely to sustain face, chest, and lower extremity injuries. Snowboarders had more abdominal and upper extremity injuries ($p < .05$). Snowboarders were more likely to undergo CT (20 vs. 16%, $p = .008$), and skiers were more likely to undergo surgery (25 vs. 22% $p = .021$). Need for intensive care (12 vs. 13%, $p = .43$) and mortality (0.3 vs. 0.3%, $p = .75$) were similar. Median length of stay was greater for skiers (2 days vs. 1 day, $p < .001$).

Conclusion: Many children are treated at United States trauma centers for ski and snowboard injuries. One in 10 is severely injured. Different injury patterns between sports can be used to tailor prevention efforts. However, avoiding head injury and improving helmet use should be a priority for all children on the slopes.

Level of Evidence: III

Type of study: Prognostic

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Approximately 10 million people enjoy snow sports each year in the United States according to industry reports and more than 20% of alpine skiers and snowboarders are youths <18 years of age [1,2]. More recently, however, participation has plateaued or decreased according to the National Ski Areas Association [3]. This coincides with growing concern in the public and the literature about injuries in youth sports participants, especially traumatic brain injury (TBI). The incidence of skiing and snowboarding related injuries requiring emergency department visits in children is estimated at 15–20 per 1000 participants [4]. Young age and male sex have previously been associated with greater risk of injury and TBI as a result of alpine sports is most frequent in children and adolescents [5,6].

Existing studies have demonstrated skiing and snowboarding are associated with the risk of severe injuries resulting in hospitalization and even death. It is also accepted that injury patterns vary based on sex, age, and sport [7,8]. Despite an abundance of literature describing injuries in skiers and snowboarders, the characteristics and severity of injuries seen at trauma centers have not been compared specifically in children. Additionally, it is not known if the decrease in snowboarding participation has been accompanied by a decrease in pediatric trauma due to the sport. The purpose of this study was to compare the injuries sustained by youth skiers and snowboarders treated at trauma centers in the United States so that parents can be informed about the risks associated with these sports and injury prevention efforts can be refined.

1. Methods

Children <15 years of age injured from skiing or snowboarding were identified for inclusion from the 2011–2015 National Trauma Data Bank (NTDB) [9]. The NTDB is the national trauma registry of the American

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College of Surgeons Committee on Trauma that contains de-identified patient-level data for all trauma patients at ACS level I and II verified centers and other participating centers. The percentage of hospitals contributing data by state is provided in annual reports and most contributing trauma centers define pediatric trauma as injured patients <15 years of age. Data is collected via the National Trauma Data Standard and validation software is applied following submission to the ACS. Injuries sustained from skiing from 2011 to 2014 were defined as international classification of disease (ICD) 9 codes E885.3 and ICD 10 code V00.32 for part of 2015. Similarly, snowboarding injuries were defined as ICD-9 E885.4 and ICD-10 V00.31.

Demographics, injury characteristics, resource utilization, and outcomes were compared between ski and snowboard injuries using *t* tests, chi squared tests, and univariate logistic regression analysis. Severe injury was defined as ISS \geq 16 or AIS \geq 3 for a particular body region. ICD 9 and 10 diagnosis codes were used to identify examples of specific injuries among those with AIS \geq 3. Major surgical procedures were identified using the HCUP procedure classifications. Time trends in ski vs. snowboard injuries were determined using the Cochran-Armitage trend test using those patients treated at hospitals that both contributed to NTDB for the duration of the study period and treated \geq 6 patients with ski or snowboard injuries. Results were reported as mean \pm standard deviation, median (interquartile range), and *n* (percentage). Multivariable analyses identified independent risk factors associated with severe injury and severe head injury. Analysis was performed using SAS software, version 9.4 (SAS Inc., Cary, NC).

2. Results

There were 3268 injured children treated at NTDB hospitals over the five-year study period, 1655 (50.6%) injured from skiing and 1613 (49.4%) from snowboarding. Care was provided at ACS pediatric trauma centers for 1228 children (37.6%) while the remaining 62.4% presented to other trauma centers. Overall cohort characteristics are given in Table 1. Nearly all (99.8%) were blunt injuries. Severe injury ISS \geq 16 occurred in 274 (8.4%). Lower extremity injuries were most common

(25.4%) though one quarter of patients sustained head injuries (24.5%) and 8.2% had a severe TBI (AIS \geq 3). Helmet use was reported in 1320 injured children (40.4%). Intensive care was required for 418 (12.8%) injured children and a surgical procedure in 762 (23.3%). In-hospital mortality was low at 0.03%.

Injured snowboarders were older and more likely to be male (84.1 vs. 67.9%, $p < .001$) than injured skiers (Table 1). ISS was greater for skiers (5 vs. 4, $p < .001$) though severe injury was similar between groups (8.8 vs. 7.9%, $p = .31$). Head injuries of any severity were more frequent among injured snowboarders (26.4 vs. 22.7%, $p = .013$) and helmet use was greater among injured skiers (46.4 vs. 34.2%, $p < .001$) however severe head injury was similar between sports (8.5 vs. 7.9%, $p = .57$). While snowboarders were more likely to present with upper extremity and abdominal injuries, skiers more frequently had lower extremity, facial, and thoracic injuries (all $p < .05$). Spine injuries were similar between groups and rarely severe.

The most frequent severe head injuries were subdural hematomas, which occurred in 53 patients (6.6% of all head injuries). Severe abdominal injuries were most likely to be Grade III or IV splenic injuries ($n = 171$, 39.1% of all abdominal injuries) and femur fractures were most frequent among those children with severe lower extremity injuries ($n = 266$, 32.0% of all lower extremity injuries).

Injured snowboarders were more likely to undergo CT (19.5 vs. 15.9%, $p = .008$) and specifically head CT (13.1 vs. 10.5%, $p = .020$) while use of thoracic and abdominal CT was similar between sports (both $p > .05$). There was no difference in emergency department disposition (ED), with 12.0 vs. 14.1% of injured children able to be discharged from the ED ($p = .20$). Major surgical procedures were more likely in injured skiers (25.0% vs. 21.6%, $p = .021$) and ski injuries were also associated with greater median length of stay (2(1, 3) vs. 1(1, 2) days, $p < .001$). There was no difference in mortality (0.03 vs. 0.03%, $p > .99$).

On multivariable analysis, only increased age (13–14 years) was associated with greater odds of severe injury ISS \geq 16 (OR = 1.69, $p = .004$). Patient sex, sport of choice, and year of participation was not associated. Helmet use was not associated with decreased odds of severe head injury (OR = 1.09, $p = .54$) however

Table 1
Characteristics of Ski and Snowboard Injuries in Children.

	All injured patients <i>N</i> = 3268	Ski injuries <i>n</i> = 1655	Snowboard injuries <i>n</i> = 1613	<i>p</i> Value
Age (years)	11.5 (2.6)	11.0 (2.7)	11.9 (2.5)	<.001
Age group (years)				
0–9	647 (19.8%)	429 (25.9%)	218 (13.5%)	<.001
10–12	1139 (34.9%)	611 (36.9%)	528 (32.7%)	
13–14	1482 (45.3%)	615 (37.2%)	867 (53.8%)	
Male sex	2479 (75.9%)	1123 (67.9%)	1356 (84.1%)	<.001
Median ISS	4 (4.9)	5 (4.9)	4 (4.9)	<.001
Helmet use	1320 (40.4%)	768 (46.4%)	552 (34.2%)	<.001
Severe injury (ISS \geq 16)	274 (8.4%)	147 (8.9%)	127 (7.9%)	.31
Head injury	801 (24.5%)	375 (22.7%)	426 (26.4%)	.013
Severe	267 (8.2%)	140 (8.5%)	127 (7.9%)	.57
Facial injury*	369 (11.3%)	235 (14.2%)	134 (8.3%)	<.001
Spine injury	293 (9.0%)	159 (9.6%)	134 (8.3%)	.20
Severe	23 (0.7%)	12 (0.7%)	11 (0.7%)	>.99
Abdominal injury	437 (13.4%)	185 (11.2%)	252 (15.6%)	.002
Severe	225 (6.9%)	84 (5.1%)	141 (8.7%)	<.001
Thoracic injury	179 (5.5%)	106 (6.4%)	73 (4.5%)	.021
Severe	138 (4.2%)	86 (5.2%)	52 (3.2%)	.005
Upper extremity injury	820 (25.1%)	272 (16.4%)	548 (34.0%)	<.001
Severe	18 (0.6%)	6 (0.4%)	12 (0.7%)	.16
Lower extremity injury	831 (25.4%)	592 (35.8%)	239 (14.8%)	<.001
Severe	326 (10.0%)	218 (13.2%)	108 (6.7%)	<.001
Any CT	577 (17.7%)	263 (15.9%)	314 (19.5%)	.008
CT head	385 (11.8%)	173 (10.5%)	212 (13.1%)	.020
Surgical procedure	762 (23.3%)	414 (25.0%)	348 (21.6%)	.021
ICU admission	418 (12.8%)	204 (12.3%)	214 (13.3%)	.43
Median LOS	1 (1.3)	2 (1.3)	1 (1.2)	<.001
In-hospital mortality	10 (0.03%)	<10	<10	>.99

* None were severe. Data are presented as mean (standard deviation), median (interquartile range), or *n* (%). Column percentages are reported.

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