

KOTOWICZ, Zuzanna, PABIŚ, Jakub, PODGÓRSKI, Piotr, GÓRECKA, Sandra, OLSZAŃSKI, Miłosz, BOGUSZ, Aleksander, KWIATKOWSKI, Oskar, KOŁODZIEJ, Anna and KRÓL, Anita. Risks, Patterns, and Preventive Measures in the Analysis of Snowboarding Injuries. *Journal of Education, Health and Sport*. 2024;64:192-205. eISSN 2391-8306. <https://dx.doi.org/10.12775/JEHS.2024.64.013>  
<https://apcz.umk.pl/JEHS/article/view/49659>  
<https://zenodo.org/records/10894475>

The journal has had 40 points in Minister of Science and Higher Education of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of 05.01.2024 No. 32318. Has a Journal's Unique Identifier: 201159. Scientific disciplines assigned: Physical culture sciences (Field of medical and health sciences); Health Sciences (Field of medical and health sciences). Punkty Ministerialne 40 punktów. Załącznik do komunikatu Ministra Nauki i Szkolnictwa Wyższego z dnia 05.01.2024 Lp. 32318. Posiada Unikatowy Identyfikator Czasopisma: 201159. Przypisane dyscypliny naukowe: Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu). © The Authors 2024; This article is published with open access at Licensee Open Journal Systems of Nicolaus Copernicus University in Torun, Poland  
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The authors declare that there is no conflict of interests regarding the publication of this paper.  
Received: 05.03.2024. Revised: 28.03.2024. Accepted: 29.03.2024. Published: 29.03.2024.

## **Risks, Patterns, and Preventive Measures in the Analysis of Snowboarding Injuries**

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## **ABSTRACT**

### **Introduction**

Snowboarding is an activity that appears to be gaining popularity among people who are interested in winter sports. The dynamic evolution of the method of snowboarding comes with it the risk of injuries, the consequences of which can be catastrophic. As a result of the fact that this sporting activity is distinguished by a diverse riding technique and calls for the use of specialized equipment, the mechanism of damage is also distinct from that which is

known in, for instance, skiing. In addition, comparable to skiing, snowboarding has a sub-discipline that is linked with the execution of tricks and jumps. In a disproportionate manner, this raises the probability of an accident occurring. Wrist, shoulder, and ankle joints are among the most often injured structures in the body. Trauma to the brain and spine are remarkably uncommon, nonetheless, they are the ones that have the most serious repercussions. It is imperative that special attention be made to the avoidance of these incidents, which is why both medical professionals and proprietors of ski resorts stress the need of people wearing helmets and other protective gear, such as wrist guards. It is anticipated that the implementation of these techniques will lead to a decrease in the occurrence of the most common and serious forms of injuries, as well as a reduction in the strain placed on the organization that provides medical care.

### **Aim of the study**

This review aims to characterize the most common injuries acquired during snowboarding, analyze their mechanism and to show methods of prevention.

### **Material and method**

This article presents the current state of knowledge on snowboarding injuries, their mechanisms and prevention in various scientific articles. Publications describing injuries that occur while snowboarding were reviewed using the PubMed platform. The search included the keywords 'snowboard', 'injuries', 'fracture', 'trauma'.

**Keywords:** snowboard; injuries; fracture; trauma;

## Introduction

Snowboarding has become increasingly popular since its inception in the 1970s and its debut in the Olympics in 1998 [1]. Since the 1990s, the popularity of snowboarding has grown rapidly. With the new discipline of winter sports, new types of injuries emerged that differed from those seen in skiers. This is due, among other things, to differences in the design of the equipment, the position assumed during the ride and the mechanism of the fall itself [2]. Skiing and snowboarding both require high-speed navigation across unpredictable terrain, putting skiers and snowboarders at danger of serious injury.

The number of snowboarding-related injuries is on the rise, with a focus on conditions affecting the head and spine [3]. The novice group exhibits the highest incidence of injuries among snowboarders, potentially indicative of a more demanding initial assimilation process for snowboarders to master speed control and stopping techniques [4]. Among adults, the wrist is the most frequent location of injury while snowboarding, making up 15 to 28% of all injuries. The aforementioned is followed by injuries to the soft tissue of the shoulder, sprained ankles, contusions on the legs, damage to the medial collateral ligament (MCL) of the knee, fractures of the clavicle, lacerations on the upper body, concussions, fractured ankles, and damage to the anterior cruciate ligament (ACL) of the knee [5]. Head injuries, while less common than other skiing and snowboarding injuries, are the primary cause of mortality and disability in winter sports [6]. Helmets and wrist guards have been suggested as potential protective equipment due to the prevalence and severity of head and wrist injuries while snowboarding [7]. The leading causes of injury are falling on the same level, loss of control while jumping, colliding with an immovable object, and colliding with another person on an on-piste area [8]. When compared to a similar fall on hard or icy slopes, which causes half of all injuries, powder snow absorbs the hard fall, lowering injuries by two thirds and, in slush conditions, even down to one fifth. It is recommended for beginners to practice on slopes that are maintained properly or in powder-snow conditions [9]. This can reduce the incidence of, not only life-threatening injuries, but also minor accidents that often occur in this type of winter sport. In this article, we would like to summarize the knowledge we have gathered so far on the types of snowboarding injuries and their consequences shedding light on methods of prevention and treatment.

## **Head injuries**

Fatal snowboarding accidents are mainly caused by serious head injuries, which are more common among snowboarders compared to skiers [10]. Depending on the snowboarder's degree of skill, the method by which a head injury most usually happens might differ. Prior research has indicated that the primary reasons for head injuries in snowboarding include basic falls on slopes among novices and falls during jumps among professionals. The most prevalent injury mechanism involves falling backward, resulting in an impact on the occipital region [11]. The main cause of those backward falls is the snowboard's back edge catching the slope. The study found that the "opposite-edge phenomenon" occurred predominantly on mild to moderate slopes among novice and intermediate snowboarders [12]. A study compared the difference between the severity of head injury (according to the Glasgow Coma Scale) among skiers and snowboarders. This work showed that head injuries occurred more frequently in snowboarders but were less severe than those in skiers. This may be due to the position adopted on a snowboard in which the rider is more likely to suffer uncontrolled falls to the back and occipital area [13]. Snowboarders who wore helmets had a significantly lower risk of sustaining a head injury compared to those who did not have one, according to a recent systematic review of multiple studies on the subject. Furthermore, the review found no evidence of an increased risk of neck injury [14]. Acute subdural hematoma, which is a life-threatening emergency, was the predominant intracranial damage pattern demanding intervention, in line with existing data [15]. This type of head injury is characterized by a bad prognosis and mortality rates in the literature are reported to be up to the 60% range, depending on the patient's condition [16].

## **Injuries of upper extremities**

Up to 22% of all snowboarding injuries occur at the wrist, making it the most frequent site of injury among snowboarders. Fractures comprise about two-thirds of wrist injuries. Inexperienced snowboarders, females, and lower age groups are more susceptible to wrist fractures and sprains. Experienced male snowboarders were more prone to hand, elbow, and shoulder injuries. [17]. Snowboarders are, in the first place, most likely to suffer a fracture of the distal part of the radius, followed by clavicle and proximal humerus fractures. Wrist injuries most often result from a fall on an upright upper limb, and are widespread in inexperienced snowboarders who protect themselves from a fall this way. The incidence of this injury could be minimized by implementing snowboarding classes that incorporate

specialized fall training so that students learn to distribute their body weight by scrolling rather than falling with their forearms extended [10]. Treatment of radius bone fracture most often involves immobilization and stabilization of the fragments, but in case of displacement of the fragments or an open fracture, surgical intervention is required [18]. To reduce the risk of fractures in the wrist, companies have begun to produce special protectors. Although the purpose of wrist protectors is to mitigate strain on the dorsal and volar distal radius bones during impact, they have been associated with both-bone forearm fractures as a result of heightened tension in the forearm's midsection [19].

### **Vertebral fractures**

Vertebral injuries are a common type of injury sustained by snowboarders. It is estimated that they are responsible for around 23 percent of the injuries that are handled in trauma centers located close to the slopes. The proportion of men is significantly higher than women when it comes to this type of injury. This is most likely related to the fact that males ride at a faster speed and are significantly more inclined to take risks than women. The most common injury occurs after a fall on snow from one's own height and after a fall related to a failed jump or evolution in the air. More often the lumbosacral region is broken, next is thoracic. The cervical region is the least frequently broken. Among snowboarders, coccyx fracture also occurs, which ranks as the 3rd most common region of injury [20]. It is important to remember that vertebral injuries are often associated with spinal cord injuries, which can even result in nerve paralysis and disability.

### **Spinal cord injuries**

The incidence of spinal cord injury is about 5.1 per 100,000 visitors to a ski resort, according to the study. The injury was most often sustained by men at about 27 years of age and their level was described as intermediate [21]. Spinal cord rupture is a major cause of disability, particularly among younger people, and has a significant impact on the number of years lived with disability. It is a significant concern in today's healthcare and is responsible for a large percentage of mortality [22]. Most of the accidents occurred during jumps and falls that resulted in compression fractures of the thoracolumbar junction and fractures of the transverse processes of the vertebrae in this segment of the spinal column [21]. The occurrence of spinal cord injury is predominantly associated with spinal fractures. There have been descriptions of additional uncommon mechanisms, including traumatic disc rupture.

Fracture-dislocation injuries to the spinal cord are frequently devastating. An axial compressive force delivered cranially in neck flexion is the most often described mechanism of damage resulting in quadriplegia. The absence of protective cervical lordosis and cervical vertebral alignment exacerbates the injury [23].

Helmets are known to clinically reduce the incidence of head injuries. It has been alleged that their weight may increase the risk of cervical spine injury, but it has been confirmed that they have no effect on the incidence of spinal trauma in that region. By planning and maintaining their slopes with injury prevention as a top priority, ski resorts can contribute to a decrease in injuries. Accessing professional, well-prepared terrain parks and providing instruction on safe jumping and riding techniques may reduce spinal injuries, particularly among snowboarders [24].

### **Lower extremities injuries**

Injury rates to the lower extremity represent a spectrum that ranges from 21% to 52%, they are less common than upper extremity injuries [25]. This phenomenon is hypothesized to be associated with the biomechanics of snowboarding injuries, given that the rider is immobile on the board and the board cannot independently exert torque on one knee during a fall. The majority of lower limb injuries in snowboarding happen to the front/leading leg, typically the left one [17]. Furthermore, it is crucial to note that the shell of snowboard boots is significantly more flexible than that of ski boots. The increased mobility of the knee joint and tibia in the shell makes the ankle joint more susceptible to damage.

Generally, the most common injury is on the leading side, that is, if the rider uses the left foot as the leading one, usually most of the damage is on the same side. Among injuries to the lower limb, cuts/abrasions to the skin of the lower leg are the most common. In second place are sprains, for example, in the knee and ankle joints. Also frequent are fractures among which most are those of the shin bone, femur and foot. Fractures and sprains occur more often during an isolated fall or as a result of a jump, while abrasions/injuries occur more often as a consequence of a collision with an object, obstacle or other slope user [25].

In terms of ankle injuries, sprains dominate over fractures. A rather unusual ankle injury in snowboarding is a fracture from the lateral process of the talus. This occurs as a result of a

failed landing after a jump, resulting in inversion and compression in the ankle joint. This fracture is often mistaken for an ankle sprain, and requires specialized diagnostic imaging and, in some cases, surgical treatment and a lengthy hospital stay [17]. An ankle sprain can result in prolonged impairments in functioning, post-traumatic osteoarthritis, and persistent instability of the ankle. These symptoms may manifest in around 40% of individuals with ankle sprain within twelve months post-injury [26].

### **„Boarder belly” and other abdominal injuries**

Snowboarders are nearly twice as prone to chest and abdominal injuries compared to skiers [27,28]. The spleen is frequently damaged among the solid organs in the abdominal cavity, and an early diagnosis can decrease the death rate. [29] "Boarder belly" or „snowboard spleen” is a spleen injury resulting from a fall while performing evolutions in the air. It usually affects male athletes using terrain parks [27,28]. This may be due to the fact that more snowboarders are using their left foot as a guide (regular stance). When falling forward, the rider lands striking the left subcostal region with his left elbow, which can cause damage to the spleen. On the contrary, in a similar mechanism, but using the right foot as the leading foot, the liver is damaged because the snowboarder lands on the right subcostal area. However, these are conjectures and therefore further research into this correlation should be conducted [13].

Kidney injuries are relatively rare, but can be associated with dangerous consequences, for example bleeding, followed by the formation of a haematoma, which can become superinfected and develop into an abscess. In rare cases where significant trauma to the kidney occurs, for example with a tear of its vascular pedicle or rupture of the capsule, urgent surgery may be required, even resulting in the loss of the kidney. Kidney injuries during snowboarding are more common compared to other winter sports, but virtually all cases of this type of injury in the cited study were treated conservatively and rarely led to loss of the organ [30].

## **Conclusion**

The United States of America is the birthplace of snowboarding, which is becoming an increasingly popular winter sport. During the winter season, it is performed by both amateurs and professionals who compete in a variety of different disciplines. Both children and adults are susceptible to injuries, some of which leave no traces, such injuries include ankle sprains or skin abrasions, while others leave permanent effects or are life-threatening, such as a subdural hematoma resulting from hitting one's head on ice. Many of them involve prolonged and arduous rehabilitation, inability to work and, in extreme cases, even death. The most common injury is to the upper extremities, including a fracture in the wrist joint, contrary to injuries in skiing where the lower extremities predominate. It is the responsibility of every person who uses the slopes, as well as the owners of ski resorts and companies that manufacture sporting equipment, to reduce the likelihood of accidents occurring during the ride. The implementation of several preventative measures, including the mandatory use of helmets in certain countries and the utilization of wrist protectors, has resulted in a significant reduction in the number of injuries reported and an improvement in the overall safety of the sport. When compared to other winter sports, snowboarding is easily distinguishable due to the position that is assumed while riding, the equipment that is used, and the physical characteristics of movement on the slope. This translates into a slightly different mechanism of fall and damage as a result of the fall in comparison to skiing, which is now more popular and has been around for longer.

## **Author's contribution**

Conceptualization, Zuzanna Kotowicz, Jakub Pabiś; methodology, Zuzanna Kotowicz, Jakub Pabiś and Piotr Podgórski; software, Jakub Pabiś, Piotr Podgórski; check, Miłosz Olszański, Aleksander Bogusz and Anita Król; formal analysis, Oskar Kwiatkowski, Anna Kołodziej and Miłosz Olszański; investigation, Sandra Górecka, Anita Król and Anna Kołodziej; resources, Zuzanna Kotowicz; data curation, Jakub Pabiś, Piotr Podgórski; writing - rough preparation, Zuzanna Kotowicz, Sandra Górecka and Anita Król; writing - review and editing, Zuzanna Kotowicz, Oskar Kwiatkowski and Sandra Górecka; visualization, Jakub Pabiś; supervision, Piotr Podgórski, Anna Kołodziej; project administration, Zuzanna Kotowicz, Miłosz Olszański, Aleksander Bogusz and Oskar Kwiatkowski; receiving funding, Zuzanna Kotowicz.

All authors have read and agreed with the published version of the manuscript.

### **Disclosure**

### **Funding statement**

The study did not receive special funding.

### **Informed Consent Statement**

Not applicable

### **Acknowledgments**

Not applicable

### **Conflict of Interest Statement**

The authors report no conflicts of interest.

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