



Free Falling: Characteristics and Prevention of Injury and Death in Extreme Aerial Sports Tourists

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Abstract

Extreme aerial sports are unique in terms of their high degree of lethality, life-changing injuries, and the lack of experience required by amateur participants. As society gradually re-emerges from the pandemic, we are likely to witness a renewed interest in outdoor adventure activities, including extreme aerial sports such as bungee jumping and skydiving. Sports physicians, general practitioners and travel medicine advisers should have a basic familiarity with the risks associated with bungee jumping and skydiving. Serious injury can occur during bungee jumping when the safety harness fails, the cord elasticity is miscalculated, or the cord is not properly connected to the platform. There is a predominance of ocular injuries, especially retinal haemorrhage. More severe non-fatal injuries include facet joint dislocation with quadriplegia, carotid artery dissection, and non-fatal hanging. The majority of adverse skydiving incidents occur during the landing phase and most injuries involve the lower extremities. When travelling as a skydiving tourist, individuals should carry documents explaining each aspect of the equipment and a note for security personnel. Tourists should check if their insurance covers skydiving. Future research should investigate the experiences of aerial sports tourists, in relation to the level of preparation and safety measures applied to their jumps.

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The tragic death of a 27-year-old male skydiving instructor from Ireland following a skydiving accident in New Zealand in March 2019 highlighted the dangers inherent in this extreme sport.¹ The deceased was reported to have sustained extensive brain injuries having landed on his head during descent. Prior to the COVID-19 pandemic, international adventure sports tourism had reached new heights in terms of popularity and global appeal. As amateur sports participation gradually re-emerges from the pandemic, we are likely to witness a renewed interest in outdoor adventure activities, including extreme aerial sports such as bungee jumping and skydiving. This viewpoint article considers the safety profile of these sports from the perspective of the amateur enthusiast, and offers practical advice, which may benefit participants and their healthcare advisers.

Risks of Bungee Jumping

Normally, bungee jumps originate from bridges or cranes. New Zealand is considered the birthplace of the activity. China boasts the world's highest bungee at 233m from the Macau Tower. Popular European bungee sites include the

Europabrücke in Innsbruck, Austria (192m) and the Verzasca Dam at Ticino in Switzerland (220m). Serious injury can occur when the safety harness fails, the cord elasticity is miscalculated, or the cord has not been properly connected to the platform.

A study from New Zealand reported that bungee jumping had a mean client injury incidence rate per million participant hours of 477, making it the third most dangerous adventure sport, after snow sports (2229.3) and horse-riding (759.5).² Bentley et al recorded 54 bungee accident compensation scheme claims between June 2004 and July 2005 among New Zealand residents.³ The application of safety measures across the sector was inconsistent at that time although the situation has improved since then with the introduction of adventure activities regulations.

A recent literature review by Burchette et al reported a predominance of ocular injuries, especially retinal haemorrhage, followed by spinal trauma and pulmonary injuries (Table 1).⁴ More severe non-fatal injuries have included facet joint dislocation with quadriplegia, carotid artery dissection, and non-fatal hanging. The authors

Table 1. Common Injuries Associated With Extreme Aerial Sports Participation

Extreme Aerial Sport	Commonly Associated Injuries
Bungee jumping	Ocular injuries (especially retinal haemorrhage)
	Spinal trauma
	Pulmonary injuries
	Orthopaedic-related injuries
	Lower limb fractures (especially of the leg)
Skydiving	Lower limb contusions
	Ankle sprains
	Spinal trauma
	Upper limb fractures

suggested that the occurrence of femoral shaft fracture could be minimised by use of a body harness as a primary restraint and a more restrictive ankle harness that applies an even load through both legs. Most ocular bungee jumping injuries are subconjunctival in location, but retinal haemorrhages resulting from a sudden increase in intrathoracic and venous blood pressure in the upper body during the deceleration phase of the jump are of particular concern. Contraction of the abdominal wall muscles and breath-holding are also thought to contribute to these vascular pressure changes.⁵ Sight-threatening retinal detachment is also recognised as a risk of bungee jumping.⁶

McKay states that there is a culture of under-reporting of bungee jumping injuries and an overall lack of legislation.⁷ New Zealand and Costa Rica were among the first countries to issue formal, industry-specific regulations in recognition of the fact that self-regulation was insufficient to protect the industry and its clients. The author discusses how the bungee jumping industry is vulnerable to price competition, which could potentially lead to safety issues if operators ignore safety measures in an effort to remain competitive with rival companies.

Skydiving Injuries and Fatalities

Skydiving is performed as a recreational activity and a competitive extreme sport. According to British Skydiving, there are three ways to be introduced to the activity, viz. tandem jumps, static line jump-square canopy, and accelerated free-fall jumps. Tandem jumps require very little training and carry the lowest level of risk.⁸ In 2018, United States Parachute Association (USPA) members reported approximately 0.65 injuries per 1000 jumps. In

2020, USPA recorded 11 fatal skydiving accidents in the United States out of roughly 2.8 million jumps.⁹ British Skydiving conclude that tandem jumping is safest for novice jumpers. Between 2000 and 2019, they reported an overall fatality rate of 0.8 deaths per 100 000 jumps. From 2015 to 2019, the total injury rate reported was 0.5 injuries per 1000 jumps. There were no reported tandem fatalities in the U.K. in the last 20 years out of 753 444 reported jumps, with an injury rate of 0.9 out of 1000 jumps for students in the last 5 years. This is in stark contrast to a fatality rate for first time accelerated free fall jumps of 9.6 deaths per 100 000 jumps over 20 years.⁸

According to a Swedish study, the risk of an injury event was six times higher for students than for licenced skydivers. The majority of student incidents were miscalculations during wing parachute flight using fully operational equipment under normal conditions. Some 88% of incidents occurred during the landing phase and 51% of injuries involved the lower extremities.¹⁰ According to the USPA, between 3 and 3.5 million jumps are completed each year in the United States. Between 1993 and 1999, 241 recreational skydiving deaths were recorded in the United States, 31% of them due to incorrect procedures, 27% to defective landings, and 15% to mid-air collisions.¹¹ A recent prospective cohort study from France of over 500 000 skydivers over a 10-year period concluded that the highest risk of death occurred in experienced and male skydivers, with the highest risk of injuries reported in novice skydivers. The authors also pointed to the safety of tandem skydiving.¹²

Skydiving Tourism

Personal safety and security advice are core elements of pre-travel health consultations and as such travel medicine providers should convey an understanding of the specific risks associated with adventure sports activities, including extreme aerial sports.^{13,14} When travelling as a skydiving tourist, it is essential to consider the language spoken at the drop-zone before travelling. When travelling with their own skydiving equipment, tourists should carry documents explaining each aspect of the equipment and a note stating that security must not touch or open the container without them being present. The reserve handle, in particular, should be secured. The hook knife should be placed in luggage only. If travelling with an automatic activation device, the automatic activation device should be switched off. All equipment should be

Table 2. Practical Advice for Novice Aerial Sports Participants

Phase of Participation	Recommendation
Pre-participation	Plan ahead and research the applicable aerial sport.
	Participate with a reputable company.
	Consult with a general practitioner, travel medicine adviser or sports physician to determine if medically fit to partake.
	Participants should ensure that their insurance covers the relevant activity.
At sports arena	Consider tandem skydiving as it has the lowest risk of injury for first-time skydivers.
	Dress suitably for the activity; wear appropriate footwear and comfortable clothing.
	Avoid drinking alcohol and eating large meals prior to participation.
	Carefully follow instructions and procedures in place.

cushioned during transit. Tourists should check if their insurance specifically covers skydiving and if there is a cap. It preferably should include repatriation in the event of serious injury or death.¹⁵ Different licencing levels exist in different countries. Some drop-zones have their own local rules, so it is vital to receive a drop-zone orientation briefing. Skydiving abroad can present differences in humidity, temperature, and altitude, which affect how the parachute canopy performs. **Table 2** summarises practical advice for novice aerial sports participants.

Extreme aerial sports are unique in terms of their high degree of lethality, life-changing injuries, and the relative lack of experience required by amateur participants. Sports physicians, general practitioners and travel medicine advisers should have a basic familiarity with the risks associated with bungee jumping and skydiving and their mitigation. We recommend that future research investigate the experiences of aerial sports tourists, in relation to the level of preparation and safety measures applied to their jumps.

Authors' Contributions

All authors contributed equally to this study.

Conflict of Interest Disclosures

The authors have no conflicts of interest to declare.

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