KUBAS, Maria, KRZEMIŃSKA, Katarzyna, CZERWIK, Julia, KUSZNERUK, Julia, KŁUSEK, Magdalena, CHAWRYLAK, Katarzyna, KUBAS, Wojciech and SADOK, Aleksandra. The health aspects of skiing. Quality in Sport. 2024;23:54686. eISSN 2450-3118.
https://dx.doi.org/10.12775/QS.2024.23.54686
https://apcz.umk.pl/QS/article/view/54686

The journal has been 20 points in the Ministry of Higher Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Higher Education and Science of 05.01.2024. No. 32553.
Has a Journal's Unique Identifier: 201398. Scientific disciplines assigned: Economics and finance (Field of social sciences); Management and Quality Sciences (Field of social sciences).
Punkty Ministerialne z 2019 - aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 r. Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398.
Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).

The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 27.08.2024. Revised: 19.09.2024. Accepted: 30.09.2024. Published: 30.09.2024.

THE HEALTH ASPECTS OF SKIING

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ABSTRACT
Introduction and Purpose:
This article presents a comprehensive analysis of the risks and benefits associated with downhill skiing. The article elucidates the prevalence and etiology of common injuries, while also delineating the salutary effects of engaging in the sport.
Methods: A literature search was conducted using PubMed and Google Scholar, focusing on articles from 2019 to 2024, including observational studies, clinical trials, meta-analyses and systematic reviews.
State of Knowledge: Skiing is a globally popular winter sport, attracting millions of enthusiasts each year. The sport's combination of outdoor adventure, social activity, and the allure of winter landscapes contribute to its enduring global popularity. Despite its global popularity, skiing carries a significant risk of injury, with knee injuries, particularly ACL sprains, being the most common, especially among women. Despite these risks, alpine skiing offers significant physical health benefits, including improved cardiorespiratory fitness, muscle strength and mental health, making it a beneficial lifelong sport, particularly for older adults.
Conclusion: It is notable that while injuries such as ACL sprains and fractures are prevalent, particularly among beginners and those who engage in risk-taking activities, the sport also offers significant health benefits. Alpine skiing has been demonstrated to enhance cardiorespiratory fitness, muscle strength, and mental well-being, thereby conferring significant benefits that extend throughout the lifespan, despite the potential for injury.

Keywords: skiing, injuries, ACL, MCL, alpine skiing, spine injuries, knee injuries, head injuries, upper limb injuries, lower limb injuries, skiing benefits

INTRODUCTION

It would be fair to say that downhill skiing is one of the most widely enjoyed winter sports globally. There are over 2,000 ski resorts operating across 67 countries, which equates to approximately 400 million skier days each year. It is important to remember that, as with any other sport, skiing involves an inherent risk of injury.While much research has been conducted on the risks associated with traumatic and non-traumatic injuries in skiing, there has been limited investigation into the sport's potential health benefits. For the millions who

ski regularly during the winter season, it becomes an integral part of their physical activity routine.
However, in addition to these adverse effects of skiing, there are also benefits associated with the practice of the sport. The objective of this review is to present an analysis of the prevalence and etiology of common bodily injuries sustained during skiing, as well as to highlight the positive aspects of this physical activity.

MATERIALS AND METHODS OF RESEARCH

A thorough literature review was conducted using the PubMed and Google Scholar databases. The search terms included "skiing injuries," "alpine skiing injuries," "skiing head injuries," "skiing spine injuries," and "skiing knee injuries." Articles published between 2019 and 2024 were considered. Filters were applied to include observational studies, clinical trials, meta-analyses, and systematic reviews.
To ensure the quality of the selected studies, they were evaluated based on relevance, methodology, and significance. A systematic data extraction process was carried out, focusing on key findings, study design details, and participant characteristics.

STATISTICS OF INJURIES

The data indicated a higher incidence of injury among males compared to females. It has been observed that knee injuries, particularly anterior cruciate ligament [ACL] sprains, occur with greater frequency in females than in males. Conversely, males are more susceptible to fractures. The propensity for males to engage in riskier behaviours is associated with a higher incidence of injuries, which are frequently more severe.[1]
In adult ski racers, the knee is the most commonly injured body part. The next most commonly affected areas are the lower leg or back, the head and upper extremity, or just the upper extremity. In the case of younger skiers (those under the age of 18), the second most commonly injured body part is the spine, followed by the hand or the lower leg, foot, and ankle. The most common specific diagnosis in both adult and youth skiers is an ACL injury, followed by concussions and lower leg fractures.[2]
In the analysis of Zhi-lin et. al the subject of the study is the cause of public behaviour related to skiing accidents. A total of 24 unsafe maneuvers were observed among the skier cohort, with collisions representing the most frequent incident type (22 occurrences, 37.28% incidence rate). The primary contributing factor was the failure to slow down adequately and maintain a safe distance from others, which was identified in 22 instances. Experimental studies have demonstrated that blocking on intermediate trails can result in significant accidents, such as the propulsion of a dummy down the hill for approximately 20 metres following contact with the skis. In order to mitigate the risks involved, it is of the utmost importance to maintain a safe distance from others. The data demonstrate that incidents associated with the failure of protective nets are particularly prevalent, occurring on six occasions with an incidence rate of 31.58%. A decade ago, historical data identified protection defects as a significant contributing factor to injuries, with an injury rate of 16.1%. This highlights the persistent challenges with regard to safety standards and the necessity for enhanced regulations and inspections at Chinese ski resorts. Furthermore, research indicates that accidents on icy or uneven ground occur with a 26.32% frequency, despite regulations mandating a minimum snow layer thickness of 30 cm and no exposed surfaces or ice. Furthermore, the inadequacy of artificial snow maintenance contributes to the existence of hidden dangers. It is incumbent upon skiers to remain apprised of the conditions at their chosen resort and of any pertinent weather updates. Similarly, resorts must ensure that they disseminate information in a timely manner, with a view to enhancing safety.[3]

AGE - AN IMPACT ON SKIING INJURIES

Age is a potential factor that may influence an individual's susceptibility to injury, the underlying mechanisms of injury, and the severity of the resulting injury. As children mature, their physiology undergoes changes that alter their anatomy and coordination, thereby increasing the risk of injuries to tendons, ligaments, or bones, particularly among those who engage in skiing and snowboarding. Young athletes are particularly susceptible to musculoskeletal injuries due to factors such as growth spurts and imbalances in relative strength among different anatomical structures as they mature physiologically. In addition to physiological development, other factors can also influence injury risk. These include maturity status, coordination, skills, ability to assess risk, and the use of protective equipment, all of which can vary significantly with age and impact injury risk or severity.[4]
The mean age of injured patients in these studies ranged from 24 to 35.4 years, with an overall mean age of 30.3 years. Two studies have indicated that the age groups most susceptible to injury are children, adolescents, and adults over the age of 50. However, an alternative study identified no elevated risk for adults over the age of 55, with the exception of tibial plateau fractures. The disparate presentation of data pertaining to age-related injuries renders it challenging to draw definitive conclusions regarding the impact of age on injury risk. Furthermore, the growing age of the recreational skiing population introduces additional complexity to the analysis of age and skiing-related injuries.[5]

MECHANISM OF INJURIES

The popularity of recreational skiing is on the rise, with an increasing number of individuals engaging in this winter activity. As a well-established winter sport, skiing carries a substantial risk of injury. Despite differences in demographics, equipment and skill levels, skiing can cause injuries, which may result in physical, psychological and financial challenges in both the short and long term. A more comprehensive grasp of the injuries sustained by those engaged in this form of recreational activity is pivotal to the prevention of injuries and the reduction of their frequency, severity and impact. A substantial body of research has identified discrepancies in the injury profiles of skiers, with variations contingent upon their equipment and techniques. Typically, skiers adopt a forward stance on their skis, utilise poles and wear boots with hard shells and removable bindings. It is of the utmost importance for orthopaedic surgeons to have a comprehensive understanding of the injuries that can occur during skiing, as all regions and anatomical systems are susceptible to damage during this activity.[6]
Prior research has indicated that the risk and severity of accidents for skiers on marked groomed slopes are contingent upon their behaviour, particularly their speed in the immediate vicinity of an accident. The kinetic energy of a moving body is proportional to the square of its speed, and higher speeds also diminish a skier's capacity to navigate around obstacles or avoid other skiers. These factors are pivotal in understanding why the majority of ski accidents entail high-speed collisions. [7]
In alpine skiing, knee joint injuries are a common occurrence, with ACL ruptures representing the most prevalent diagnosis. This phenomenon frequently occurs in situations where the knee joint is in an elevated inverted position. For instance, it may occur during the landing phase after a jump or when an excessive backward squat is performed during the swing phase, resulting in the displacement of the lower leg by the ski boot while the thigh is pulled backward by the weight of the body. Another frequent occurrence is the sudden internal rotation of the ski on the snow pile, which results in an abrupt cessation of movement

and subsequent excessive pronation of the knee and hip joints, leading to a valgus position. Injuries to collateral ligaments typically result from simple weight-bearing accidents, whereas fractures are frequently caused by direct impact or landing after jumps. Collisions with other skiers or snowboarders are also a common source of injury.[8]
The most common cause of injury among paediatric patients was collision with snow or the ground, accounting for 70.8 per cent of cases. The next most common causes were collisions with immovable objects and injuries caused by twisting movements, followed by incidents while getting on or off a chairlift. Collisions with other people accounted for 3.2% of injuries. In addition, collisions with ski poles, collisions with skis and other injuries accounted for a total of 3.2% of all injuries.[9]

HEAD AND FACIAL INJURIES

Head injuries among downhill skiers ranged from 15.7% to 38% and were more common among experienced skiers, probably due to their higher risk taking behaviour. Forward falls were identified as the main cause of head injury, followed by side falls. Only four studies detailed the location of cranial injuries and the type of fall, focusing on the main bones (frontal, parietal, temporal, occipital and facial. Of these, three studies had larger sample sizes, allowing more detailed analysis. A study of head injuries on Japanese ski slopes found that the occipital region was most commonly injured (53.2%), followed by the frontal region (37.3%). Similar patterns were observed in another study, where the occipital region accounted for 40.8% of injuries, followed by the frontal (37.0%) and temporal (18.5%) regions.

In a study that looked at the type of fall and the resulting cranial injury, forward falls (caused by loss of control on uneven surfaces or crossing skis) mainly involved the frontal bones (36.9%) and facial bones (27.4%), followed by the occipital region (22.6%). Side falls, often caused by catching the edge of the ski, showed a similar pattern, with occipital injuries (30.8%) more common than facial injuries (26.9%). Falls to the rear, caused by loss of balance, mainly involved the occipital region (57.1%), with other regions (excluding the temporal region) more evenly distributed. Collisions with other skiers or objects resulted in a similar distribution of injuries to the facial (30.5%), frontal (28.4%) and occipital (27.7%) regions. For all types of falls and collisions, the temporal region was the least affected.[10]
A clinical review of facial trauma in adults by Galgano et al. revealed that the average age was 38 years, with young adults (ages 18-25) accounting for 36% of the injuries. The proportion of patients aged 65 years and over was only 8.8% of the total sample. The most common injuries were concussions, followed by lacerations, fractures, and contusions. Dental injuries were infrequent, accounting for less than one percent of all injuries. The data indicated that head injuries were more prevalent in women (80%) than in men (60%), whereas oral injuries were more common in men (8%) than in women (1%). No correlation was identified between the location of the injury and the age or race of the patient. The data indicated that concussions and contusions were more frequently observed in women (69%, 15%) than in men (54%, 9%), whereas lacerations were more common in men (24%) than in women (8%). No gender-based differences were observed in the occurrence of dental fractures or injuries. Furthermore, no association was identified between injury type and age or race.
Among the patients who sustained fractures, the most common types were nasal (30.35%) and cervical spine fractures (30.35%), followed by midface (26.8%), mandible (8.9%), and skull fractures (3.6%). The age group most frequently affected by fractures was that of 41-65 year olds, with an average age of 43 years. The high percentage of nasal fractures is consistent

with trends observed in other sports. Although this study was focused on adults, previous research indicates that the most common facial fracture site in paediatric patients engaged in winter sports is also the nose. This pattern supports the idea that younger skiers are particularly prone to injury due to ongoing growth and less developed coordination, skills, and perception.[11]

UPPER LIMB INJURIES

Upper limb injuries are frequently the second most prevalent type of injury sustained by athletes, surpassed only by those sustained during skiing. However, a number of factors can influence the ranking of these injuries within a given sport. According to data from the United States Injury Review, upper limb injuries may be considered second most prevalent, with the thumb and shoulder being the most commonly affected areas.[5]
The data collected in the review by Weinstein et al. is indicated that upper limb fractures represent the second most common injury among adult skiers who engage in the sport for recreational purposes. These injuries include glenohumeral joint [GHJ] dislocation, clavicle fracture and acromioclavicular [AC] joint injury. In children who engage in skiing as a recreational activity, these injuries also represent the second most common category of injury, with fractures, hand sprains, and radial wrist fractures being the most prevalent types.
An equally common injury he describes among skiers is injury to the ulnar collateral ligament [UCL] of the thumb, often known as 'skier's thumb'. This injury usually results from a sudden valgus force on the thumb during a fall, such as when a skier falls while still holding a ski pole. Patients usually feel tenderness on palpation of the affected ligament and may show instability when a passive valgus load is applied to the metacarpophalangeal [MCP] joint. [12]
A review by Robinson et al. reported that two long-term studies analysing injuries at ski resorts showed that injuries to the UCL of the MCP joint of the thumb accounted for between 6.6% and 7% of all recorded skiing injuries. One of these studies identified this injury as the third most common type of injury. [13]

A prospective recording of activity in all cases admitted within one year in a combined primary care and orthopaedic emergency department serving a defined population at a University Hospital in Oslo revealed that skiing accidents were one of the most common causes of acute shoulder injuries, affecting primarily the oldest age group.[14]
The primary causes of shoulder injuries include axial loading, resisting forced abduction of the humerus, and direct impacts to the shoulder. Axial loading and direct impacts are more likely to result in clavicle fractures or AC sprains. The primary cause of rotator cuff injuries is resisting forced abduction, while forced abduction combined with external rotation is a common cause of anterior shoulder dislocations, as reported by patients. Nevertheless, the precise incidence of injuries resulting from these mechanisms remains unclear. Posterior shoulder dislocations are uncommon, representing only 0.4% of all glenohumeral dislocations.[5]

A dislocation of the glenohumeral joint (GHJ) typically arises from a fall on the arm, specific stresses applied to the arm, an axial load on the arm, or a direct impact to the shoulder. The most common cause of anterior GHJ dislocation is a combination of forced abduction, extension, and external rotation of the arm. In rare instances, a direct impact to the posterior aspect of the shoulder may also result in dislocation. Posterior GHJ dislocations typically result from a combination of forcible adduction, flexion, and internal rotation of the arm, frequently occurring in conjunction with high-energy trauma. Infrequently, posterior dislocations may result from a direct impact to the anterior aspect of the shoulder, a posterior

axial load applied to a flexed arm, or strong muscle contractions during seizures or electrocution. Inferior glenohumeral joint (GHJ) dislocations typically occur as a result of a forceful hyperabduction of an already abducted arm, which causes the humeral head to lever against the acromion. Infrequently, this type of dislocation can also be caused by an axial load applied to a fully abducted arm. These mechanisms are typically associated with falls from a height, whereby the individual attempts to brace or catch themselves.[15]

A retrospective descriptive epidemiological study was conducted on data from Denver Health Winter Park Medical Center. The study concentrated on individuals who had sustained clavicle fractures while skiing or snowboarding at Winter Park Resort. The results indicate that clavicle fractures among skiers accounted for 2.8 per cent of all injuries, which is slightly higher than the 2.2 per cent reported in previous studies. The primary cause of these injuries was falling on the snow while skiing or snowboarding, accounting for 92.4% of cases. The majority of these fractures (85.5%) involved the middle clavicle. In the case of lateral clavicle fractures, the most prevalent classification was Neer type 2A, followed by types 5, 1, 3 and 2B. Over half of the clavicle fractures were classified as comminuted (54.5%), with the majority exhibiting oblique/spiral characteristics (90.1%). Intra-articular fractures were relatively uncommon, occurring in only 19 cases (4.8%). There was only one instance of an open clavicle fracture (0.3%), and only five patients (1.3%) required transfer to a tertiary care centre. A small percentage of fractures occurred without displacement, without shortening (23.4%), and without angulation. The data indicated that women were more prone to sustaining collarbone fractures while skiing than snowboarding, whereas men exhibited a greater proclivity for such injuries while snowboarding compared to skiing. This is due to the fact that younger males are more prone to engage in risky activities, such as skiing or snowboarding at high speeds, attempting aerial stunts, or using substances such as alcohol and cannabis while on the slopes. Additionally, younger skiers and snowboarders are often less experienced. In contrast to many studies of non-snow sports, our study did not find a bimodal age distribution of fractures. This may be due to the lower representation of older people among skiers and snowboarders.[16]

The epidemiology of ACJ dislocations is also prevalent in non-contact, high-speed sports such as skiing. These dislocations are primarily caused by direct trauma to the shoulder, and thus are common in activities involving contact, high speeds, or traffic incidents.[17]
An ACJ injury may result from either direct or indirect trauma, with the most common cause being a direct impact to the lateral acromion when the arm is in an adducted position. Injuries resulting from indirect trauma are typically associated with the position of the arm and may occur subsequent to a fall onto the same side of the body when the arm is either adducted or outstretched. This increases the susceptibility of the acromioclavicular and coracoclavicular ligaments to injury.[18]

LOWER LIMB INJURIES

Lower limb injuries represent the most common category of injury sustained in alpine skiing. In adults, knee ligament injuries, particularly the medial collateral ligament [MCL] or the ACL injuries, are the most common and account for between 10% and 33% of all skiing-related injuries. Additionally, tibial fractures remain common, accounting for up to 6.4% of injuries. Less common lower limb injuries include partial tears of the gastrocnemius muscle caused by binding failure during forward falls, as well as ankle sprains, fractures and lacerations caused by ski edges.[5]

The medial collateral ligament (MCL) is a flat band of connective tissue extending from the medial epicondyle of the femur to the medial condyle of the tibia, and plays a crucial role in providing valgus stability to the knee joint. MCL injuries are a common occurrence in sporting activities, with skiing accounting for 60% of all knee injuries. These injuries can result from sudden movements such as turning, cutting, or twisting, as well as from direct blows to the lateral knee that produce excessive valgus stress. While MCL injuries can occur in isolation, they often co-occur with other knee injuries. This is exemplified by the "unhappy triad," which involves simultaneous injuries to the MCL, anterior cruciate ligament (ACL), and medial meniscus.[19]

The MCL is the most commonly injured part of the knee. However, the findings of this study indicate that the ACL is also frequently affected and often occurs alongside injuries to other structures within the knee joint. [20]
The typical mechanism of ACL injury has shifted from a backward twisting fall to a forward twisting fall due to advancements in sports equipment. In a backward twisting fall, external forces cause internal rotation of the lower leg with the knee flexed. In contrast, in a forward twisting fall, external forces (such as skis acting as leverage) cause external rotation of the lower leg in a valgus position.[8]
The most prevalent mechanisms that result in [ACL] ruptures in skiing are classified as the "slip-catch," "dynamic snowplough," and "landing back-weighted" mechanisms. The "slip-catch" and "dynamic snowplough" mechanisms are typically observed during the execution of a turn on skis, whereas the "landing back-weighted" mechanism is predominantly evident during the landing phase following a jump. In the "slip-catch" and "dynamic snowplough" mechanisms, the skier initially loses balance inwards and/or backwards, resulting in the outside ski having reduced contact with the snow and subsequently deviating from its trajectory. Subsequently, the inner edge of either the outer or inner ski makes an abrupt contact with the snow surface, resulting in excessive compression of the knee joint, valgus alignment of the knee, and internal rotation of the tibia. Although the arthrokinematic characteristics of these injury mechanisms are similar to those observed in ACL injuries sustained during recreational skiing, the underlying causes and events leading to the injury are specific to competitive alpine skiing. This is due to the direct interaction between the skis and the snow, which is influenced by the use of aggressive equipment and the preparation of artificial snow surfaces. In the "landing back-weighted" mechanism, the skier typically loses balance during flight due to the transfer of angular momentum from the forward to the backward direction at the moment of jump take-off. This results in the skier landing on the tails of the skis first, with the entire ski then making contact with the snow surface. This sequence of events results in the rotation of the skis forward as the skier falls backward, leading to tibiofemoral compression and the tibia being pushed forward by the stiff rear part of the ski boot. Furthermore, the abrupt and forceful contraction of the quadriceps muscles during the landing phase may contribute to an increase in anterior tibial translation and stress on the ACL. [21]

Tibial plateau fractures are a common injury that have become increasingly prevalent over time. Those with limited skiing experience, including children and adolescents, are at an elevated risk of sustaining lower leg fractures. In fact, children under the age of 10 are nine times more likely to be injured in this manner than skiers over the age of 20. Furthermore, a retrospective study by Stenroos et al. involving patients who presented with tibial fractures at four trauma centres in Finland revealed that the most common fracture among adult skiers was of the tibial shaft (63%), followed by fractures of the proximal tibia (27%) and distal tibia (10%). Furthermore, the study indicated that adults are significantly more likely than children

to experience proximal tibial fractures, with the most common cause being a fall onto the snow.[5] Tibial plateau fractures are a common consequence of downhill skiing, particularly among those with a history of the sport. Although recent data indicates that diaphyseal fractures remain the most common type of tibial fracture, the occurrence of tibial plateau fractures among skiers is nearly three times higher than that of distal tibial fractures. These fractures typically result from axial compressive forces combined with varus or valgus stresses, which cause the proximal tibia to collide with the femur. This leads to either splitting fractures, compression fractures, or a combination of both. Tibial plateau fractures are classified using a variety of systems, with the Schatzker classification being the most prevalent in North America. Schatzker types I through III are typically associated with low-energy fracture patterns, which are often observed in osteoporotic bone and result in compression fractures. In contrast, Schatzker types IV through VI are associated with high-energy injuries, such as those sustained in motor vehicle accidents or other high-velocity incidents. Individuals of a younger age are more likely to experience a split fracture of the lateral plateau due to their stronger bone structure. In contrast, individuals of an older age are more prone to compression fractures.[22]

DEEP CUTS LIMBS INJURIES

It is notable that serious skiing-related injuries frequently include deep cuts, which account for a significant proportion of all skiing injuries, with figures ranging from 5.6% to 33.6%. In a study of 20,000 injured skiers, Johnson et al. identified lacerations as the third most common injury, following knee sprains and thumb ligament injuries. The majority of injuries (93.9%) occurred in the lower extremities, while the upper extremities were affected in 6.2% of cases. In an analysis conducted by Sergio Soares, the primary mechanisms for these injuries were identified as inadvertent release of bindings (52.2%), inappropriate skiing skills for the slope (21.7%), collisions (17.4%), and jump landings (8.7%).[23]

SPINE INJURIES

A higher incidence of fractures or dislocations was observed in the cervical spine, followed by the thoracic and lumbar spine. Injuries to the cervical spine were more prevalent among skiers and were the most probable cause of spinal cord injuries (SCI). In addition to head injuries, those with injuries to the thoracic and lumbar vertebrae were more likely to experience multiorgan trauma than those with injuries to the cervical spine. The majority of skiing-related injuries are the result of falls or collisions, with a high prevalence of cervical injuries.[24]

The typical skiing fall results in forward movement, which can lead to hyperextension of the cervical spine. Falls that involve axial loading frequently result in burst fractures. The lumbar spine is the most frequently injured area in the majority of studies, with injury rates ranging from 30.1% to 64.8%. Cervical spine injuries were reported in 40.7% of cases, while lumbar spine injuries accounted for 35.2%.

It is found that thoracic spine fractures are the most common, a finding that is supported by much of the literature on the subject. Indeed, the thoracic spine is often cited as the second most commonly injured region, with rates between 19.8% and 31.1% . Additionally, thoracic spine injuries tend to be more severe.

Vertebral body fractures are the most prevalent form of spinal injury, with two studies identifying these as mainly compression fractures. However, Tarazi et al. reported that only 40% of cases were compression fractures, while burst fractures accounted for nearly 60% of cases. It is uncommon for more severe distraction and rotation type fractures to be reported.

Yamakawa et al. observed that transverse process fractures were present in over a quarter of skiing injuries . Conversely, Tarazi et al. did not report transverse process fractures but noted a high incidence of cervical facet fractures. Spinous process, odontoid peg, and teardrop fractures are rarely mentioned in skiing injury reports.[25]

LEVEL OF SKIING AND THE RISK OF INJURY

A study conducted by the Department of Orthopaedics and Traumatology at the Faculty of Medicine, Erzincan University in Erzincan, Turkey, investigated the injury patterns and epidemiological characteristics of individuals seeking medical attention after sustaining injuries while skiing or snowboarding recreationally. The study highlighted one notable finding.

As reported by the patients themselves in the course of our study, over half (60.8%) were classified as belonging to the beginner to intermediate level. This finding is consistent with those of previous studies and a meta-analysis, which have identified lower skill levels as a significant risk factor for injuries. A comparative analysis of objective skill levels versus self-reported abilities revealed that there is often a discrepancy between the two, with skiers and snowboarders frequently overestimating their proficiency. This indicates that a greater number of injured participants may, in fact, be novices, contrary to their self-assessment. It remains a significant and challenging task for ski resorts to educate novice skiers and snowboarders about resort safety and to encourage them to ski or board within their skill level.[6]

BENEFITS OF SKIING

Despite hazard of skiing, there are many positive aspects of this sport. It is thought that the benefits of this activity include increased physical exercise, which could contribute to a healthier lifestyle, and the potential to meet the widely accepted physical activity guidelines of 150 minutes of moderate or 75 minutes of vigorous activity per week.Skiing is a winter outdoor sport that is typically conducted on snow-covered slopes in mountainous regions. The activity is characterised by cold temperatures and moderate altitudes, with typical ranges between 1,500 and 2,500 metres. Skiers ascend using ski lifts and cable cars and then descend, employing muscular exertion to counteract the force of gravity through the execution of downhill turns. The generation of muscle power is primarily achieved through eccentric and isometric contractions, with energy supplied both anaerobically and aerobically. This results in intensity-dependent responses of the cardiopulmonary system. The challenges to these systems are contingent upon a number of factors, including skiing speed, turn radius, terrain steepness, snow and ambient conditions, skiing equipment, and the individual's skill, fitness, and health. It is therefore evident that the considerable variability in cardiopulmonary and metabolic responses to downhill skiing is to be expected.

Downhill skiing can provide sufficient stimuli to promote beneficial adaptations in both sexes across a range of age groups. Furthermore, the cold temperatures and moderate altitude (hypoxia) experienced during skiing may also contribute to the beneficial effects of this activity. Furthermore, skiing can facilitate an increase in leisure-time activity levels, which are typically associated with a more favourable lifestyle. Even a single weekly skiing session can contribute significantly towards meeting the recommended physical activity guidelines of 150 minutes of moderate-to-vigorous activity per week. This is essential for improving or maintaining cardiorespiratory fitness and preventing or treating chronic diseases. It has been demonstrated that skiing can enhance VO2max, particularly by increasing capillary density in the primary muscle groups used. Furthermore, there is a well-established inverse relationship

between cardiorespiratory fitness and cardiovascular risk factors. Research has shown that long-term skiing is associated with healthier lifestyle characteristics and better health status compared to the general population. A significant "dose-dependent" effect of skiing on self-reported cardiovascular risk factors such as hypercholesterolaemia, hypertension, diabetes and memory problems has been observed. Another study in elderly participants showed improved exercise capacity (cardiorespiratory fitness, VO2max), reduced body fat mass and improved glucose tolerance after 12 weeks of supervised skiing compared to controls. In addition, increased endothelial progenitor cells and reduced peripheral arterial tone were reported, suggesting the preventive potential of skiing on atherogenesis. The effectiveness of downhill skiing in reducing cardiovascular risk factors is supported by evidence that eccentric exercise has a beneficial effect on lipid concentrations and glucose tolerance. Downhill skiing may not only promote healthy ageing, but also help to maintain a high level of fitness, similar to other popular winter sports such as cross-country skiing.[1]

It has been demonstrated that participation in alpine skiing has a beneficial impact on the prevention of sarcopenia and muscle weakness in older individuals. The latter years of life are regarded as a distinctive period for all individuals. It is of the utmost importance to engage in recreational activities during this period, as they facilitate the maintenance of body weight, enhance flexibility and elevate serotonin levels, which are commonly referred to as the 'happy hormone'. Some studies indicate that older individuals who engage in physical activity and adhere to a healthy lifestyle may exert a significant influence on the process of biological ageing, potentially reducing their biological age by up to 25 years. Consequently, skiing represents an optimal recreational activity, as it enhances motor abilities and exerts a beneficial influence on biological processes. [26]

Lifetime sports are activities that can be enjoyed at any age. They are driven by intrinsic motivations such as enjoyment or health benefits and are especially popular among older adults. Alpine skiing (AS) is the epitome of a lifetime sport, offering a unique opportunity to increase physical activity during winter. Its popularity as an outdoor activity during this season makes it the perfect choice for those looking to embrace the winter season with a healthy dose of winter sports. While learning AS can be complex and carries some risks, it allows for early participation, which leads to high adherence and a low dropout rate. It also aligns perfectly with sports practice recommendations for older adults, even for those with chronic conditions.

Recent studies have proven the numerous physical health benefits associated with AS. This sport is an effective way to improve cardiorespiratory fitness and strengthen key locomotor muscles. It involves intervallic strength and endurance at moderate to high intensity. While research on the mental health benefits of AS is limited, there is compelling evidence that it helps maintain and improve mental health in adults. It has been shown to have positive effects on mood, self-concept, depression levels and life satisfaction. Skiing, typically practised over the course of a day, is an effective combination of beneficial cardiovascular responses and necessary rest periods during lift rides. The intermittent medium- to high-intensity efforts engage the entire locomotor system, which undoubtedly boosts the ability to perform daily tasks and improves bone density, reduces body fat, and lowers insulin resistance – factors all linked to overall health. [27]

SUMMARY

Skiing despite the prevalence of injuries such as ACL sprains and fractures, particularly among novice skiers and those who engage in risky behaviour, alpine skiing offers significant

health benefits. The sport has been demonstrated to enhance cardiorespiratory fitness, muscle strength and mental wellbeing, conferring lifelong advantages despite the inherent risks.

Disclosure
Conceptualization, MK, and KK; methodology, MK; software, KK; check, KC,JC,JK; formal analysis, KC; investigation, WK; resources, MK; data curation, JC; writing- rough preparation, AS; writing- review and editing, KC; visualization, WK,MK,KC,AS,JK,JC,KK,MK; supervision, MK; project administration,KK; receiving funding,MK
All authors have read and agreed with the published version of the manuscript.

Funding
This research received no external funding.

Institutional Review Board Statement
Not applicable.

Informed Consent Statement
Not applicable.

Data Availability Statement
The data presented in this study are available on request from the corresponding author.

Conflicts of Interest
The authors declare no conflicts of interest.

Acknowledgments
None.

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