Alpine Skiing Injuries

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Context: Alpine skiing is a popular sport worldwide but has significant risk for injury. The epidemiology of skiing-related injuries has been described, which has led to the identification of risk factors for specific types of injuries.

Evidence Acquisition: Pertinent literature from peer-reviewed publications was reviewed.

Study Design: Clinical review.

Level of Evidence: Level 5.

Results: The adoption of international standards for ski-boot-binding systems has changed the profile of skiing-related injuries over time, as has the widespread use of helmets. An understanding of mechanisms of injury, risk factors, and preventative measures may decrease the incidence of skiing-related injuries.

Conclusion: Advances in standards for skiing equipment have been effective at decreasing both the frequency and severity of skiing-related injuries, but additional efforts are required to improve the safety of the sport.

Keywords: alpine skiing; injury; anterior cruciate ligament (ACL); epidemiology; head injury

METHODS

A comprehensive review of the published literature from 1985 to 2018 pertaining to alpine skiing injuries was performed. Pertinent articles were identified from PubMed, Ovid, and Google Scholar using the search terms ski, alpine skiing, injury, and epidemiology. Additional studies, including studies regarding specific skiing injuries, were identified from the references of relevant papers. Studies focused on primarily snowboarding injuries or on alpine ski racing injuries were excluded.

EPIDEMIOLOGY OF ALPINE SKIING INJURIES

Multiple studies on the epidemiology of alpine skiing injuries have been published (Table 1).

Age

Table 1 presents data from studies reporting on a total of 64,667 injuries. The mean age of injured patients evaluated in these studies ranged from 24 to 35.4 years, with an overall mean age of 30.3 years. In 2 studies, the populations at greatest risk for injury were children and adolescents and...
adults older than 50 years; however, in another study, there was no greater risk of injury in adults older than 55 years, with the exception of tibial plateau fractures. Because of the varying ways that data on the age of injured patients are presented, it is difficult to draw any conclusions about the effect of age on the overall risk of injury. Moreover, the age of the recreational skiing population is rising, further complicating analysis of age and skiing-related injuries.

Sex

Among reported injuries, there was a higher percentage of males injured than females (Table 1). Knee injuries, especially ACL sprains, are more common among females than males, while males are more likely to sustain fractures. Male sex is associated with greater risk-taking behavior, which may lead to a greater number of injuries with greater severity.

Injury Site

Most injuries occur to the lower extremity, with reports ranging from 43% to 77% of all alpine skiing–related injuries. This is followed by injuries to the upper extremity, which account for approximately 14% of injuries and primarily involve the thumb and shoulder. Head and neck injuries account for 13% of all injuries. This data is summarized in Table 2.

Specific locations of injury are summarized in Table 3. The knee is the most common site of injury, with reports ranging from 27% to 41% of all injuries. Reports of the second most common site of injury vary widely between studies. Common sites of injury include the shoulder, hand/wrist, and the lower leg.

Injury Type and Severity

The most common type of knee injuries are ligamentous sprains involving the ACL and/or medial collateral ligament (MCL). Other common specific diagnoses include head contusions and concussions, glenohumeral dislocations, and sprains to the wrist and hand. A summary of the most commonly reported diagnoses is presented in Table 4. One limitation of many of the reviewed studies is that the ability to diagnose accurately is limited by the lack of imaging available at mountainside clinics, and it is therefore difficult to obtain a complete understanding of the injury type and severity. Additionally, data have been collected on severe injuries. These injuries were beyond the scope of injuries treated at mountainside clinics and were treated at an emergency department. Data from the National Trauma Data Bank of the United States from 2007 through 2014 identified 1353 patients with severe (defined as Injury Severity Score [ISS] >15) skiing-related injuries in the United

Table 1. Ski injury epidemiology studies

| Study                  | Year(s) of Study   | Country   | Sport                        | No. of Injuries | Mean Age, y | % Male/% Female |
|-----------------------|--------------------|-----------|------------------------------|-----------------|-------------|-----------------|
| Coury et al⁵          | 1995-2000, 2009-2010 | USA       | Skiing                      | 1196            | 35.4        | 48/52           |
| Patrick et al⁴²        | 1996               | USA       | Skiing                      | 124             | 34          | NR              |
| Patrick et al⁴²        | 2013               | USA       | Skiing                      | 112             | 34          | NR              |
| Kim et al⁴⁷           | 1988-2006          | USA       | Skiing                      | 9465            | 30          | 55.5/44.5       |
| Stenroos and Handolin⁶³| 2006-2012          | Finland   | Skiing                      | 2911            | 24          | 57/43           |
| Langran and Selvaraj²⁹ | 1999-2000          | Scotland  | Skiing                      | 440             |             | 51.8/48.2       |
| Sacco et al⁵²          | 1990-1996          | USA       | Skiing                      | 238             | 29          | 66/34           |
| Davidson and Laliotis⁷ | 1983-1992          | USA       | Skiing                      | 24,340          | 27.9        | 50/50           |
| Rust et al⁴¹          | 2006-2008          | USA       | Skiing                      | 811             | 39          | 55.2/44.8       |
| Sulheim et al⁴⁶        | 2002               | Norway    | Skiing                      | 3277            |             | 60/40           |
| Ruedl et al⁴⁹         | 2010-2011          | Austria   | Skiing, snowboarding, telemark | 2326          | 36.2        | 51.3/48.7       |
| Burtscher et al⁴      | 1997-1998          | Austria   | Skiing                      | 17,914          | 33          | 48/52           |
| Burtscher et al⁴      | 2002-2003          | Austria   | Skiing                      | 2433            | 32          | 50/50           |

NR, not reported.
States.8 The median age reported was 38 years, and 78.9% of injuries occurred in males. These results were consistent with the results reported by Weber et al69 in their analysis of a trauma database including Germany, Austria, Switzerland, Finland, Slovenia, Belgium, Luxembourg, and the Netherlands. That study reported 174 skiers with major trauma (ISS > 21), with a mean age of 39.2 years and 78.2% of injuries occurring in males. Despite the fact that younger age is associated with increased risk-taking behavior,70 the mean reported age of skiers with severe injuries was higher than the mean reported age of those with mild to moderate injuries.4,5,7,27,42,49,51,52,63,66

Risk factors for skiing injuries that have been identified include age, sex, skiing experience level, self-assessed skill level, body mass index, and trail difficulty.2,5,7,42,49,51 However, these risk factors vary widely between studies.

### Trends Over Time
With advances in equipment and increased helmet use, the trend has been toward a decreasing number of skiing-related injuries of all types.18,23,25,50,58 However, the number of traumatic fatalities has remained constant.15,64 The types of injuries sustained have changed with time, most notably with a

#### Table 2. Injuries to each region

| Study            | Head/Neck Injuries, n (%) | Thorax/Abdomen Injuries, n (%) | Spine Injuries, n (%) | Upper Extremity Injuries, n (%) | Lower Extremity Injuries, n (%) | Total Injuries, n |
|------------------|----------------------------|-------------------------------|----------------------|--------------------------------|--------------------------------|------------------|
| Sulheim et al66  | 642 (19.6)                 | 92 (2.8)                      | 167 (5.1)           | 888 (27.1)                     | 1484 (45.3)                     | 3277             |
| Stenroos and Handolin63 | 437 (15)                 | 87 (3)                        | 146 (5)             | 990 (34)                       | 1252 (43)                       | 2911             |
| Ruedl et al49    | 288 (12.4)                 | 56 (2.4)                      | 67 (2.9)            | 637 (27.4)                     | 1277 (54.9)                     | 2326             |
| Sacco et al52    | 40 (17)                    | 43 (18)                       | 26 (11)             | 17 (7)                         | 183 (77)                        | 238              |
| Davidson and Laliotis7 | 3894 (16)             | 1460 (6)                      | 730 (3)             | 4868 (20)                      | 12,657 (52)                     | 24,340           |
| Rust et al51     | 89 (11)                    | 97 (12)                       | NR                  | 251 (31)                       | 414 (51)                        | 811              |
| Burtscher et al4 | 1648 (8.1)                 | 692 (3.4)                     | NR                  | NR                             | 11,130 (54.7)                   | 20,347           |
| Total            | 7038 (13)                  | 2527 (5)                      | 1136 (2)            | 7651 (14)                      | 28,397 (52)                     | 54,250           |

NR, not reported.

#### Table 3. Most common injury sites and percentage of injuries per study occurring at each site

| Study                | First % | Second % | Third % | Fourth % | Fifth % |
|----------------------|---------|----------|---------|----------|---------|
| Coury et al5         | Knee 35 | Shoulder 12 | Thumb 8 |          |         |
| Patrick et al42      | Knee 27 | Wrist/hand 20 | Shoulder/arm 20 | Foot/ankle 13 | Head 10 |
| Langran and Selvaraj29 | Knee 36.7 | Head/face 14.2 | Ankle/calf 8.1 | Thumb 7.1 | Shoulder 6.9 |
| Davidson and Laliotis7 | Knee 34 | Leg 9 | Head 9 | Shoulder 8 | Face 6 |
| Sulheim et al66      | Knee 27.3 | Head 17.9 | Shoulder 11.2 | Lower leg 8.9 | Hand 8.8 |
| Ruedl et al49        | Knee 35.9 | Shoulder 16.8 | Lower leg 13 | Head/neck 12.4 | Arm 10.3 |
| Burtscher et al4     | Knee 40.8 | Shoulder/back 16.3 | Arm 12.4 | Lower leg 8.3 | Head 8.1 |
| Urabe67              | Knee 16.8 | Shoulder 12.8 | Lower leg 10.8 | Ankle 10.0 | Head 9.6 |
decreased incidence of tibial fractures and an increased incidence of ACL injuries of the knee.\textsuperscript{23-25,27,62}

\section*{SPECIFIC INJURIES}

\subsection*{Head and Neck}

Brain injuries are the most common severe traumatic injury associated with skiing\textsuperscript{8,9} and the injury with the highest fatality prevalence.\textsuperscript{47,72} Disturbances in consciousness or signs of concussion have been reported in 22\% to 42\% of skiing-related head injuries.\textsuperscript{15,33} Notably, the incidence of head injuries and of potentially serious head injuries (PSHIs) has decreased with the widespread use of helmets.\textsuperscript{55} The most frequent cause of head injury is falling, followed by collisions with an object other than the skiing surface, which cause 23.1\% to 42.5\% of head injuries.\textsuperscript{15,16}

Concussions have been reported as the most common head injury,\textsuperscript{51} although Coury et al\textsuperscript{5} reported that open wounds of the scalp and face were the most common. The inclusion of lacerations and open wounds is highly variable among studies.

\subsection*{Upper Extremity}

While injuries to the upper extremity are more common in snowboarders than in skiers,\textsuperscript{27,34} they still make up 14\% of skiing injuries (see Table 2). The most common injuries involving the shoulder include rotator cuff injury, anterior glenohumeral dislocations and subluxations, acromioclavicular sprains, proximal humeral fractures, and clavicular fractures.\textsuperscript{26,35,41} Injuries to the elbow and fractures of the mid- and distal humerus, radius, and ulna are uncommon.\textsuperscript{2,5,26-28,35,51,66}

Injuries to the wrist include fractures and sprains, and injuries to the hand include fractures of the bones of the hand and digits.\textsuperscript{27,42} By far the most common is injury to the ulnar collateral ligament (UCL) of the thumb metacarpophalangeal joint—commonly known as skier’s thumb (Figure 1).\textsuperscript{5,27,75} In fact, skier’s thumb may be the most common ski injury, but it is frequently underreported due to the patients’ perception that this injury is not serious.\textsuperscript{19} Skier’s thumb is most commonly caused by a fall on an outstretched hand with the thumb abducted because the skier still grips the pole as the hand strikes the snow surface.\textsuperscript{21,46,73} Hard-packed snow or icy conditions aggravate this situation.\textsuperscript{73} Snowboarders experience this type of injury very infrequently, which implicates poles as the probable cause of this injury among skiers.\textsuperscript{27}

The most common mechanisms of injury to the shoulder are axial loading and resistance to forced abduction of the humerus and a direct blow to the shoulder.\textsuperscript{20,35} Direct blows to the shoulder and axial loading are more likely to cause fracture of the clavicle or acromioclavicular sprain.\textsuperscript{35} Resistance to forced abduction is the most common mechanism of rotator cuff injury, and forced abduction with external rotation is the most common mechanism of anterior shoulder dislocation based on patient description of injury events; however, the exact proportion of injuries caused by these mechanisms is unclear.\textsuperscript{28} Posterior dislocations of the shoulder are infrequent, accounting for 0.4\% of glenohumeral dislocations.\textsuperscript{41}

In a case-control study evaluating 318 humeral fractures over the course of 34 ski seasons, Bissell et al\textsuperscript{2} reported that helmet use and sex were not risk factors for humeral fractures, while greater skill, increased age, and less frequent falling were all factors associated with the injured population.

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\begin{table}[h]
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\begin{tabular}{|l|c|c|c|c|c|c|c|}
\hline
\textbf{Study} & \textbf{Country} & \textbf{n} & \textbf{First} & \textbf{Second} & \textbf{Third} & \textbf{Fourth} & \textbf{Fifth} & \textbf{Sixth} \\
\hline
Coury et al\textsuperscript{5} & USA & 1196 & Knee ligament sprain/strain & Internal derangement of knee & Wrist and hand sprain/strain & Open wound of scalp/face & Shoulder dislocation & Tibia/fibula fracture \\
\hline
Rust et al\textsuperscript{21} & USA & 811 & ACL tear & Knee sprain & Closed head injury & Shoulder dislocation & Gastrocnemius tear & Tibial plateau fracture \\
\hline
Kim et al\textsuperscript{27} & USA & 9465 & ACL tear & MCL tear & MCP-UCL injury of thumb & Shoulder soft tissue & Leg contusion & Upper body laceration \\
\hline
Langran and Selvaraj\textsuperscript{29} & Scotland & 440 & Knee sprain & Head/face laceration & Tibia/fibula fracture & Thumb sprain & NR & NR \\
\hline
Sulheim et al\textsuperscript{66} & Norway & 3189\textsuperscript{a} & Head contusion & Knee sprain & Wrist fracture & Back contusion & Knee contusion & Head wound \\
\hline
Johnson et al\textsuperscript{24} & USA & 20,045 & Knee sprain & MCP-UCL injury of thumb & Laceration & Soft tissue shoulder injury & Knee contusion & Upper extremity contusion \\
\hline
\end{tabular}
\caption{Most common injuries}
\end{table}

\textsuperscript{a}Only 3189 of 3277 subjects had information available on diagnosis.

ACL, anterior cruciate ligament; MCL, medial collateral ligament; MCP, metacarpophalangeal; NR, not reported; UCL, ulnar collateral ligament.
Lower Extremity

Injuries of the lower extremity are the most common alpine skiing–related injuries.\textsuperscript{3,7,45,51,65,66} Ligamentous injury to the knee is by far the most common, with either the MCL or ACL described as the most commonly injured ligament, accounting for 10% to 33% of all skiing-related injuries (Table 4).\textsuperscript{5,27,29,51,66} Additionally, fractures of the tibia are still quite common, accounting for up to 6.4% of injuries (Table 4). More infrequently seen injuries of the lower extremity include partial gastrocnemius tears due to a failure of the binding to release in a forward fall, ankle sprains and fractures, and lacerations caused by the ski edge.

**ACL**

Between 1992 and 2000, the incidence of grade III ACL sprains increased,\textsuperscript{24} and while it has since decreased,\textsuperscript{25} the incidence of ACL injuries remains high, with the incidence reported as 0.23 ACL injuries per thousand skier days.\textsuperscript{24,25} This rate is comparable with the calculated 0.2 ACL tears per 1000 athlete-exposures (AEs) in female soccer players and higher than the 0.09 ACL tears per 1000 AEs in male soccer players.\textsuperscript{37} A great deal of research has been dedicated to identifying risk factors for and mechanisms of injury. Risk factors for ACL injury that have been identified include female sex,\textsuperscript{31,54,71} lower core strength,\textsuperscript{45} and nondominant leg.\textsuperscript{49} Moreover, Csapo et al\textsuperscript{6} demonstrated that exposure to cold decreases the rate of force development of the knee flexor muscles, decreasing the capacity to counter extension and anterior shear, and therefore increasing the risk of ACL injury.

**Mechanisms of ACL Injury.** While ACL injuries due to collisions with stationary objects or with other skiers do occur, they account for only 2% of ACL injuries.\textsuperscript{54} While a variety of mechanisms have been described, 3 major noncontact mechanisms have been identified. The valgus-external rotation mechanism has been reported as the most common\textsuperscript{20,66} and involves a fall forward with the inner edge of the front of the ski catching in the snow. This causes immediate abduction and external rotation of the tibia, generating a valgus force about the knee with the ski acting as a lever to maximize torque.\textsuperscript{20,66} This mechanism may produce a concomitant MCL sprain.\textsuperscript{44} In other studies, the “phantom foot” mechanism (Figure 2) has been identified as the most common cause of ACL injury.\textsuperscript{14} In this mechanism, “the uphill arm is back and the skier is off balance to the rear with the hips below the knees. The uphill ski is unweighted, with all the weight on the inside edge of the downhill ski tail and the upper body is generally facing the downhill ski.”\textsuperscript{14}

This causes internal rotation of the downhill knee.\textsuperscript{9,14,20,53} Finally, a boot-induced mechanism has been described and involves an anterior force applied to the tibia by the boot top that occurs while landing from a jump on a fully-extended knee, which results in an anterior translation of the tibia relative to the femur, rupturing the ACL (Figure 3).\textsuperscript{14,20,86}

Shea et al\textsuperscript{54} examined the frequency of these mechanisms in a study in which patients selected an option on a survey that most closely described their own injury mechanism. It is important to note that the study design relies on patient recall of the injury event, which is not reliable.\textsuperscript{54} They found that valgus-external rotation was the most common (32.9%), followed by phantom foot (22.5%), hyperextension (19.0%),...
boot-induced (7.8%), collision (2.2%), and other (15.6%). They also observed an increased risk for the phantom foot mechanism in the 30- to 40-year age group.

Sex-Based Differences. Data from other sports have shown that females are at increased risk for ACL injury compared with males, and the same has been observed in skiing injuries. While Shea et al. did note a significantly greater prevalence of ACL injuries in females than in males, analysis of self-reported mechanisms of injury (including phantom foot, valgus-external rotation, boot-induced, and hyperextension) did not indicate an increased risk for any mechanism of injury between males and females.

Tibial Fractures

Tibial fractures once constituted greater than 20% of all skiing-related injuries, and while the incidence of fractures has decreased after the adoption of International Organization for Standardization (ISO) and ASTM International standard shop practices, they are still among the most common injuries to the lower leg. Skiers who are beginners, children, or adolescents are at increased risk for lower leg fractures, with children younger than 10 years having a 9 times greater risk than skiers older than 20 years. Additionally, Stenroos et al. conducted a retrospective study of patients presenting to 4 trauma centers in Finland with tibial fractures sustained while skiing. They reported that the most common fracture in adult skiers was a fracture of the tibial shaft (63%), followed by a fracture of the proximal tibia (27%), and a fracture of the distal tibia (10%). They also found that adults were significantly more likely to sustain proximal tibial fractures than children and that the most common mechanism of fracture was a fall on the snow surface.

Tibial Shaft Fractures. Tibial shaft fractures are the most common type of lower extremity fractures sustained by skiers. The frequency of these fractures has significantly decreased with the development of better boots and bindings, as well as the adoption of international standards for equipment and equipment testing, including standards for ski-boot-binding (SBB) system compatibility. Bindings not releasing during falls has been identified as a major cause of tibial shaft fractures.

Tibial Plateau Fractures. While tibial shaft fractures are more common, the incidence of tibial plateau fractures is rising. It is hypothesized that this rise in incidence is due to the increasing age of the skiing population, as age is a risk factor.
for tibial plateau fractures. Additional risk factors include female sex, less frequent falling, and greater self-reported level of experience. In a study using the AO (Arbeitsgemeinschaft fur Osteosynthefragen) classification system to analyze 188 patients with proximal tibial fractures, 145 patients had intra-articular involvement, with 96 classified as type B fractures and 49 as type C fractures. The risk factors for type C fractures as compared with type A were increased age, greater body mass index, icy snow conditions, higher speed, and greater skiing skill.

**FATALITIES**

While fatalities due to skiing and snowboard–related accidents are extremely uncommon—it is estimated that just 0.01% of all skiing-related injuries are life-threatening—approximately 38 fatalities occur each ski season in the United States, equaling 0.67 fatalities per million skier visits. This rate has remained constant over several decades. This report excludes deaths due to medical problems, so all fatalities reported were due to traumatic injury. In a study that did include these fatalities, acute cardiac events accounted for more than half of all deaths. Of the fatalities due to injury, brain trauma was the most common cause of death, and the injuries were mostly sustained in males due to a collision with objects other than the snow surface.

**SKI EQUIPMENT**

**Helmets**

The use of helmets has been widely advocated, and the proportion of skiers wearing helmets has significantly increased in recent years to exceed 80% as of 2017-2018. While many of the injuries prevented by helmet use were minor, such as lacerations and contusions, there is evidence to support the reduction of PSHI with helmet use. However, there has been conflicting data surrounding the risk reduction of head injuries with helmet use, including widespread concerns that helmet use may lead to an increase in risk-taking behavior and increased risk of neck injury. Russell et al performed a meta-analysis of 12 studies analyzing the effect of helmets on head and neck injuries and found that skiers wearing helmets were significantly less likely to sustain a head injury and had no associated increased risk of neck injury. Haider et al confirmed these results with a systematic review of helmet use and relation to injury. They found that helmets do reduce prevalence and severity of head injury, with no apparent increase in risky behavior and in neck injury.

The incidence of fatalities has remained constant even as helmet use has widely increased. This is likely because the accident scenarios that result in fatality exceed the protective capacity of helmets, and even if fatal head injury is prevented, the skier sustains other injuries capable of causing death.

Overall, the data indicate that increased helmet use most likely reduces the risk of minor and moderate head injuries and PSHI but does not decrease the overall incidence of fatalities. There is no indication that there are any adverse effects of widespread helmet use.

**Ski-Boot-Binding Systems**

SBB systems have been designed and optimized to protect the tibia and have reduced the incidence of tibial shaft fractures, boot-top contusions, and ankle injuries. Advancements in SBB systems in recent decades include the following: reduction of friction in boot to binding interface and boot to ski interface, standardization of SBB interfaces, stiffening of boots at the ankle to limit dorsiflexion and allow the system to transmit loads at the heel, and implementation of ISO standard shop practices that include mandatory inspection and testing of equipment. ISO and ASTM standards are similar to each other and exist to ensure optimal equipment function, including binding release. The inappropriate failure of bindings to release has been identified as one of the main causes of skiing-related lower leg injuries. In fact, it has been shown that greater than 75% of equipment associated with lower leg injuries does not meet ISO standards. A randomized controlled trial comparing a group of skiers who had their bindings checked and adjusted after standard shop practices with a control group of skiers with no intervention reported a decreased risk of lower extremity equipment-related injuries in the experimental group.

While advances in SBB systems have succeeded in reducing the incidence of injuries to the lower leg and ankle, these changes were not designed to protect the knee from sprains. Therefore, it is possible to experience forces and moments that will result in an ACL injury without causing a normally functioning binding to release.

**Ski Poles**

Ski poles may act as a lever to amplify forced abduction of the thumb when the skier’s hand makes contact with the snow surface while grasping the pole during a fall. There is evidence that ski pole grips with an anterior protective bow can prevent the catching of the thumb in the snow in a sudden fall. However, these grips are no longer made. Ideally, the skier should discard the pole prior to hitting the ground to avoid a skier’s thumb injury. As stated earlier, thumb UCL injuries are very uncommon in snowboarders.

**INJURY PREVENTION**

Injury prevention has focused on international standards for SBB systems and the promotion of helmet use. The National Ski Areas Association has been very active in this regard, with campaigns such as “Lids on Kids” and “Heads Up,” as well as local efforts such as “PHAT” (Protect your Head at All Times). These programs have been highly effective, with an increase in helmet use for 14 consecutive years. Moreover, an estimated 80% of all skiers and snowboarders and 89% of all minors wore helmets in the 2016-2017 ski season.

While the majority of injury prevention measures have centered on equipment, injury prevention educational programs have also been implemented in a limited capacity. Vermont Ski Safety Equipment has been promoting ski injury prevention through injury awareness training since 1971. Their website
advocates methods for avoiding ACL injury related to both the boot-induced mechanism and the phantom foot mechanism. The tips include improved awareness of situations in which the skier is at greater risk for ACL injury and methods for falling safely and for regaining control. This is different from formal ski lessons, which have not been shown to reduce the likelihood of injury.

The effectiveness of this awareness training was studied in a matched-cohort study of ski-area employees (ski instructors and ski patrollers). In this study, employees at 20 ski areas were exposed to an ACL injury awareness training program designed to educate participants on the situations that lead to ACL injury and how to respond appropriately. They reported a 62% decline in severe knee sprains in the group exposed to the injury prevention program, while no decline was observed in the control group of ski area employees who did not receive awareness training at 22 other ski areas. This data demonstrates that awareness training is the only proven intervention to reduce the incidence of severe knee injuries, although the participants were ski-area employees and a similar study has not been performed in the general population. More data is necessary to determine the actual effectiveness of awareness training on ACL injury prevention among recreational skiers.

**CONCLUSION**

Skiing, while a very popular sport, carries considerable risk for injury. Steps have been taken in recent decades to reduce the risk of injuries, which include advances in standards for equipment and increased education about safe practices. These advances have been effective at decreasing both the frequency and severity of skiing-related injuries, but additional efforts are required to improve the safety of the sport.

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