

What Athletes Need to Know for Safe Jumping in Downhill Skiing

While much of the technical work behind jump safety is done by course designers and simulation engineers, an **athlete's behaviour before, during, and after a jump is a critical variable in determining their safety**. The shape of a jump dictates much of what happens in the air, but how an athlete manages take-off, flight, and landing remains the factor they can most directly control.

Execute an Active Down Motion at Take-Off

The athlete's movement at the point of departure is the most critical factor they can control to influence their flight trajectory and landing impact.

- Perform a Strong Flexion**
 - To reduce the Equivalent Landing Height (ELH), the measure of impact intensity, athletes should perform a strong downward flexion movement (an **"active down motion"**) during take-off.
 - In practical terms, a more **"crouched" position** at the time of take-off helps manage the intensity of the landing impact.
- Manage the Take-Off Angle**
 - Simulation data shows that a **negative active take-off angle (approximately -3°** , corresponding to a strong flexion/downward motion) significantly reduces ELH compared to a neutral (0°) or upward ($+1^\circ$) motion.
 - This difference in angle has a direct, measurable effect on **landing forces**.
- Counteract Speed Sensitivity**
 - This **active downward motion** is especially vital on jumps that are **highly sensitive to take-off speed**.
 - A slight increase in velocity can drastically change the flight trajectory and lead to dangerously high landing loads.

Anticipate Rotation and Trajectory During Flight

The **physical shape of the jump** dictates what the athlete will experience while in the air. Athletes must be aware of these forces and prepared to manage them.

- Anticipate Rotation**
- If a jump has a concave take-off (where the inclination increases, for example, 1° every 2 metres), it will naturally induce rotation during the flight phase.
 - On a 40-metre jump with a concave profile, an athlete may experience approximately 20° of rotation, which must be managed to ensure a controlled landing.

- Trajectory Sensitivity**
- Athletes should be aware that some jumps are highly sensitive to take-off speed.
 - Small increases in velocity can drastically change the flight trajectory and increase landing loads.
 - Understanding this sensitivity helps athletes approach the jump with appropriate speed management.

Aim for a Controlled, Upright Landing

The flight phase must conclude with a **specific body orientation to minimise the risk** of serious injury.

- Maintain Symmetry and Balance**
- Athletes should strive for a balanced landing, symmetrically on both legs, in an upright position.
 - Maintaining an upright posture at the end of the air phase is essential for safely absorbing impact energy and preventing the high landing loads that lead to severe injuries.

- Avoid a Back-Weighted Position**
- One of the most critical safety steps is ensuring the centre of mass is not too far back upon impact.

- Landing in a **back-weighted (backward) position is the second most common skiing situation for an ACL injury**. This makes avoiding a backward landing posture a non-negotiable priority.

Safety Simulation Limitation

- It is important to note that the predictive safety assessments provided by simulation software are only considered meaningful when the athlete achieves a balanced, upright landing.
- These models do not account for back-weighted landings, edge-catching, or three-dimensional movements, reinforcing why athlete technique at landing remains a critical safety factor beyond what design alone can control.

In summary, the most effective way for an athlete to manage a downhill jump is to:

- **Actively flex at take-off** to lower landing forces
- **Prepare for rotational forces** if the jump is concave
- **Land symmetrically and upright** while strictly avoiding being weighted toward the back of their skis

Jump design creates the conditions for safety, but the athlete's technique is what delivers it.