

## ORIGINAL ARTICLE

## Video analysis of falls experienced by paediatric iceskaters and roller/inline skaters

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**Objectives:** To evaluate differences in the way iceskaters and roller/inline skaters fall.

**Methods:** Children's falls related to skating were videotaped and categorised based on type of skating activity, child's estimated age, direction of fall, whether the child attempted to break the fall, and whether the head struck the skating surface.

**Results:** In total, 216 iceskating and 201 roller/inline skating falls were captured on videotape. In both iceskating and roller/inline skating, the majority of falls were forward in direction. The skaters attempted to break the falls with their arms or hands in over 90% of falls in both iceskating (93.1%) and roller/inline skating (94.5%). A greater proportion of falls in iceskating resulted in the head striking the skating surface (13.0%) than did those in roller/inline skating (3.0%) (odds ratio=4.8; 95% confidence interval 1.9 to 13.3;  $p<0.001$ ).

**Conclusions:** This study found that paediatric iceskaters and roller/inline skaters fall similarly and that both types of skaters try to break their falls with their arms or hands; however, because iceskating takes place on a low friction surface, attempts to break falls with the arms or hands are often unsuccessful, leading to head and face injuries. The development of a new type of protective gear, a wrist guard with a non-slip palm, should stop iceskaters from striking the head, protect against upper extremity fractures, and unlike a bulky helmet, should not discourage children from skating.

Multiple studies have explored injuries in children associated with rollerskating and inline skating.<sup>1–10</sup> However, little research has examined the epidemiology of paediatric injuries related to iceskating.<sup>11–13</sup> (Knox, unpublished data) Only one study has compared iceskating injuries with other skating related injuries among children.<sup>13</sup> (also Knox, unpublished data). It demonstrated that iceskaters sustained significantly more head and face injuries than rollerskaters and inline skaters. In contrast, rollerskaters and inline skaters experienced significantly more fractures to the upper extremities, mainly to the wrist and lower arm, than iceskaters.

One hypothesis for the increased risk of head and face injuries among iceskaters is that they fall in such a way (perhaps backwards or sideways) that they are unable to break the fall with their arms or hands.<sup>13</sup> Another hypothesis is that skaters in all three activities fall similarly and try to break their falls with their arms or hands, but because iceskating takes place on a low friction surface, attempts to break a fall in this manner are unsuccessful, leading to the head striking the skating surface. Rollerskaters and inline skaters may be able to break their falls successfully, thus protecting the head and face but leading to arm and wrist fractures. (Knox, unpublished data)

The objective of this study was to determine if there are differences in the way children fall during different types of skating activities by (a) examining the direction children fall in each type of skating activity, (b) determining if any attempt was made to use the arms or hands to break the fall, and (c) determining the success of any such attempts in preventing the head from striking the skating surface.

## METHODS

This study was approved by the internal review board at Columbus Children's Research Institute.

Like previous studies that have effectively used video analysis to collect detailed information about the mechanisms

of sports related injuries and the movement patterns of athletes,<sup>14–24</sup> this study used video analysis to evaluate skating falls in children. Researchers obtained permission from local skating rinks to videotape children's falls for each type of skating activity (iceskating, rollerskating, and inline skating). One public session at an indoor iceskating rink and two public sessions at an indoor roller/inline skating rink were videotaped. Researchers reviewed the videotapes and recorded falls on a fall report form.

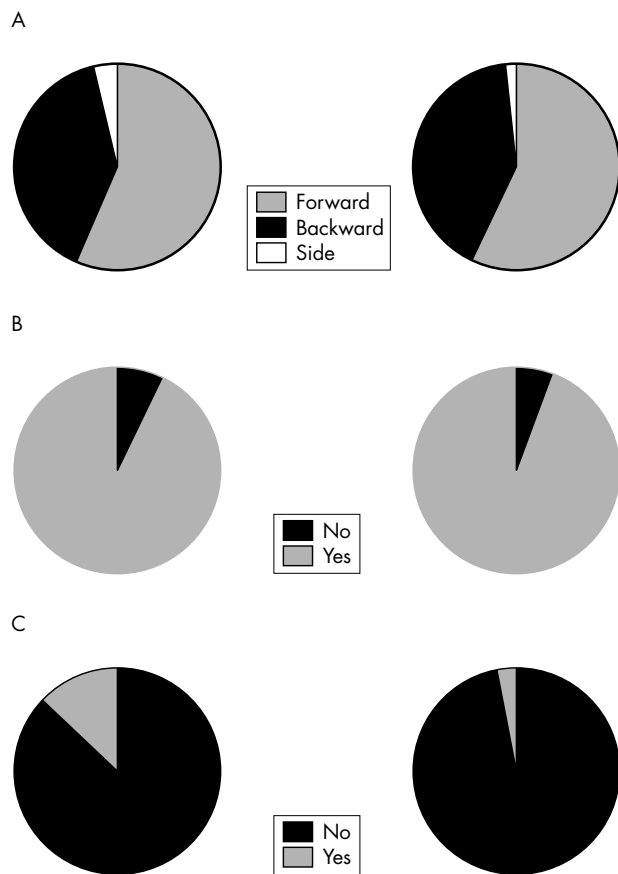
The unit of interest was the fall rather than the child, because each fall represents a potential for injury. For example, if one child fell 10 times during a videotaping session, 10 falls were recorded. Information captured by the fall report form included the type of skating activity, estimated age of the child ( $\leq 6$  years or  $>6$  years of age), direction of fall (forwards, backwards, or to the side), whether the child attempted to break the fall with the arms or hands, and whether the child's head struck the skating surface. For the purpose of this study, rollerskating and inline skating were combined into one category because of the similar injury patterns reported in previous studies.<sup>9 13 25 26</sup> (Knox, unpublished data)

## Statistical analysis

Data were entered, coded, and analysed in SPSS (version 13.0) and EpiInfo (version 6). The  $\chi^2$  test was used to examine differences between different types of skating activities and different age groups of skaters. Odds ratios and 95% confidence intervals were used to measure the magnitude and direction of differences, and p values were used to assess the statistical significance, with  $p<0.05$  considered significant.

## RESULTS

In total, 216 iceskating and 201 roller/inline skating falls were captured on videotape. Over 70% of roller/inline skating falls were among children  $\leq 6$  years of age (71.6%) while only



**Figure 1** Comparison of paediatric skating falls by type of skating activity. Left, iceskating; right, roller/inline skating. (A) Direction of fall; (B) attempted to break fall; (C) head struck skating surface.

15.7% of iceskating falls occurred in this age group (15.7%) (odds ratio (OR) = 13.5; 95% confidence interval (CI) 8.2 to 22.5;  $p < 0.001$ ).

In both iceskating and roller/inline skating, more falls occurred in a forward (56.9% and 56.7%, respectively) than in a backwards (41.7% and 39.3%) or sideways (1.4% and 4.0%) direction (fig 1). The skaters attempted to break their falls with their arms or hands in over 90% of both iceskating and roller/inline skating falls (93.1% and 94.5% respectively) (fig 1). Although the difference was not significant (OR = 2.4; 95% CI 1.0 to 5.8;  $p = 0.054$ ), skaters attempted to break their falls more often when falling forwards (95.8%) than backwards (90.5%). A greater proportion of iceskating falls resulted in the child striking the head on the skating surface (13.0%) than did roller/inline skating falls (3.0%) (OR = 4.8; 95% CI 1.9 to 13.3;  $p < 0.001$ ) (fig 1). This difference remained significant even when controlling for age (OR = 4.4; 95% CI 1.6 to 12.5;  $p < 0.01$ ). In addition, a greater proportion of skating falls that resulted in the child's head striking the ground occurred among children  $> 6$  years of age (10.9%) than among those aged  $\leq 6$  years (4.5%) (OR = 2.6; 95% CI 1.1 to 6.4;  $p < 0.05$ ).

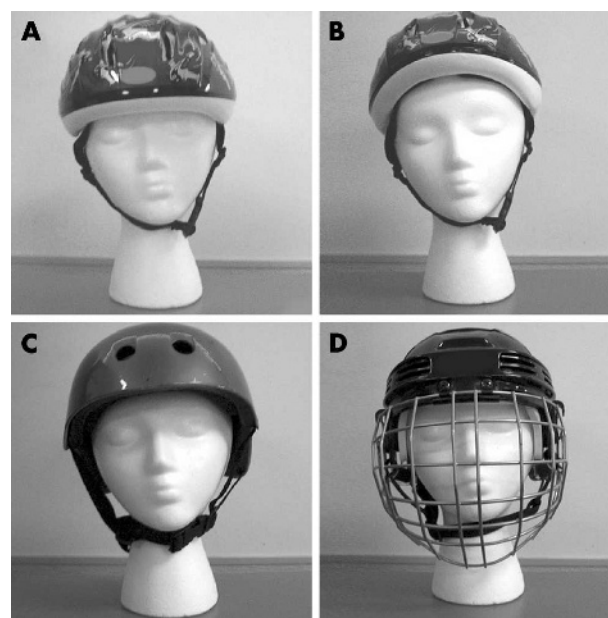
## DISCUSSION

This study found support for the hypothesis that paediatric iceskaters and roller/inline skaters fall similarly, and that both types of skaters try to break their falls with their arms or hands. However, because iceskating takes place on a low friction surface, attempts to break falls with the arms or hands are often unsuccessful, leading to head and face

injuries. The vast majority of both iceskaters and roller/inline skaters fell forward and attempted to break the fall with the arms or hands, but iceskaters were nearly five times more likely to strike their head on the skating surface when they fell than were roller/inline skaters. This explains the finding from prior studies that iceskaters are significantly more likely than roller/inline skaters to sustain head injuries.<sup>13</sup> (Knox, unpublished data)

Past skating related studies have also found that skaters aged  $\leq 6$  years are at significantly higher risk of head injuries than older children.<sup>13</sup> (Knox, unpublished data) Thus, in this study, we expected to see more falls resulting in the head striking the ground among younger children. However, we found a greater proportion of skating falls that resulted in the child's head striking the ground occurred among children  $> 6$  years of age. This apparent discrepancy may be an artefact of our sample, as more of the iceskaters who we observed fall were in this age group. Additionally, the younger iceskaters we observed were more likely than the older skaters to have parental assistance and/or use some other type of stability assistance. Thus, we believe this study actually underestimates the problem of head injuries associated with younger iceskaters who strike their heads when they fall. Younger children have a higher centre of gravity, which can cause them to fall head first. Younger children may also have less developed arm strength and thus may be unable to prevent their head from striking the skating surface even when they attempt to break the fall with the arms or hands. Further studies are needed to examine differences in paediatric skating related falls by age.

In 1998, the American Academy of Pediatrics issued a recommendation that children and adolescents wear full protective gear, including a helmet, wrist guards, and knee and elbow pads, while inline skating.<sup>27</sup> Similar recommendations have been made for rollerskating activities.<sup>9</sup> <sup>13</sup> Given our finding that a greater proportion of iceskaters strike their



**Figure 2** Protection provided to paediatric skaters during frontal falls by various types of helmets. (A) Bicycle helmet worn correctly, good coverage of the forehead, limited coverage of the face; (B) bicycle helmet worn incorrectly, very limited coverage of the forehead and face; (C) multisport helmet worn correctly, good coverage of the forehead, limited coverage of the face; (D) hockey helmet worn correctly, best coverage of the forehead and face.

head than roller/inline skaters, the growing movement to recommend that iceskaters should also wear helmets appears prudent. However, over half of all iceskating falls occur in a forward direction, and iceskaters sustain significantly more face and head injuries than do roller/inline skaters.<sup>13</sup> (Knox, unpublished data) Bicycle helmets and multisport helmets, the helmets currently most commonly worn by children who iceskate, may not adequately protect an iceskater's face and front of the head from hitting the skating surface (fig 2). To be most effectively protected against head and face injuries, iceskaters would need to wear full hockey style helmets with facemasks (fig 2). An unfortunate side effect would undoubtedly be that children would choose not to iceskate rather than be forced to wear a bulky and expensive helmet. In fact, several studies on recreational bicycling have found a decrease in participation among children who were required to wear a helmet.<sup>28-29</sup>

An alternative way to prevent head injuries among iceskaters might be wearing of gloves with a grip palm surface so that attempts to break a fall with the arms or hands would successfully stop the head from striking the ice by preventing the hands from sliding. However, iceskaters might then experience the same increased risk of upper extremity fractures as roller/inline skaters who do not wear wrist guards.<sup>30-32</sup> A new type of protective device that would prevent slipping but still protect the arm and wrist needs to be developed. Recommending or requiring children who iceskate to wear a wrist guard with a palm that allows them to grip the ice should stop iceskaters from striking the head, protect against upper extremity fractures, and unlike a bulky helmet, not discourage children from skating.

Selection bias due to the convenience sample of paediatric skating falls evaluated in this study presents some limitations. Because of the layout of the skating rinks and the position of the camera, not every fall was captured on videotape. Additionally, if researchers could not definitively complete the fall report form based on the videotape of the fall (for example, if the skater was partially blocked from view by other skaters), the fall was not included in the study. The skating facilities were chosen based on their willingness to allow researchers to videotape and their proximity to the researchers. Thus, the children skating in these facilities are not representative of all ice, roller, and inline skaters, especially children who skate in locales other than indoor rinks (such as sidewalks, parks, or outdoor rinks). Because the researchers did not survey the skaters, age was estimated based primarily on the height and weight of the child. Information about other factors that may influence falls such as skill level, speed of the skater when the fall occurred, and body mass of the skater was not collected. In addition, we were unable to calculate the exposure based risk rates for falls because the number of skaters or number of skater hours was not collected. Despite these limitations, this study, the first video analysis of paediatric skating falls, provides important information regarding the differences in the way children fall while participating in various skating activities, and how these differences affect the risk of injury.

Although iceskaters and roller/inline skaters fall in similar directions and both types of skaters attempt to break their falls with their arms or hands, iceskaters hit their head more often than roller/inline skaters. As the cause of injury is the head striking the skating surface, a helmet acts only as a secondary prevention mechanism to reduce the risk of injury once the head hits the ground. A wrist guard with a palm that allows iceskaters to successfully break the fall with the hands before the head hits the ground could act as a primary prevention mechanism to reduce the rate of head injuries among iceskaters to a rate similar to that among roller/inline skaters.

## What is already known on this topic

- In 1998, the American Academy of Pediatrics issued a recommendation that children and adolescents wear full protective gear, including a helmet, wrist guards, and knee and elbow pads, while inline skating
- Similar recommendations have been made for roller-skating activities
- To date, there are no such formal recommendations for the use of protective equipment while iceskating
- The only study that has compared iceskating injuries with other skating related injuries among children found that iceskaters sustained significantly more head and face injuries than roller and inline skaters
- The growing movement to recommend that iceskaters should also wear helmets appears prudent

## What this study adds

- This study found that pediatric iceskaters and roller/inline skaters fall similarly, and both types of skaters try to break their falls with their arms or hands
- Because iceskating takes place on a low friction surface, attempts to break falls with the arms or hands are unsuccessful leading to head and face injuries
- As over half of all iceskating falls occurred in a forward direction, and iceskaters sustained significantly more face and head injuries, bicycle helmets and multisport helmets may not adequately protect an iceskater's face and front of the head from hitting the skating surface
- The development of a new type of protective gear, a wrist guard with a non-slip palm, should stop iceskaters from striking their head, protect against upper extremity fractures, and unlike a bulky helmet, not discourage children from skating

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Competing interests: none

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## ELECTRONIC PAGES .....

### Online case reports

The following electronic only articles are published in conjunction with this issue of *BJSM* (see also page 213).

#### Ocular blunt trauma: loss of sight from an ice hockey injury

D S Morris

A case of ocular blunt trauma is described in which a 17 year old male ice hockey player collided with an opponent during a game. The opponent's stick travelled under the patient's half face visor and struck his left eye causing hyphema, angle recession, lens subluxation, and choroidal rupture over the macula, permanently reducing his vision to counting fingers. Sequelae of ocular blunt trauma are discussed along with

methods of injury prevention by addressing players' behaviour and safety equipment. This injury is unlikely to have occurred with properly used full face protection.

(*Br J Sports Med* 2005;40:e5) <http://bjsm.bmjournals.com/cgi/content/full/40/3/e5>

#### Transverse colon rupture in a young footballer

S C M Dutson

The case is reported of a 16 year old footballer who sustained a blunt abdominal injury resulting in traumatic rupture of the transverse colon and transverse process of L1.

(*Br J Sports Med* 2005;40:e6) <http://bjsm.bmjournals.com/cgi/content/full/40/3/e6>