FIS Alpine Skiing Injury Surveillance

A Synthesis of Injury Data from University of Innsbruck (2017–2024)

About the Data

This report draws on injury surveillance data collected through the FIS Single Penalty system. This is when athletes sustain injuries severe enough to prevent competition for **at least 8 months**. These applications therefore form the basis of the analysis.

It is important to understand that this surveillance system captures only the **most severe injuries**. Minor sprains, bruises, and moderate injuries that allow return within a season are not included. The data therefore represent the tip of the injury iceberg, but arguably the most consequential tip: the most severe injuries that demand the longest rehabilitation periods.

Time Period and Volume

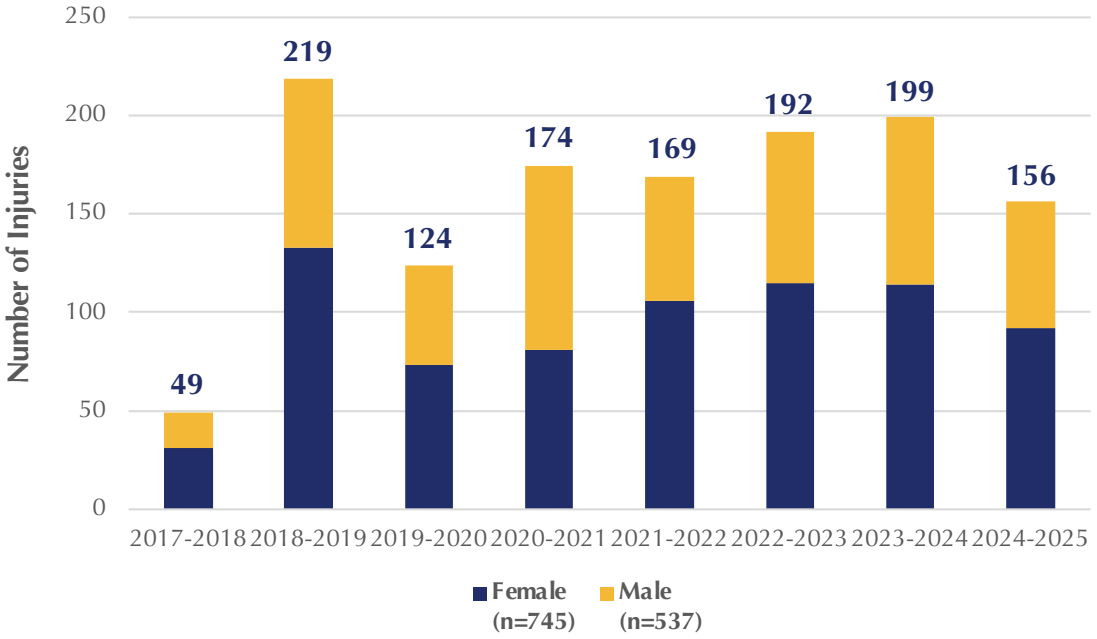
Data spans five competition seasons from **2017-2018 to 2023-2024 seasons** (seasons running from 1st May to 30th April). Across this period, **more than 1,090** Single Penalty applications were submitted, of which more than **1121 were skiing-related injuries.** It should be noted that there are more injuries than applications as some athletes had injuries including more than one body part. The remainder includes off-snow injuries, medical illness, military/study absences, and pregnancy.

Geographic Distribution

Injury applications come from **43 nations**, reflecting the global reach of competitive alpine skiing. The distribution largely mirrors the traditional alpine skiing powerhouses, with Austria (15.2%), Italy (14.6%), USA (11.0%) Switzerland (10.7%), and Sweden (7.7%) comprising the top five nations. Together, these five countries account for over 59% of all applications.

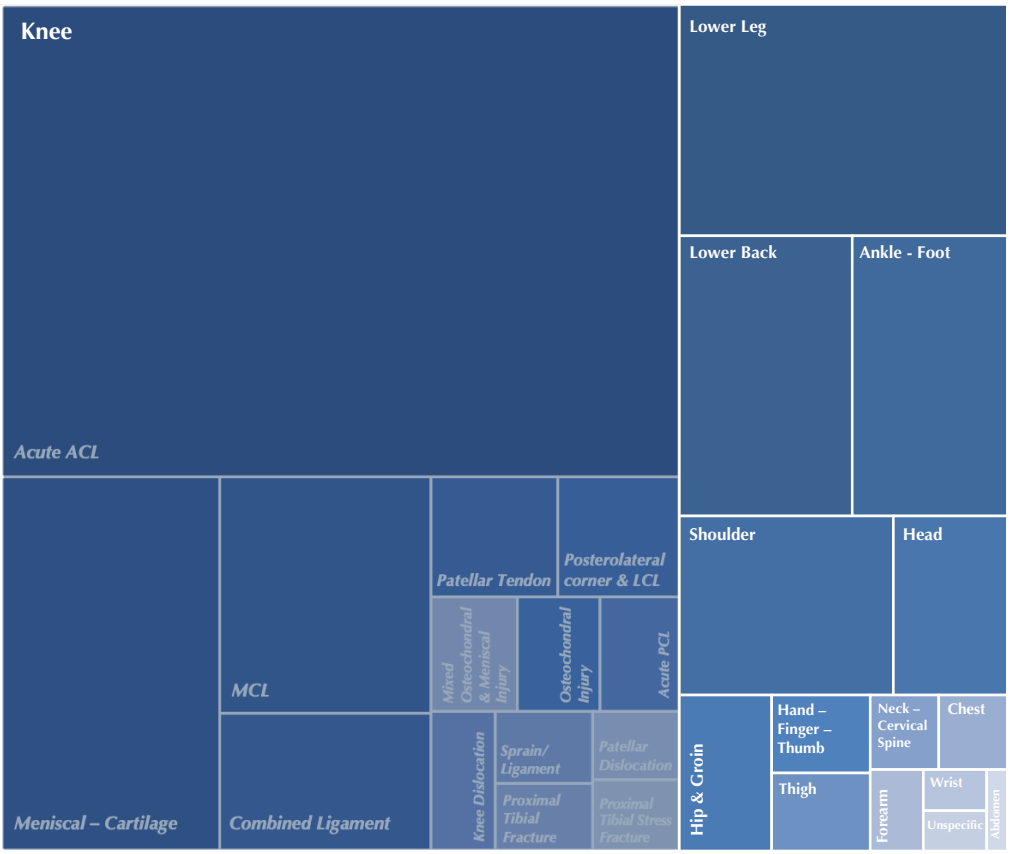
Sex Differences

Female athletes consistently represent a higher proportion (66%) of severe injury cases compared to males. For knee injuries specifically, females account for 58% of cases, showing a consistent seasonal pattern over time.



The Knee Dominates the Injury Burden

The knee is the most vulnerable anatomical region for severe time-loss injuries. Across the combined seasons, knee injuries account for **67%** of all skiing-related Single Penalty applications. Other injury regions trail considerably behind: lower leg and lumbar spine injuries account for approximately 9% and 6% of cases, followed by ankle and foot injuries (5%), and shoulder injuries (4.5%). Of lower leg injuries, almost **65%** of them are **midshaft tibial fractures with or without fibula fracture**. **Ankle syndesmosis sprains, tibia and fibula fractures at the ankle joint and ankle fractures** account for **53.6%** of the ankle and foot injuries. At the shoulder, **48.2%** of the injured structures are **shoulder dislocations**, whereas 14.8% are clavicular fractures. Of the head injuries, **80.7%** are reported as **concussion** (or brain injuries).



Proportional view of injury distribution

ACL Injuries: The Core Challenge

Within knee injuries, the **anterior cruciate ligament (ACL)** represents the dominant structure affected, accounting for **55%** of all knee injuries, making it by far the most common specific diagnosis. Other notable knee structures affected include meniscal cartilage injuries (13%), MCL injuries (8%), and combined ligament injuries (4%). A long tail of less frequent diagnoses includes patellar tendon and LCL injuries, osteochondral lesions, and dislocations and tibial fractures.

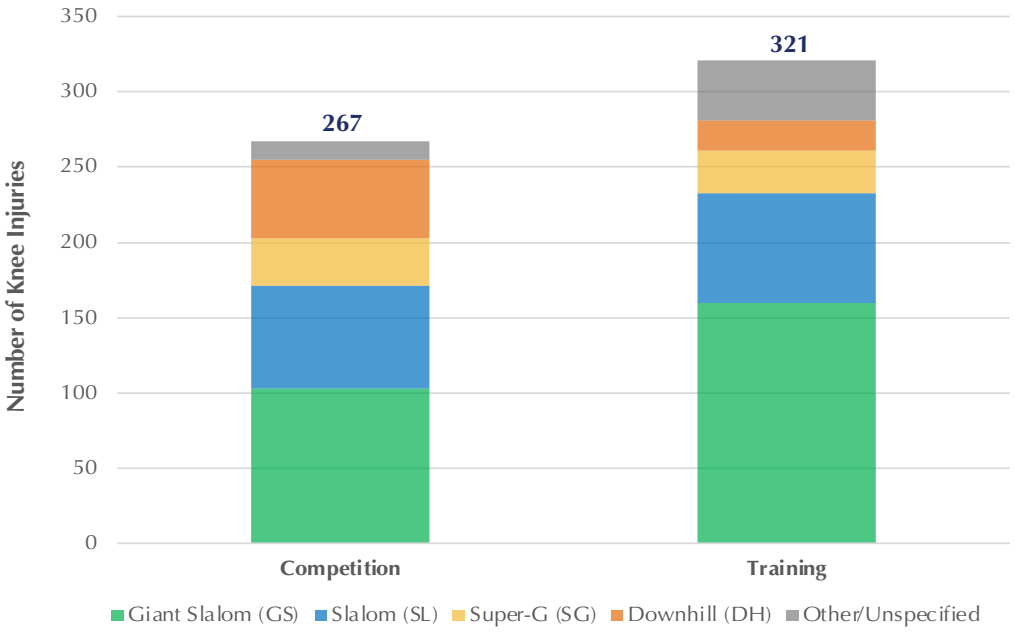
Where and When Knee Injuries Happen

Discipline Risk

Giant Slalom consistently emerges as the highest-risk discipline, contributing on **45%** of knee injuries, followed by **Slalom** at approximately **25%**, with speed events (**Super-G and Downhill**) collectively accounting for **22%**.

The "Hidden Risk" of Training

A critical finding: **training environments appear at least as risky as competition**. 55% of all knee injuries occurred during training versus 45% in competition. However, Downhill is the only discipline where competition injuries exceed training injuries.

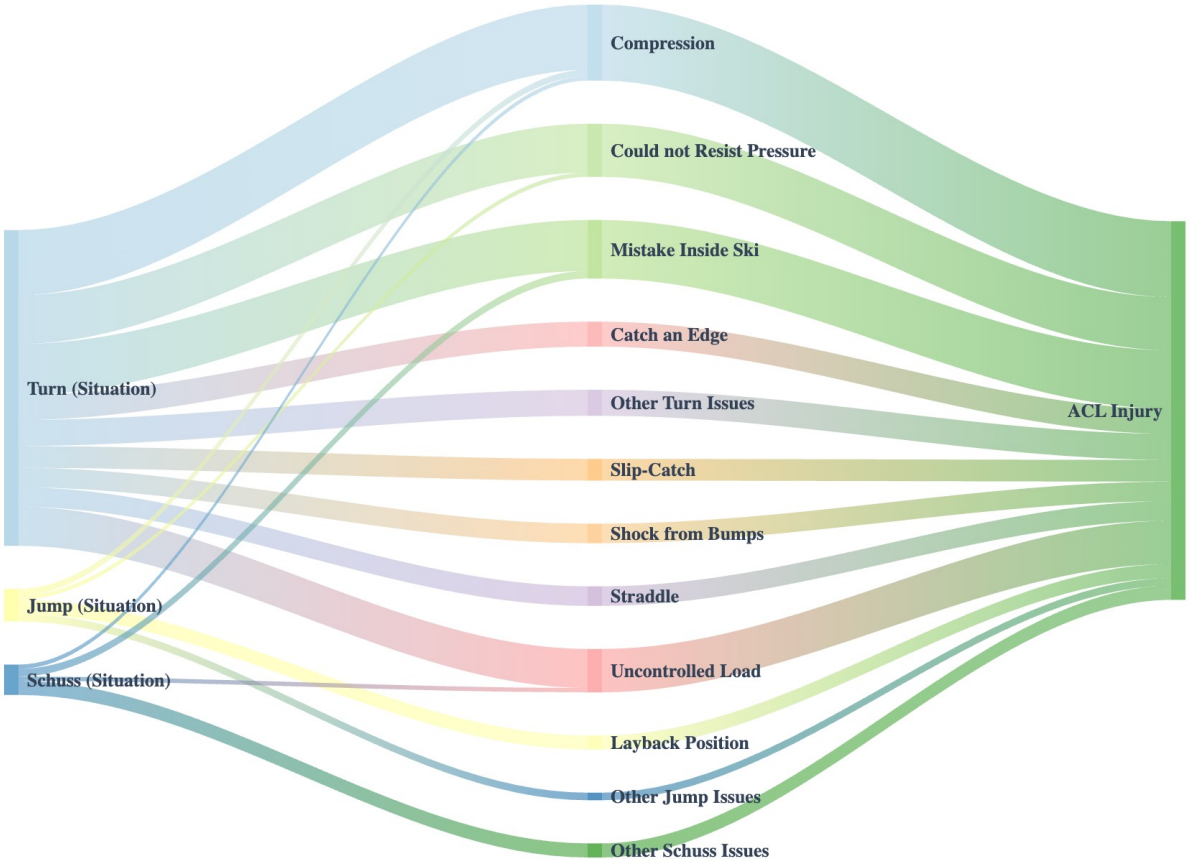


How Knee Injuries Happen: Phases of Skiing & Mechanism Patterns

The most frequently reported injury triggers form a consistent cluster across seasons. Together, these four mechanisms account for roughly **60% of cases** where triggers were identified:

- Compression forces
- Inability to resist accumulated stress/pressure
- Inside ski errors
- Uncontrolled loading with self-steering difficulties

Across ACL injuries, the **turning phase** is the primary origin (around **75%**). The main culprit is not a fall, but compressions or mistakes on the inside ski. **Jump landings and schuss** sections each contribute smaller proportions (approximately 8% each), with traverse, finish, and start phases making up the remainder. For injuries occurring during **jumps** specifically, the pattern differs. Layback position errors and poor landings emerge as the primary triggers, highlighting the distinct biomechanical demands of aerial phases.



Minor categories are grouped for readability

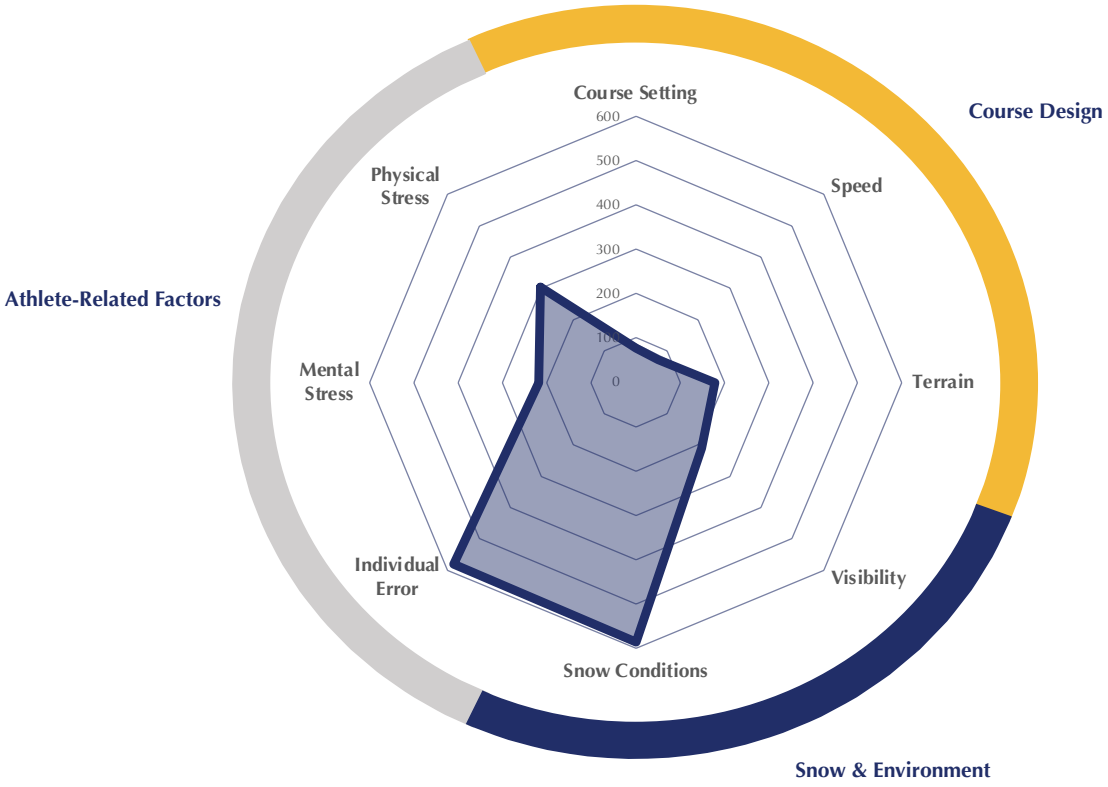
Falls characterise approximately **75%** of ACL injury events. Injuries occur during the fall more commonly than before it, with **forward and backward twisting** falls occurring at roughly equal frequencies. In addition, a meaningful portion of cases (approximately **15%**) are recorded as **no fall.**

Environmental Context: What the Conditions Tell

Contrary to the assumption that poor conditions drive injury rates, most severe accidents occur under **good conditions**: clear visibility (+80% of cases), minimal wind, and groomed slopes. **Mixed and artificial snow** surfaces predominate over natural snow; injuries being frequently associated with aggressive or icy/firm surfaces.

Contributing Factors for ACL injury: What Athletes and Teams Report

When assessing influential factors, athletes and teams consistently rate **individual error and snow conditions** (**26% each**) on top of several factors. While **physical and mental stress** receive some attribution (**14%** and **10%**, respectively), course design factors (e.g., course setting, speed and terrain) are less commonly cited as major contributors (14%).



A note of caution: these are **self-reported influential factors**, and the questionnaire design included default responses. Therefore, the retrospective attribution of causation should be interpreted carefully.

The Typical Injury Profile

Data over seasons suggest the **typical** severe alpine skiing injury to be an ACL rupture sustained by a female athlete during a Giant Slalom turn on aggressive or firm snow with good visibility. The mechanism is predominantly non-contact or indirect contact (compression or catching an edge), driven by high biomechanical loads that exceed the athlete's capacity to resist forces during a turn.