

Children Should Wear Helmets While Ice-Skating: A Comparison of Skating-Related Injuries

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ABSTRACT. *Objective.* This study compares injuries, especially head injuries, among ice-skaters with those among skateboarders, rollerskaters, and in-line skaters, to determine the need for helmet use during recreational ice-skating by children.

Design. A comparative study of a consecutive series of patients.

Setting. The emergency department of a large, urban, academic, children's hospital.

Participants. Children treated for injuries related to recreational ice-skating, skateboarding, rollerskating, and in-line skating.

Results. During a 31-month period, 419 consecutive children were evaluated in the emergency department for skating-related injuries. Children were predominately male (53.9%), with a mean age of 10.0 years (SD: 3.0 years; median: 10.0 years; range: 1–18 years). The most frequent mechanism of injury was a fall. Overall, 76.5% of children (215 of 281 children) were reported to be wearing no protective equipment, such as a helmet or padding on the elbows or knees, at the time of injury. Ice-skaters were more likely to have adult supervision than were skateboarders (relative risk [RR]: 5.16; 95% confidence interval [CI]: 2.13–12.46), rollerskaters (RR: 1.21; 95% CI: 1.09–1.35), and in-line skaters (RR: 2.08; 95% CI: 1.72–2.51). Ice-skaters were at greater risk of injury to the head (20.0%) than were in-line skaters (4.9%) (RR: 4.09; 95% CI: 1.81–9.23); a weak difference was noted between ice-skaters and rollerskaters (9.9%) (RR: 2.18; 95% CI: 1.04–4.57), with no significant difference in head injuries between ice-skaters and skateboarders (15.9%) (RR: 1.60; 95% CI: 0.54–2.93). Ice-skaters demonstrated lacerations to the head in 68.8% of abnormal head examinations, compared with 37.0% for rollerskaters (RR: 1.86; 95% CI: 1.08–3.20) and 50.0% for in-line skaters (RR: 2.06; 95% CI: 1.35–3.16); however, there was no significant difference in lacerations to the head between ice-skaters and skateboarders (53.3%) (RR: 1.29; 95% CI: 0.76–2.19). Injuries to ice-skaters occurred more often in an indoor skating facility (92.9%, 52 of 56 cases), compared with injuries to skateboarders (3.6%, 1 of 28 cases) (RR: 13.96; 95% CI: 2.01–96.76), rollerskaters (63.4%, 59 of 93 cases) (RR: 1.46; 95% CI: 1.23–1.74), and in-line skaters (10.9%, 15 of 137 cases) (RR: 8.48; 95% CI: 5.23–13.75).

Conclusions. The proportion of head injuries among ice-skaters in this study was greater than that observed for participants in other types of skating, for which hel-

met use is recommended and often required. Children should wear a helmet during recreational ice-skating. Mandatory helmet use by pediatric ice-skaters at indoor rinks should be implemented. Use of other types of protective equipment, such as wrist guards, knee pads, and elbow pads, should be considered for prevention of injuries to the extremities during ice-skating. Caution should be used when allowing young children to participate in recreational ice-skating. Additional research should be conducted in other populations, to corroborate these findings and to evaluate ice-skating safety recommendations for children. *Pediatrics* 2004;114:124–128; *skating, injuries, helmet, pediatric, trauma, head injury.*

ABBREVIATIONS. ED, emergency department; RR, relative risk; CI, confidence interval.

In 2001, an estimated 56 300 children 5 to 14 years of age were treated in hospital emergency departments (EDs) for injuries related to skateboarding. Rollerskating was associated with 28 400 injuries in 2001, whereas in-line skating injuries totaled 42 800.¹ Most of the injuries were caused by falls, and the majority of injuries involved an upper extremity (specifically, the forearm and wrist).^{2–9} The American Academy of Pediatrics released policy statements regarding in-line skating and skateboarding, stipulating that protective gear (helmets, wrist guards, and knee and elbow pads) should be worn during these activities to prevent serious injuries resulting from falls.^{2,3}

Recreational ice-skating was associated with an estimated 11 100 injuries treated in hospital EDs in 2001.¹ Although ice-skaters experience falls onto hard surfaces, not unlike those that occur among in-line skaters, rollerskaters, and skateboarders, there are currently no formal guidelines or recommendations regarding the use of protective equipment while ice-skating. A study by Freeland¹⁰ recommended that all ice-skaters <16 years of age wear helmets to prevent head injuries. In 2000, Ron Ludington, a member of the World Figure Skating Hall of Fame and director of the Ice Skating Science Development Center, lobbied the International Skating Union to make helmets mandatory for skaters during practice. This action came shortly after Ludington witnessed a fall of one of his skaters that caused a severe brain injury.¹¹ Although there are no data regarding the effectiveness of helmets in ice-skating, helmet use has been shown to prevent up to 74% of severe traumatic brain injuries associated with recreational bicycling.¹²

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TABLE 1. Information About Children With Skating-Related Injuries, According to Type of Skating Activity

Skating Activity	No. (%) of Children	Completed Follow-up Assessment, %	Mean Age, y	Male, %
Ice-skating	60 (14.3)	75.0	9.5	51.7
Skateboarding	44 (10.5)	52.3	10.5	86.4
Rollerskating	131 (31.3)	61.1	9.6	35.1
In-line skating	184 (43.9)	71.7	10.2	60.3
Total	419 (100.0)	67.1	10.0	53.9

Little has been reported regarding the epidemiologic features of pediatric injuries associated with recreational ice-skating. Two studies included children in their study populations; however, neither focused specifically on pediatric injuries.^{10,13} This study compares injuries, especially head injuries, among ice-skaters with those among skateboarders, rollerskaters, and in-line skaters, to determine the need for helmet use during recreational ice-skating by children.

METHODS

Data for this study were obtained from the medical records of a consecutive series of children treated in the ED of a large academic children's hospital for injuries related to recreational ice-skating, skateboarding, rollerskating, or in-line skating. This hospital is a tertiary care facility and a level 1 pediatric trauma center. Cases were included only if the child was directly involved in skating. For example, children who were hit by skates or run over by a skater but were not personally using skating equipment were excluded from the study. Follow-up information was obtained by contacting the parents of study patients by telephone or mail. Follow-up assessment was completed for 67.1% of patients (281 of 419 patients) (Table 1).

Data collected from ED medical records included patient age and gender, the body region injured, and the type of injury. Information regarding the mechanism of injury, the product involved, the location of the injury event, the use of protective gear, and the presence of adult supervision was collected during the follow-up assessment if the information was not available in the patient's medical record. This study was approved by the hospital's human subjects research committee.

Data were analyzed by using Epi Info software, version 5.01b (Centers for Disease Control and Prevention, Atlanta, GA). Statistical analyses included the χ^2 test with Yates' correction and the 2-tailed Fisher's exact test. Results were considered statistically significant for *P* values of <.05. Relative risks (RRs) and 95% confidence intervals (CIs) were also calculated.

RESULTS

Demographic Features and Types of Injuries

A total of 419 consecutive children were evaluated in the ED for skating-related injuries (Table 1). The children were predominately male (53.9%), with a mean age of 10.0 years (SD: 3.0 years; median: 10.0 years; range: 1–18 years). The most frequent mechanism of injury was a fall (91.4%) (Table 2). Six of the 17 injuries (35.3%) sustained through collision with a stationary object were the result of collision with a wall. Other objects included a chair, a mailbox, a stone, and a car bumper. Two of the 3 children hit by a vehicle were hit by a car, and 1 child was struck by a bicycle. Other mechanisms of injury included combinations of colliding with another skater and falling, colliding with a stationary object and falling, falling and being run over by another skater, and striking one's own foot with a skate blade. Overall, 76.5% of

children (215 of 281 children) were reported to be wearing no protective equipment (such as a helmet, wrist guards, or padding on the elbows or knees) at the time of injury. In 79.6% of cases (223 of 280 cases), parents reported being aware of the dangers of the skating activity before the child's injury. Most children (74.4%, 209 of 281 children) made changes in protective gear use or adopted new safety behaviors after the injury event (Table 3). The most frequent change was to discontinue the skating activity (36.5%, 76 of 208 cases).

Ice-Skating

Most ice-skating injuries were to the face (38.3%, 23 of 60 cases), including 16 injuries to the chin. Twelve additional injuries (20.0%) were to the head (Table 4). Lacerations were the most common type of ice-skating-related injury (41.7%, 25 of 60 cases). There were 20 soft-tissue injuries (33.3%) and 11 fractures (18.3%). Eighty-nine percent of children (8 of 9 children) ≤ 6 years of age sustained an injury to the head or face, compared with 52.9% of children (27 of 51 children) > 6 years of age; however, this difference was not statistically significant (*P* = .49; RR: 1.36; 95% CI: 0.75–2.45).

Children were injured primarily at indoor skating facilities (92.9%, 52 of 56 children) (Table 5). Adult supervision was reported for 98.2% of cases (55 of 56 cases), and 78% of children (36 of 46 children) reported no protective equipment use. A total of 4.3% (2 of 46 children) reported wearing a helmet, 8.7% (4 of 46 children) wore padding only, and 8.7% (4 of 46 children) wore a helmet and padding.

Skateboarding

The majority of skateboarding-related injuries (32.0%) were to an upper extremity (Table 4), and the injuries were mainly to the hand and wrist (57.1%, 8 of 14 cases). The most common type of injury to skateboarders was a fracture (36.4%, 16 of 44 cases),

TABLE 2. Number and Percentage of Children With Skating-Related Injuries According to Mechanism of Injury

Mechanism of Injury	No.	%
Fell	383	91.4
Ran into stationary object	17	4.1
Collided with another skater	7	1.7
Hit by vehicle while skating	3	0.7
Stepped on by other person's skates	1	0.2
Ran into moving object	1	0.2
Other mechanism	7	1.7
Total	419	100.0

TABLE 3. Changes Made in Protective Gear and Safety Behavior After Injury

Change Made	No. of Patients
No longer participates in skating activity	76
Wears helmet and padding	58
Wears padding only	22
Wears helmet only	18
Limits skating activity to certain locations	7
Other	27
Total	208

followed by soft-tissue injury (31.8%, 14 of 44 cases) and laceration (25.0%, 11 of 44 cases). Other injuries included 1 closed-head injury and 2 concussions. For children ≤ 6 years of age, 62.5% of injuries (5 of 8 cases) were to the head and face, compared with 33.3% of injuries (12 of 36 cases) among children > 6 years of age ($P = .047$; RR: 2.50; 95% CI: 1.21–5.17). Upper-extremity injuries were sustained by 12.5% of children (1 of 8 children) ≤ 6 years of age, compared with 36.1% of children (13 of 36 children) > 6 years of age ($P = .43$; RR: 2.39; 95% CI: 0.36–16.06). Injuries to the hand and wrist occurred only among children > 6 years of age (22.2%, 8 of 36 children).

Eighty-seven percent of skateboarders (20 of 23 children) reported not using any protective gear. One child reported wearing a helmet only. One child reported wearing some type of padding, and 1 child reported wearing both a helmet and padding. Nineteen percent of children (4 of 21 children) were under adult supervision at the time of the injury. Most skateboarding injuries (92.8%) took place outdoors, on a sidewalk, driveway, or street (Table 5).

Rollerskating

The upper extremity was the most frequently injured body region for rollerskaters evaluated in the ED, accounting for 52% of injuries (68 of 131 cases) (Table 4). Injuries to the forearm were the most common upper-extremity injury (48.5%, 33 of 68 cases). Soft-tissue injuries accounted for 48.1% of rollerskating-related injuries (63 of 131 cases), whereas fractures occurred in 38.2% of cases (50 of 131 cases). Ten children (7.6%) had lacerations, and the remaining 8 children (6.1%) presented with other injuries. Children ≤ 6 years of age received injuries to the head and face in 37.5% of cases (9 of 24 cases), compared with 15.9% of cases (17 of 107 cases) among children > 6 years of age; however, this difference was not statistically significant ($P = .11$; RR: 1.99; 95% CI: 0.98–4.05).

Ninety percent of children (71 of 80 children) were reported not to be wearing protective equipment at the time of injury. Only 5.0% (4 of 80 children) reported wearing a helmet, 2.5% (2 of 80 children) reported wearing padding, and 3.8% (3 of 80 children) reported wearing both a helmet and padding. Eighty-one percent of children (72 of 80 children) were reported to be under adult supervision at the time of injury. Rollerskating injuries frequently (63.4%) occurred at an indoor skating facility (Table 5).

In-Line Skating

The majority of in-line skating-related injuries (57.6%, 106 of 184 cases) involved the upper extremities (Table 4). The upper-extremity injuries most commonly involved the forearm (58.1%, 61 of 105 cases). The most common type of injury among in-line skaters was a fracture (45.6%, 84 of 184 cases), followed by soft-tissue injury (34.8%, 64 of 184 cases) and laceration (17.4%, 32 of 184 cases).

Most in-line skating injuries (74.5%, 102 of 137 cases) took place outdoors, on a sidewalk, driveway, or street (Table 5). Eight percent of injuries (11 of 137 cases) took place at other locations, such as a bike path, playground, stairs, or garage. Sixty-seven percent of children (88 of 132 children) reported wearing no protective equipment. Only 13.6% of children (18 of 132 children) reported wearing a helmet and padding, 6.8% (9 of 132 children) reported wearing padding only, and 12.9% (17 of 132 children) reported wearing a helmet only. Forty-seven percent of children (60 of 127 children) were under adult supervision at the time of injury.

Group Comparisons

Ice-skaters were at greater risk of injury to the head (20.0%) than were in-line skaters (4.9%) ($P < .001$; RR: 4.09; 95% CI: 1.81–9.23); however, a weak difference was noted between ice-skaters and rollerskaters (9.2%) ($P = .06$; RR: 2.18; 95% CI: 1.04–4.57), with no significant difference in head injuries between ice-skaters and skateboarders (15.9%) ($P = .78$; RR: 1.60; 95% CI: 0.54–2.93). Ice-skaters demonstrated lacerations to the head in 68.8% of abnormal head examinations, compared with 37.0% for rollerskaters ($P = .03$; RR: 1.86; 95% CI: 1.08–3.20) and 50.0% for in-line skaters ($P = .002$; RR: 2.06; 95% CI: 1.35–3.16); however, there was no statistically significant difference in lacerations to the head between ice-skaters and skateboarders (53.3%) ($P = .48$; RR: 1.29; 95% CI: 0.76–2.19) (Table 6). In-line skaters and rollerskaters were at greater risk for upper-extremity injuries than were skateboarders and ice-skaters ($P < .001$; RR: 1.98; 95% CI: 1.43–2.74). In-line skating was associated with more fractures, compared with ice-skating ($P < .001$; RR: 2.49; 95% CI: 1.43–4.35).

Injuries to ice-skaters occurred more often at an indoor skating facility (92.9%, 52 of 56 cases), compared with those to skateboarders (3.6%, 1 of 28 cases) ($P < .001$; RR: 13.96; 95% CI: 2.01–96.76), rollerskaters (63.4%, 59 of 93 cases) ($P < .001$; RR: 1.46; 95% CI: 1.23–1.74), and in-line skaters (10.9%, 15 of 137 cases) ($P < .001$; RR: 8.48; 95% CI: 5.23–13.75). Ice-skaters were also more likely to have adult supervision than were skateboarders ($P < .001$; RR: 5.16; 95% CI: 2.13–12.46), rollerskaters ($P = .005$; RR: 1.21; 95% CI: 1.09–1.35), and in-line skaters ($P < .001$; RR: 2.08; 95% CI: 1.72–2.51).

DISCUSSION

This study describes injuries related to ice-skating and compares them with injuries associated with skateboarding, rollerskating, and in-line skating. Head injuries are the focus. Several studies have

TABLE 4. Number and Percentage of Children With Skating-Related Injuries According to Body Region Injured and Type of Skating Activity

Body Region Injured	No., %			
	Ice-Skating	Skateboarding	Rollerskating	In-Line Skating
Head	12 (20.0)	7 (15.9)	13 (9.9)	9 (4.9)
Face	23 (38.3)	10 (22.7)	14 (10.7)	26 (14.1)
Upper extremities	15 (25.1)	14 (31.8)	68 (51.9)	106 (57.6)
Lower extremities	8 (13.3)	11 (25.1)	23 (17.6)	28 (15.2)
Other	2 (3.3)	2 (4.5)	13 (9.9)	15 (8.2)
Total	60 (100.0)	44 (100.0)	131 (100.0)	184 (100.0)

TABLE 5. Number and Percentage of Skating-Related Injuries According to Location of the Injury Event and Type of Skating Activity

Location	No., %			
	Ice-Skating	Skateboarding	Rollerskating	In-Line Skating
Outdoor sidewalk, driveway, or street	1 (1.8)	26 (92.8)	23 (24.7)	102 (74.5)
Outdoor skating rink or skateboard facility	1 (1.8)	0 (0)	0 (0)	0 (0)
Indoor skating rink or skateboarding facility	52 (92.9)	1 (3.6)	59 (63.4)	15 (10.9)
Indoors	0 (0)	1 (3.6)	9 (9.7)	9 (6.6)
Other	2 (3.5)	0 (0)	2 (2.2)	11 (8.0)
Total	56 (100.0)	28 (100.0)	93 (100.0)	137 (100.0)

The location at which the injury took place was unknown in 4 ice-skating cases, 16 skateboarding cases, 38 rollerskating cases, and 47 in-line skating cases.

TABLE 6. Number and Percentage of Skating-Related Head Injuries According to Type of Head Injury and Type of Skating Activity

Type of Head Injury	No., %			
	Ice-Skating	Skateboarding	Rollerskating	In-Line Skating
Laceration	22 (68.8)	8 (53.3)	10 (37.0)	20 (50.0)
Soft tissue	2 (6.2)	2 (13.4)	5 (18.5)	9 (22.5)
Other injury	8 (25.0)	5 (33.3)	12 (44.5)	11 (27.5)
Total	32 (100.0)	15 (100.0)	27 (100.0)	40 (100.0)

described the epidemiologic features of skating injuries; however, this is the only study, to our knowledge, that incorporates injuries related to ice-skating. Although the mechanisms of injury were similar for all 4 skating activities, the anatomic locations and types of injuries varied. Ice-skaters sustained injury to the head in 20.0% of cases, and the most frequent type of head injury among ice-skaters was a laceration. Injuries to the head were significantly less frequent among skateboarders (15.9%), rollerskaters (9.2%), and in-line skaters (4.9%). The majority of injuries among rollerskaters and in-line skaters were to the upper extremities, especially the forearms. Frequent forearm injuries in these 2 groups are consistent with findings in previous studies.^{5,7,8} The large number of forearm injuries among rollerskaters and in-line skaters suggests that these children may be falling in a forward direction and attempting to stop the fall with their arms. Our study results suggest that skateboarders and ice-skaters may fall differently, possibly backward or sideways; this does not allow the children to use their arms to stop their fall and thus causes more injuries to the head and fewer to the upper extremities. Additional studies should be performed to examine the direction in which children fall while using different types of skates.

The proportion of injuries to the head and face among children ≤ 6 years of age was greater than that among children > 6 years of age for skateboarding, rollerskating, and in-line skating, but this relationship was statistically significant only for skateboarding. This inverse relationship between head and face injuries and age may be attributable to the higher center of gravity of younger children, which causes them to topple headfirst. Also, the arm strength of young children may not be enough to stop a forward fall and prevent them from striking their heads.

The rate of use of protective equipment by children in this study was low. Approximately three-fourths of the study participants reported wearing no protective equipment at the time of injury. In addition, reported use has been demonstrated to overestimate actual protective equipment use.¹⁴ These findings support the need for increased educational efforts and mandatory helmet use laws and local ordinances to increase helmet use and the adoption of other skating safety behaviors.

Some opponents to laws mandating bicycle helmet use claim that such requirements discourage participation in recreational bicycling by individuals who do not want to wear a helmet. Inasmuch as more than one-third of the children in this study discon-

tinued their skating activity after their injury, mandatory helmet use may have the opposite effect on recreational skating. By preventing head injuries, helmet use may promote continued participation in skating.

Almost all ice-skating injuries occurred at an indoor rink, with adult supervision at the time of injury. This provides a contained environment in which prevention strategies can be more readily implemented, monitored, and enforced. Mandatory helmet use by pediatric ice-skaters at indoor rinks should be implemented. Another way to encourage helmet use by children may be to promote helmet use by competitive figure skaters.

The proportion of head injuries among ice-skaters in this study was greater than that observed for other types of skating, for which helmet use is recommended. This supports the recommendation that helmets be worn by children during recreational ice-skating. In 2003, a bill was introduced in the New York State legislature that mandated helmet use while ice-skating for children <14 years of age, with some exceptions for figure skating.¹⁵ It also stipulated that ice-skating facilities require children <14 years of age to wear a helmet and that rental helmets and helmet safety information be made available at these facilities.¹⁵

Caution should be used when allowing young children to participate in recreational ice-skating. The American Academy of Pediatrics recommends that children <5 years of age should not use skateboards, because they may not be developmentally ready, and that children between 6 and 10 years of age should ride only with close supervision.³ Our study findings suggest that these recommendations may apply to ice-skating by children, given the similarity between the injury patterns observed for skateboarders and ice-skaters in our study population.

Limitations of this study include missing data and inconsistent documentation, as typically found in patient medical records. Recall bias or participants' desire to please the investigators might have affected the information obtained from the parents during follow-up assessments after treatment in the ED. There were different response rates among the skating activities, which might be an additional source of bias. Children who are examined in the ED of our pediatric tertiary care hospital might not be representative of children who are treated for skating-related injuries at other health care facilities or children who do not seek medical attention.

Additional research should be conducted in other populations, to corroborate our findings and evaluate the evidence regarding our recommendations. A prospective case-control study should be considered, to evaluate the effectiveness of helmets in reducing

head injuries among children participating in recreational ice-skating.

CONCLUSIONS

The proportion of head injuries among ice-skaters in this study was greater than that observed among participants in other types of skating, for which helmet use is recommended and often required. Children should wear helmets during recreational ice-skating. Mandatory helmet use by pediatric ice-skaters at indoor rinks should be implemented. The use of other types of protective equipment, such as wrist guards, knee pads, and elbow pads, should also be considered for prevention of injuries to the extremities during ice-skating. Caution should be used when allowing young children to participate in recreational ice-skating. Additional research, including a prospective case-control study, should be conducted in other populations, to corroborate these findings and evaluate ice-skating safety recommendations for children.

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