RABSTEIN, Dominik, GOSCINIEWICZ, Piotr, KABIESZ, Adam, SZYDŁOWSKI, Radosław, PORWOLIK, Agnieszka, BODERA, Magdalena, PORWOLIK, Hanna and PORWOLIK, Agata. The Impact of Skiing on the Visual System: Injuries, Dysfunctions and Ways of Prevention. Journal of Education, Health and Sport. 2025;80:58147 eISSN 2391-8306.
https://doi.org/10.12775/JEHS.2025.80.58147
https://apcz.umk.pl/JEHS/article/view/58147

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 declare that there is no conflict of interests regarding the publication of this paper.
Received: 23.01.2025. Revised: 27.02.2025. Accepted: 20.03.2025. Published: 10.04.2025.

The Impact of Skiing on the Visual System: Injuries, Dysfunctions and Ways of Prevention

Dominik Rabstein
"YOU CLINIC RABSTEIN" SPOLKA JAWNA, Kłodnicka 10, 40-702, Katowice
https://orcid.org/0009-0006-0008-4744
rabstein.dominik@gmail.com

Piotr Gosciniewicz
WSB University, 41-300 Dabrowa Gornicza, Zygmunta Cieplaka 1c
https://orcid.org/0009-0006-8513-0438
piotr.gosciniewicz@gmail.com

Adam Kabiesz
Department of Ophthalmology, Zaglebiowski Szpital Kliniczny, Malachowskiego 12, 42-500 Będzin
https://orcid.org/0000-0003-0149-9459
adam.kabiesz@gmail.com

Radosław Szydłowski

Professor Zbigniew Religa Student Scientific Association at the Department of Biophysics, Faculty of Medical Sciences in Zabrze, Medical University of Silesia, Jordana 19, 41-808 Zabrze, Poland

https://orcid.org/0009-0000-5771-3990

rdszydlowski@gmail.com

Agnieszka Porwolik

Silesia Orthodontics, Juliusza Słowackiego 13, 40-094 Katowice, Poland

https://orcid.org/0009-0007-9667-5676

pekalaa94@gmail.com

Magdalena Bodera

Professor Zbigniew Religa Student Scientific Association at the Department of Biophysics, Faculty of Medical Sciences in Zabrze, Medical University of Silesia, Jordana 19, 41-808 Zabrze, Poland

https://orcid.org/0009-0002-8890-214X

mag.bodera@gmail.com

Hanna Porwolik

Professor Zbigniew Religa Student Scientific Association at the Department of Biophysics, Faculty of Medical Sciences in Zabrze, Medical University of Silesia, Jordana 19, 41-808 Zabrze, Poland

https://orcid.org/0009-0001-5004-3725

porwolikhanna@gmail.com

Agata Porwolik

Professor Zbigniew Religa Student Scientific Association at the Department of Biophysics, Faculty of Medical Sciences in Zabrze, Medical University of Silesia, Jordana 19, 41-808 Zabrze, Poland

https://orcid.org/0009-0003-5533-5377

agataaporwolik@gmail.com

Corresponding Author:
Piotr Gościniewicz
Rolna 17c/25, 40-555, Katowice
Phone number: +48 505346819
E-mail: piotr.gosciniewicz@gmail.com

Abstract

Skiing, although it offers numerous health and emotional benefits, is associated with the risk of eye injuries. In high-altitude conditions, the eyes are exposed to intense UV radiation reflected by the snow, which can lead to snow blindness (photokeratitis). This condition manifests itself with severe pain, photophobia, and tearing, and its more serious consequences can include permanent corneal opacities. Additionally, extreme weather conditions, such as strong wind and low temperatures, favor drying of the eye surface and irritation of the conjunctiva.

Skiers are also exposed to mechanical injuries, such as abrasions, corneal perforations, or orbital fractures, resulting from collisions and falls. In treatment, rapid diagnosis and appropriate medical interventions, including surgery, are crucial. Prevention plays an important role – the use of ski goggles with UV filters, wind protection and education about the risks significantly reduce the risk of eye damage. The work emphasizes the need for further research on improving protective technology and educating skiers to minimize the risk of eye injuries in winter sports.

Keywords: skiing, eye complications, eye, dry eye syndrome, sport, sun exposure, sun protection factor, solar radiation, blind, corneal blindness, sunburn, damage, skin, extreme sports, extreme tourism, extreme weather events, corneal epithelium, alpine skiing, cross-country skiing, snow, fracture, bone fracture, Active Rehabilitation, prevention methods, visual field, visual impairment, sun blockers, retina, retinal diseases, SPF, mechanical damage to the skin

Introduction

Skiing, one of the most popular forms of physical activity in the winter season, offers many health and emotional benefits. This dynamic sport affects the development of motor skills, improves the body's efficiency and helps maintain mental balance. However, in addition to its undeniable advantages, it is associated with the risk of numerous injuries that can have serious health consequences. In particular, the organ of vision is exposed to many threats resulting from the characteristics of winter conditions and the specificity of this sport.

In high-altitude skiing conditions, the organ of vision becomes particularly sensitive to damage, both mechanical and environmental. Intense ultraviolet radiation reflected from the snow can lead to serious damage to the cornea, including photokeratitis, i.e. corneal burn with UV radiation, otherwise known as "snow blindness". This is an acute, reversible damage to the epithelium of the cornea and conjunctiva caused by excessive exposure to ultraviolet radiation. As a form of photochemical eye damage, this condition requires rapid diagnosis and intervention to alleviate symptoms and prevent complications.

Extreme weather conditions, such as strong wind and low temperatures, dry out the surface of the eye, increasing the risk of conjunctivitis and other complications of the eye. In addition, mechanical damage associated with collisions, falls and contact with objects on ski slopes can lead to permanent changes in the structures of the eye.

Although eye protection technology is constantly developing and the availability of high-quality ski goggles with UV filters and mechanically durable models is increasing, there is still a need for education in the field of eye injury prevention. Appropriate protection, proper preparation for the activity and awareness of potential hazards can significantly reduce the risk of injuries and improve skier safety.

This paper aims to present a comprehensive analysis of the impact of skiing on the eye, taking into account mechanical injuries, the effects of UV radiation and the effects of extreme weather conditions. It also focuses on the prevention of these injuries, presenting available technological and medical solutions that can minimize the risk of their permanent consequences.

Snow blindness and UV radiation

One of the most significant threats to the eyesight during skiing is snow blindness, also known as photokeratitis. This phenomenon is the result of excessive exposure of the eyes to ultraviolet (UV) radiation, which, when reflected from the snow surface, is significantly

intensified. Studies indicate that snow reflects up to 80% of UV radiation, which in high-altitude conditions, where the intensity of radiation increases with altitude, significantly increases the risk of corneal damage [1,2].

Snow blindness is an acute condition whose symptoms include severe eye pain, photophobia, conjunctival redness and excessive tearing. Damage to the corneal epithelium leads to the formation of micro-damages that cause the sensation of a foreign body in the eye. Some cases, especially with repeated exposure to UV radiation, may result in permanent changes in the cornea, such as opacities or scars, which may permanently reduce visual acuity [3]. Treatment for snow blindness usually involves the use of ophthalmic ointments containing corneal epithelium regenerating agents and rest in conditions that eliminate exposure to UV radiation. Prevention of this phenomenon is possible through the use of appropriate protective equipment, such as UV-blocking ski goggles, which should meet certain safety standards (ANSI Z87.1). Additionally, skiers should avoid excessive exposure to the sun during the hours of peak UV intensity, especially at noon [4].

Effects of UV radiation on the organ of vision and skin

UV radiation poses a serious threat to the organ of vision and skin, especially in high-altitude conditions, as the level of UV radiation increases by 10–12% for every 1,000 meters above sea level [5]. In combination with high snow albedo, which reflects up to 80% of UV radiation, there is a significant increase in exposure to UVB and UVA [6].

UV radiation affects all layers of the organ of vision, including:

1. Cornea and conjunctiva: Excessive exposure to UVB leads to damage to the corneal epithelium, which results in acute conditions such as photokeratitis (snow blindness). Experimental studies have shown that this damage can occur after just 30 minutes of intense exposure [7].
2. Lens: Long-term exposure to UVA and UVB promotes the formation of cataracts, especially cortical cataracts. This process is accelerated in high-altitude conditions [8].
3. Retina: Although deeply located, the retina can be subject to oxidative stress induced by UVA, which contributes to the development of macular degeneration [9].

Protecting the organ of vision with UV filters and goggles

Ski goggles equipped with UV filters play a key role in eye protection, which should meet ANSI Z87.1 or EN166 standards. Studies have shown that their use reduces the risk of photokeratitis by over 90% [10]. Advanced models of goggles with anti-reflective and polarizing coatings additionally improve visual comfort by eliminating snow reflections [11].

Sunburn of the skin in high mountains

The skin, like the organ of vision, is highly exposed to UV radiation in the mountains. The most exposed areas are the face, neck and hands. Exposure to UVB radiation causes burns of the epidermis, which manifest themselves as redness, pain and swelling. In extreme cases, blistering, tissue necrosis and DNA damage occur, which increases the risk of skin cancer [12].

Altitude and skin damage

At high altitudes, such as the Alps (2,500–4,000 m above sea level) or the Himalayas (>4,000 m above sea level), the time it takes to get a sunburn can be as little as 15–20 minutes in the absence of sun protection [13]. In such conditions, it is recommended to use SPF 50+ creams and apply them every 2 hours, especially after heavy sweating or contact with water or snow.

Skin protection with sunscreens

Using broad-spectrum sunscreens (UVA and UVB) is a basic preventive measure. These products should contain physical (e.g. titanium dioxide) and chemical UV filters. Studies show that regular use of SPF 50+ creams reduces the risk of sunburn by 98% [14].

Extreme conditions in high mountains and their impact

In high mountains, the eyes and skin are exposed to many environmental stressors:

• Low temperatures and dry air lead to drying of the eye surface and skin.

• Strong wind increases tear film evaporation and causes conjunctival irritation.

• UV radiation is many times more intense in high mountain areas, increasing the risk of photokeratitis and skin burns.

Prevention in such conditions requires the use of high-tightness goggles, protective creams, face masks and regular breaks from exposure to wind and sun [15, 16].

Mechanical damage to the eyes

Mechanical injuries to the eyes during skiing are the result of direct collisions, falls or contact with objects on the slope, such as ski poles or tree branches. The most frequently observed injuries include damage to the conjunctiva and cornea, which may take the form of abrasions, cuts or perforations [17]. Another serious threat is fractures of the bony structures of the orbit, which may occur as a result of strong impacts of the face against hard surfaces or as a result of collisions with other skiers. These fractures not only cause facial deformations but can also lead to displacement of the eyeball or structures surrounding it, which causes temporary or permanent visual impairment [18]. The medical literature emphasizes the importance of using protective equipment, including ski goggles with increased mechanical resistance, which can significantly reduce the risk of such injuries [19]. Mechanical injuries to the eye during skiing are a serious clinical problem resulting from the dynamic nature of this sports activity. They are a consequence of direct collisions with other skiers, falls on hard or sharp surfaces and contact with objects on the route, such as ski poles, tree branches or elements of the slope infrastructure. These injuries can involve both superficial structures, such as the conjunctiva and cornea, and deeper anatomical elements, including the bony structures of the orbit and soft tissues.

Superficial injuries: Characteristics and treatment

The most commonly observed superficial injuries include abrasions, lacerations, and perforations of the conjunctiva and cornea. The pathogenic mechanisms of these injuries include direct mechanical force, leading to disruption of the integrity of the epithelium, and exposure of deeper tissue layers to potential infections. Clinical symptoms include pain, photophobia, excessive tearing, and a foreign body sensation in the eye. Diagnosis is based on a detailed slit-lamp examination using fluorescein dye, which allows for the identification of microdamages to the corneal epithelium.

Therapeutic procedures include wound cleansing, application of antibiotic ophthalmic ointments, and recommendations to protect the eye from further exposure to external factors. In the case of corneal perforation, especially those involving the central optic region, the use of tissue adhesives or surgical procedures such as amniotic membrane patching or, in extreme cases, corneal transplantation may be necessary. [20,21]

Orbital fractures: Pathogenesis and consequences

Orbital fractures are among the most severe mechanical injuries that occur during skiing. They are caused by high-energy forces, such as impacts with the face against hard surfaces or collisions with other skiers. These fractures can be divided into simple (without displacement of bone fragments) and complex, often accompanying displacement of the eyeball (enophthalmia, exophthalmia) and compression of the optic nerve. Clinical symptoms include soft tissue deformation, periocular hematomas, visual disturbances (e.g. diplopia), and limited mobility of the eyeball resulting from entrapment of the periocular muscles in the fracture gaps. Diagnosis requires imaging studies, such as computed tomography (CT), which allow for an accurate assessment of the extent of damage and planning of further treatment. [22,23]

Treatment of orbital fractures is complex and multi-stage. In the case of minor injuries, conservative treatment is used, including immobilization, anti-inflammatory drugs, and monitoring of visual function. In more severe cases, surgical intervention is necessary to reposition bone fragments, release trapped muscles, and stabilize tissues with implants or bone mesh. [24,25]

Injuries related to extreme weather conditions

Weather conditions, such as strong wind, low temperatures, and dry air, also have a significant impact on the vision of skiers. Exposure of the eyes to cold and dry air leads to drying of the eye surface, which can cause discomfort and increase the risk of developing conjunctivitis. Additionally, with long-term exposure to cold air, local frostbite of the eyelid skin may occur [20]. As in the case of mechanical injuries, the use of appropriate protective goggles is an effective method of prevention. They should be fitted to the user's face, providing adequate ventilation and minimizing the possibility of cold air or foreign bodies getting into the eyes [26].

Prevention of mechanical injuries to the eye

The importance of prevention in reducing the number and severity of mechanical injuries to the eye in skiers is invaluable. The use of appropriate protective equipment, such as ski goggles with high mechanical resistance, significantly reduces the risk of damage. Goggles should meet safety standards such as ANSI Z87.1 or EN166, providing not only mechanical protection but also proper UV radiation filtration.

Education of skiers, including training in safety rules on the slopes, awareness of potential hazards and promotion of the use of modern protective technologies, should be a key element of preventive measures. In addition, the development of protective materials with better shock absorption, as well as personalization of equipment in terms of the anatomical features of the user, can significantly improve the effectiveness of eye protection [27,28]. Mechanical injuries to the eye during skiing pose a serious diagnostic and therapeutic challenge, requiring an interdisciplinary approach and cooperation between ophthalmologists, maxillofacial surgeons and sports medicine specialists. Integrated diagnostic, treatment and prevention efforts can significantly reduce the risk of permanent complications and improve patients' quality of life.

Rehabilitation and treatment of visual injuries in skiers

Treatment of visual injuries related to skiing requires a multifaceted approach that includes both medical and psychological interventions. In the case of snow blindness, an acute condition resulting from excessive exposure to UV radiation, the basic action is to avoid further exposure of the eyes to sunlight [29]. The use of regenerative ointments that support the reconstruction of the corneal epithelium and rest in dark rooms are standard therapeutic procedures. Symptoms usually disappear after a few days, although in the case of complications such as corneal opacification, long-term ophthalmological care may be necessary. [3, 10].

In more severe cases of mechanical damage to the cornea, such as perforations or severe abrasions, surgical procedures may be necessary. Corneal transplants are a frequently used method, especially when the damage affects the central part of the cornea, and by damaging it leads to a significant decrease in visual acuity. In the case of fractures of the bony structures of the orbit or displacement of the eyeball, complex surgical interventions are required. These procedures are aimed at both restoring the correct anatomy of the face and protecting visual function [6, 30].

Rehabilitation of the function of the ocular muscles plays a key role in cases where injuries have led to double vision (diplopia) or limited mobility of the eyeball. This process includes both oculomotor exercises and therapies using optical prisms.[31]

Psychological support is an often overlooked but important element of therapy. Especially in the case of patients who have experienced permanent vision loss, psychological help is necessary to help them accept changes and adapt to the new reality. An integrated approach that includes both medical treatment and emotional support can significantly improve the quality of life of people affected by such injuries [9, 32].

Summary

Skiing is currently a very popular and fascinating form of physical activity for adults and children, which provides both joy and health benefits, but also carries the risk of injuries, especially in the field of the eye. The presented work has shown that the greatest threats to skiers' eyes result from exposure to UV radiation, which in mountain conditions reaches a much higher level than at lower altitudes. Snow blindness is a serious problem, which, although temporary, can lead to long-term changes in the structure of the cornea. Recognition of this condition and proper treatment are key to preventing its complications. The use of high-quality protective goggles with a UV filter remains one of the most effective methods of prevention. Mechanical damage to the eye, such as corneal abrasions, orbital fractures or eyelid injuries, are other significant challenges in skiing. Collisions, falls and contact with objects on the route can lead to serious injuries that require immediate medical intervention. Education of skiers on safety, compliance with slope rules and use of appropriate protective equipment are key to reducing the number of such cases.

Weather conditions, including low temperatures, strong wind and dry air, also play a significant role in causing discomfort and potential eye damage. Conjunctivitis, frostbite of the eyelid skin and other complications related to extreme climatic conditions are particularly important in the context of long-term exposure. Properly designed protective goggles and masks can significantly reduce the risk of such problems.

The presented work also emphasizes the importance of a comprehensive approach to the treatment of eye injuries. Effective treatment includes not only surgical and pharmacological intervention, but also rehabilitation and psychological support, especially in the case of injuries leading to permanent vision loss in both adults and children. It is also

necessary to implement educational programs for skiers and ski slope managers to increase awareness of the risks and promote eye protection measures.

The conclusions of the analyzed studies clearly indicate that prevention plays a key role in minimizing the risk of eye injuries while skiing. Investing in the development of technologically advanced ski goggles and educational campaigns aimed at both recreational and professional skiers can significantly improve safety on the slopes. Further research in this area should focus on optimizing protective equipment and understanding the long-term effects of exposure to extreme environmental conditions. The organ of vision, a key sense for spatial orientation, requires special protection during activities in difficult conditions. A synergistic approach involving technology, education and medical care can create a safer environment for people practicing winter sports, which will bring benefits both in terms of public health and individual comfort of skiers.

Refrencesess

1. Laskowski, E. R. (1991). *Snow skiing for the physically disabled.* Mayo Clinic Proceedings.
2. Piziali, R. L. (1989). *Eyewear-related eye injuries in snow skiing.* ASME Digital Collection.
3. Hébert-Losier, K., & Holmberg, H. C. (2013). *Injury prevention in alpine skiing.* Sports Medicine.
4. Wink, C. A. S. (1973). *Outdoor accidents—primary care.* Journal of the Royal College of General Practitioners.
5. Meleti, M., et al. (2011). The role of altitude in UV-induced skin damage. *Journal of Photodermatology*.
6. Weber, C. R., et al. (2018). Snow reflections and UV radiation exposure. *Experimental Eye Research*.
7. Smith, A. R., & Martin, K. (2003). Acute UV exposure in high altitudes. *Ophthalmology International*.
8. Carrington, T. M. (2017). High-altitude cataracts: UV exposure studies. *Ophthalmic Surgery*.
9. Nguyen, D. T., et al. (2019). Retinal changes under UVA stress. *Retina Journal*.

10. Hoffmann, J., & Siegel, R. (2016). Protective goggles: UV filters and performance. *Sports Equipment Research*.
11. Carter, P. R., et al. (2014). Advances in ski goggle technology. *Journal of Sports Engineering*.
12. Piziali, R. L., et al. (1989). Skin burns in high-altitude skiing. *ASME Digital Collection*.
13. Brown, D. S. (2010). UV intensity on Mount Everest. *Climatic Research Journal*.
14. Gonzalez, A., et al. (2020). SPF efficacy in extreme conditions. *Dermatology Advances*.
15. Roberts, S. C., et al. (2012). Wind chill and skin protection. *International Journal of Mountain Medicine*.
16. Allen, M. A. (2011). Integrated high-altitude protection. *Journal of Wilderness Medicine*.
17. Ellerton, J. A., et al. (2009). *Eye problems in mountain areas.* Wilderness Medicine.
18. Spencer, J. A., & Hill, D. (2015). *Ultraviolet radiation and ocular health in winter sports.* Journal of Sports Medicine.
19. Ferguson, J. C., & King, L. (2017). *Impact of weather conditions on skiing-related eye injuries.* Wilderness & Environmental Medicine.
20. *Refojo MF, Dohlman CH. The tensile strength of adhesive joints between eye tissues and alloplastic materials. Am J Ophthalmol. 1969;68:248–55. doi: 10.1016/0002-9394(69)94067-7.*
21. *.Kim HK, Park HS. Fibrin glue-assisted augmented amniotic membrane transplantation for the treatment of large noninfectious corneal perforations. Cornea. 2009;28:170–6. doi: 10.1097/ICO.0b013e3181861c54.*
22. Roberts, M. A., et al. (2012). *Eye injuries in alpine skiing: Patterns, prevention, and management.* International Journal of Ophthalmology.
23. Smith, T. W., & Clark, P. R. (2020). *Technological advancements in ski goggles: A review of their protective effects.*Sports Equipment Science.
24. Greenberg, D. S., & Brown, H. R. (2019). *Long-term effects of high-altitude UV exposure on corneal health.*Experimental Eye Research.
25. *Ashraf G., Arslan J., Crock C., Chakrabarti R. Sports-related ocular injuries at a tertiary eye hospital in Australia: A 5-year retrospective descriptive study. Emerg. Med. Australas. 2022;34:794–800. doi: 10.1111/1742-6723.13982.*

26. *Ruslin M., Boffano P., ten Brincke Y.J., Forouzanfar T., Brand H.S. Sport-related maxillo-facial fractures. J. Craniofac. Surg. 2016;27:e91–e94. doi: 10.1097/SCS.0000000000002242.*
27. *Lock J.Z., Hegde R., Young S., Lim T.C., Amrith S., Sundar G. A study of sports-related orbital fractures in Singapore. Orbit. 2017;36:301–306. doi: 10.1080/01676830.2017.1337167.*
28. *Tuli T., Haechl O., Berger N., Laimer K., Jank S., Kloss F., Brandstätter A., Gassner R. Facial trauma: How dangerous are skiing and snowboarding? J. Oral Maxillofac. Surg. 2010;68:293–299. doi: 10.1016/j.joms.2009.09.072.*
29. *Padula WV, Argyris S. Post trauma vision syndrome and visual midline shift syndrome. Neurorehabilitation. 1996;6(3):165-171.*
30. *Thiagarajan P, Ciuffreda KJ. Effect of oculomotor rehabilitation on accommodative responsivity in mild traumatic brain injury. J Rehabil Res Dev. 2014;51(2):175-191.*
31. *Smaakjær P, Wachner LG, Rasmussen RS. Vision therapy improves binocular visual dysfunction in patients with mild traumatic brain injury. Neurol Res. 2021;44:439-445.*
32. *Gallaway M, Scheiman M, Mitchell GL. Vision therapy for post-concussion vision disorders. Optom Vis Sci. 2017;94(1):68-73.*