

ORIGINAL ARTICLE

**WINTER SPORTS PRACTICE IN POLAND: CHARACTERISTICS, INJURIES AND RISK FACTORS**

**UPRAWIANIE SPORTÓW ZIMOWYCH W POLSCE: CHARAKTERYSTYKA, URAZY I CZYNNIKI RYZYKA**

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**ABSTRACT**

**Introduction**

As much as 13% of Poles declare active skiing or snowboarding. Literature has identified many risk and protective factors for winter sports injuries. However, their significance is not fully defined and due to the authors knowledge, literature concerning winter sports injuries in Poland is lacking.

**Aim**

To examine the characteristics of practicing winter sports, injuries related to them and analyze potential risk and protective factors.

**Material and methods**

This was a survey study. Inclusion criteria were: age 18–60, exclusion criteria were: injury of the same body part not related with winter sports in last three years and chronic musculoskeletal diseases. The statistical method was Chi-square, ANOVA with post-hoc tests and logistic regression for multivariable analysis of potential risk and protective factors. All p-values were two-tailed and significance threshold was < 0.05.

**Results**


523 persons completed the questionnaire. After implementing study criteria, 416 people (271 men and 145 women) were included in the study. 315 people were skiing, 154 people were snowboarding, 85 people were ski touring, 199 people were injured during practicing winter sports. Most often were knee injuries (n = 76), shoulder injuries (n = 52) and wrist injuries (n = 36). Risk factors were: more experience (OR = 1.04, 95%CI = 1.01–1.07) and skiing (OR = 1.93, 95%CI = 1.10–3.40), while strength training in off-season was a protective risk (OR = 0.44, 95%CI = 0.22–0.87).

**Conclusions**

In Polish winter sports participants the most commonly injured sites were the knee, shoulder and wrist. More experience and skiing were associated with higher risk of injury, while strength training in off-season was associated with lower risk of injury.

**Keywords:** skiing, snowboarding, prevention, training, experience

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## STRESZCZENIE

### Wstęp

Aż 13% Polaków deklaruje aktywne uprawianie narciarstwa lub snowboardu. W literaturze zidentyfikowano wiele czynników ryzyka i ochronnych urazów podczas uprawiania sportów zimowych. Istotność tych czynników nie jest jednak w pełni kreślona, a zgodnie z wiedzą autorów istnieją braki w obrębie literatury dotyczącej urazów w sportach zimowych w Polsce.

### Cel pracy

Zbadanie specyfiki uprawiania sportów zimowych, urazów z nimi związanych oraz analiza potencjalnych czynników ryzyka i czynników ochronnych.

### Materiał i metody

Było to badanie ankietowe. Kryteriami włączenia były: wiek 18–60 lat, kryteriami wykluczenia były urazy tej samej części ciała niezwiązane ze sportami zimowymi w ciągu ostatnich trzech lat oraz przewlekłe choroby narządu ruchu. Do analizy statystycznej zastosowany testy Chi-kwadrat, ANOVA z testami post-hoc i regresję logistyczną dla wieloczynnikowej analizy potencjalnych czynników ryzyka i czynników ochronnych. Wszystkie wartości  $p$  były dwustronne, a próg istotności wynosił  $< 0,05$ .

### Wyniki

Ankietę wypełniły 523 osoby. Po spełnieniu kryteriów badania do badania włączono 416 osób (271 mężczyzn i 145 kobiet). 315 osób jeździło na nartach, 154 na snowboardzie, 85 uprawiało skitouring. Podczas uprawiania sportów zimowych 199 osób doznało urazu. Najczęściej były to urazy kolana ( $n = 76$ ), barku ( $n = 52$ ) oraz urazy nadgarstka ( $n = 36$ ). Czynnikiem ryzyka były: większe doświadczenie (OR = 1,04, 95%CI = 1,01–1,07) oraz jazda na nartach (OR = 1,93, 95%CI = 1,10–3,40), natomiast trening siłowy poza sezonem stanowiło czynnik ochronny (OR = 0,44, 95%CI = 0,22–0,87).

### Wnioski

U polskich zawodników sportów zimowych najczęściej kontuzjowanymi miejscami były staw kolanowy, barkowy i nadgarstek. Większe doświadczenie i jazda na nartach wiązały się z większym ryzykiem kontuzji, podczas gdy trening siłowy poza sezonem wiązał się z niższym ryzykiem kontuzji.

**Słowa kluczowe:** narciarstwo, snowboard, prewencja, trening, doświadczenie

### Introduction

The growing popularity of winter sports and increasing number of ski slopes caused that in 2021, as much as 13% of Poles declared active skiing and snowboarding (Vanat, 2022). In the 2018/2019 season, there were as much as 1766 interventions of Mountain Volunteer Search and Rescue Beskids on ski areas. The most common causes of intervention were limb injuries (81%). Help was mainly provided to skiers (75%) and snowboarders

(22%) (GOPR Beskidy, 2019). In the literature many risk and protective factors such as age, sex, skiing experience level, self-assessed skill level, body mass index, specific training, trail difficulty level and equipment fitting were identified up to date (Davey et al., 2019). However, the significance of these factors is not fully defined. What is more, due to the authors knowledge, literature concerning winter sports injuries in Poland is lacking.

## Aim

To examine the characteristics of practicing winter sports, injuries related to them and analyze potential risk and protective factors.

## Materials and methods

A questionnaire survey was placed in online groups of all sorts of skiers and snowboarders from beginners to professionals. Self-designed questionnaire consisted of five sets of questions covering different issues:

1. **Demographics:** Age, gender, weight, height, type of winter activity (skiing, snowboarding, ski touring), self-assessed level of proficiency in that activity (beginner, intermediate, advanced, professional).
2. **Activity characteristics:** Skiing (on-piste, freeriding), snowboarding (on-piste, freeriding), ski touring.
3. **Off-season training:** Strength training, endurance training.
4. **Injuries sustained during winter sports:** Injuries amount and characteristics (location, type), need for rehabilitation or physiotherapy (self-exercising, supervised rehabilitation/physiotherapy), duration of ruling out from sport-related activity, pain duration.
5. **Comorbidities:** Chronic musculoskeletal or rheumatic disorders.

Responders could choose more than one activity. Responses were further analyzed statistically, using Statistica 13.1 software. The statistical method was Chi square ( $\chi^2$ ) test, ANOVA with post-hoc tests and logistic regression for multivariable analysis of potential risk and protective factors. All p-values were two-tailed and significance threshold was set at less than 0.05. 523 people responded to the survey. After implementation of study criteria, 416 people remained. Detailed data with inclusion and exclusion criteria was summarized in the Figure 1.

The included skiers consisted of 271 men and 145 women, with an average age of 32.06 years (SD = 9.49). The average height was 175.83cm (SD = 10.31), the average body

weight 74.16kg (SD = 14.45) average BMI (body mass index) 23.86 (SD = 3.49). Data of skiers self-assessed skill level was presented in Figure 2.

They practiced winter sports for on an average of 16.7 years (SD = 10.51). This duration differed significantly depending on the declared level of proficiency ( $p < 0.001$ ) and it was: for beginners 2.79 years (SD = 2.62); intermediate 11.36 years (SD = 7.83); for advanced 20.29 years (SD = 9.97); for professionals 22.45 years (SD = 10.35). 315 people were skiing, 71 of them performed freeride. 154 people were snowboarding, 45 of them performed freeride. 85 people performed ski touring. 131 people were performing some kind of off-season training. Among those, 95 were performing strength training and 97 were performing endurance training.

## Results

Among people who met study criteria 199 (47.84%) people were injured during winter sports practice. Among those were 134 men (49.45% of men) and 65 women (44.83% of women). 158 people suffered soft tissue injuries (106 men; 52 women) and 85 people suffered bone tissue injuries (61 men; 23 women). Detailed data was summarized in the Table 1.

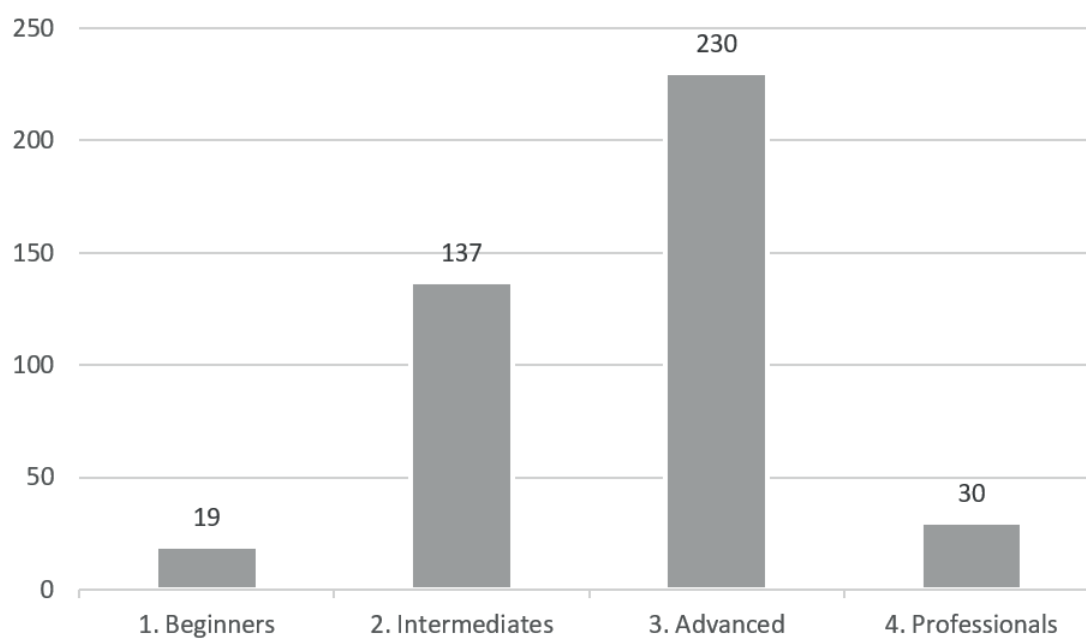
121 of the 199 participants who experienced an injury performed any rehabilitation or physiotherapy, including 35 who were self-exercising without any supervision. Injuries ruled out participants of the survey from any sport-related activity for an average of 4.44 months (SD 8.03). Pain continued through average 10.73 months (SD 15.14).

Concerning overall injury risk, calculated risk factors were: skiing (compared to snowboarding and ski-touring) and more experience; while strength training was a protective factor. Detailed data was summarized in the Table 2.

As to the soft tissue injury risk, more experience turned out to be a risk factor, while strength training a protective factor. Detailed data was summarized in the Table 3.



**Figure 1.** Flowchart of patients included and excluded from the study, with reasons



**Figure 2.** Distribution of patients included in the study according to their self-assessed skill level

**Table 1.** Type of injuries and their amount.

Type of injuries	Overall injuries	Soft tissue injuries	Bone tissue injuries
Knee injuries	91	76	15
Shoulder injuries	52	39	13
Wrist injuries	36	19	17
Hand or finger injuries	30	16	14
Forearm injuries	24	12	12
Upper arm injuries	17	6	9
Ankle injuries	15	11	4
Rib injuries	15	8	7
Foot injuries	15	2	13
Head injuries	14	10	4
Clavicle injuries	12	0	12
Shin injuries	12	6	6
Spinal injuries outside the neck	11	9	2
Hip injuries	9	8	0
Thigh injuries	8	6	2
Neck injuries	7	7	0

**Table 2.** Factors affecting injury – overall, multivariable analysis.

Variable	Odds Ratio (OR); CI 95%	"p" value
Age	1.03 (1.00–1.06)	0.059
<b>Experience</b>	<b>1.04 (1.01–1.07)</b>	<b>0.008</b>
Gender (male vs. female)	1.18 (0.69–2.03)	0.540
Body mass index	0.96 (0.89–1.03)	0.216
Freeriding	0.65 (0.38–1.09)	0.104
<b>Skiing vs no-skiing</b>	<b>1.93 (1.10–3.40)</b>	<b>0.022</b>
Endurance training in off-season	0.87 (0.41–1.90)	0.714
<b>Strength training in off-season</b>	<b>0.44 (0.22–0.87)</b>	<b>0.032</b>

Concerning bone structures injury risk, people who ski, were significantly more prone to bone structures injuries compared to snowboarders and people doing ski tours. Another risk factor was more experience. There were no protective factors detected. Detailed data was summarized in the Table 4.

### Discussion

The most important results of this study are that more experience and skiing vs snowboarding or ski-touring were associated with

higher risk of injury, while strength training in off-season was associated with lower risk of injury. Relevance of experience persisted in separate analysis of soft tissues and bony structures injuries. On the other hand, skiing was only a risk factor for bone structures injuries, while strength training was only a protective factor for soft tissues injuries. Possible explanations of above phenomena and comparison of analyzed factors are presented below.

**Table 3.** Factors affecting soft tissue injuries, multivariable analysis.

Variable	Odds Ratio (OR); CI 95%	"p" value
Age	1.03 (1.00–1.06)	0.067
<b>Experience</b>	<b>1.04 (1.01–1.07)</b>	<b>0.003</b>
Gender (male vs. female)	1.09 (0.63–1.89)	0.748
Body mass index	0.96 (0.90–1.03)	0.247
Freeriding	0.77 (0.46–1.29)	0.319
Skiing vs no-skiing	1.38 (0.78–2.43)	0.266
Endurance training in off-season	0.87 (0.42–1.81)	0.711
<b>Strength training in off-season</b>	<b>0.46 (0.23–0.91)</b>	<b>0.025</b>

**Table 4.** Factors affecting bone structures injuries, multivariable analysis.

Variable	Odds Ratio (OR); CI 95%	"p" value
Age	0.98 (0.94–1.01)	0.185
<b>Experience</b>	<b>1.05 (1.02–1.09)</b>	<b>0.003</b>
Gender (male vs. female)	1.23 (0.76–2.41)	0.283
Body mass index	1.00 (0.98–1.02)	0.659
Freeriding	0.88 (0.48–1.62)	0.687
<b>Skiing vs no-skiing</b>	<b>3.77 (1.92–7.42)</b>	<b>0.0001</b>
Endurance training in off-season	0.45 (0.19–1.09)	0.077
Strength training in off-season	0.75 (0.36–1.55)	0.441

### Age & Experience

Among the participants of our study, the risk of injury was not affected by age, however it was positively associated with experience. Because of the varying ways that data on the age and experience of injured patients is presented and analyzed, it is difficult to draw definite conclusions about the effect on the overall risk of injury in winter sports (Davey *et al.*, 2019). Injury trends were reported to occur in a bimodal fashion, with increasing incidence of trauma observed among the very young and inexperienced skiers and the older more experienced skiers seeking challenges beyond their abilities (Meyers *et al.*, 2007). Some studies suggests that beginners have a higher risk of injury due to inexperience and improper equipment fitting (Bouter *et al.*, 1989; Ekeland *et al.*, 1993; Goulet *et al.*, 1999, 1999; Hagel, 2005; Kocher *et al.*, 1998; Meyers *et al.*, 2007). However, in the current study people below 18 years

old were not included, and only 19 (4.57%) beginners were included.

### Gender

In the current study, there was no gender difference in risk of injury. Some studies show that men are more likely to suffer from bone injuries (Burtscher *et al.*, 2008; Davey *et al.*, 2019; Davidson and Laliotis, 1996). It is most likely due to greater risk-taking behavior in men (Willick *et al.*, 2017). However, newer and more complex analyzes with a larger research group show that men are more likely to have overall injuries while women are more susceptible to soft tissue injuries, including knee ligament injuries (Lefevre *et al.*, 2013; Raschner *et al.*, 2012; Shea *et al.*, 2014). Another study (Kim *et al.*, 2012) found that injury rate among snowboarders was higher in female participants, which is different from other investigations.

### Body mass index

In the literature there is an insufficient data associating BMI with the overall injuries of the skiers and snowboarders. According to our analysis BMI was not a significant risk factor. On contrary, in the study of Ruedl *et al.* who assessed injuries in female skiers, increased BMI was significant risk factor for skiing ACL injury in univariate analysis, while in multivariate analysis it was not significant (Ruedl *et al.*, 2011). Fakhry *et al.* reported BMI to be associated with an injury pattern of increased rates of extremity fractures and worsening outcomes in the general trauma setting (Fakhry *et al.*, 2021).

### Freeriding

Results of our study indicate that skiers and snowboarders who freeride have no significant difference for having an injury overall. The study by Frühauf *et al.* analyzed injuries in group of freeriders, however the authors of the current study failed to find any publication comparing injury rate in winter sports participants performing vs. not performing freeride (Frühauf *et al.*, 2020). Study by Hasler *et al.* analyzed 117 snowboarders with traumatic brain injury (TBI). 82.9% of TBI occurred while riding on-slope and 5.1% off-piste (n = 6). Analyses comparing riders off-piste (freeriders) versus on-slope showed a significantly increased adjusted OR of 26.5 (p = 0.003) for sustaining a moderate-to-severe (TBI) among off-piste snowboarders (Hasler *et al.*, 2015).

### Skiing vs snowboarding and ski-touring

In our study, skiers had higher overall and bone injury risk compared to snowboarders and people doing ski touring. This results is in agreement with the study of Wallner *et al.*, who reported less amount of severe injuries following interindividual collisions in snowboarders than skiers (Wallner *et al.*, 2022). In the study by Yoshimura *et al.*, snowboarders were almost twice as likely to require general anesthesia emergency surgery following winter sports injury. However, their study concerning trauma care patients and therefore

it cannot be extrapolated on the whole winter sports participants population. (Yoshimura *et al.*, 2022). In the recent study of Huffman *et al.*, snowboarders were more prone to acute vertebral fractures than skiers. However, the authors reported significant decrease between 2000–2003 compared to 2016–2019 (Huffman *et al.*, 2022). This is in agreement with 18-year case control study by Kim *et al.*, who noted that the rate of injury in snowboarders to skiers were varying over time likely because of the newness of snowboarding and the majority of participants being beginners (Kim *et al.*, 2012).

### Off-season training

Various training methods are proposed by different studies to prevent winter sports injuries. One of the methods are endurance training and strength training (Dem *et al.*, 2004; Hunter, 1999; Kocher *et al.*, 1998; Koehle *et al.*, 2002; Laskowski, 1999; Meyers *et al.*, 2007; Reider and Marshall, 1977; Steadman *et al.*, 1987). In spite of all the advice, there is not convincing evidence that off-season strength and endurance training can reduce the risk of winter sports injuries. In the current study group, endurance training was not a protective factor, while strength training was associated with reduced overall risk of injury and risk of soft tissues injury. Interestingly, there was no such association with bone structures injury. One of possible explanations is that in cases of bone structures injury the trauma was occurring with higher force and muscle strength was not as important as in lower-force soft tissues injuries. These results are in agreement with the 10-year longitudinal study by Raschner *et al.*, in which core strength was stated to be a critical factor in preventing injuries (Raschner *et al.*, 2012).

### Limitations of the study

This study is retrospective in design, with all inherent limitations of that. What is more, it is based on a questionnaire survey and not a professional medical database. The number of included patients is relatively high, however in some subgroups it could be higher.

Nevertheless, this study has some strengths as well. Due to strict study criteria, people with injuries not related with winter sports, people with rheumatic and musculoskeletal diseases were excluded, eliminating potential confounders. What is more, data were analyzed by the means of logistic regression, allowing for assessment of simultaneous assessment of multiple variables on the injury risk.

### Conclusion

In Polish population of winter sports participants, the most injured sites were the knee, shoulder and wrist. More experience and skiing were associated with higher risk of injury, while strength training in off-season was associated with lower risk of injury.

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Authors disclose all financial and personal relationships that could influence their work.