


Sex differences in sledging injuries: a retrospective 10-season study from a Swiss level 1 trauma centre

Jolanta Klukowska-Rötzler , Annika Buerzle, Aristomenis Konstantinos Exadaktylos, Steffen Niemann, Flavia Bürgi, Dominik Andreas Jakob

To cite: Klukowska-Rötzler J, Buerzle A, Exadaktylos AK, *et al.* Sex differences in sledging injuries: a retrospective 10-season study from a Swiss level 1 trauma centre. *BMJ Open Sport & Exercise Medicine* 2023;**9**:e001615. doi:10.1136/bmjsem-2023-001615

Accepted 9 June 2023

ABSTRACT

Objectives Sledging is a popular and traditional winter sport in Switzerland. This study examines injury patterns of patients who presented to a tertiary trauma centre in Switzerland following sledging trauma, focusing on sex differences.

Methods Retrospective single-centre study over 10 winters (2012–2022), including all patients experiencing sledging-related trauma. Injury history was collected and analysed from the patient data and demographic information. The Abbreviated Injury Scale and the Injury Severity Score (ISS) were used to classify injury types and severity.

Results 193 patients were identified with sledging injuries. The median age was 46 (IQR 28–65), and 56% were female. The most frequent mechanism of injury was a fall (70%), followed by collision (27%) and other fall on slopes (6%). Lower extremities (36%), trunk (20%) and head/neck (15%) were the most frequently injured body areas. Fourteen per cent of patients were admitted with head injuries, whereas females were significantly more likely to present with head injuries than males ($p=0.047$). Males were significantly more often admitted with fractures to the upper extremities than females ($p=0.049$). The median ISS was 4 (IQR 1–5), without significant differences between males and females ($p=0.290$). The hospital admission rate was 28.5% for sledging-related injuries. The median length of stay for patients admitted to the hospital was 5 (IQR 4–8) days. The total cost for all patients was CHF1 292 501, with a median of CHF1009 per patient (IQR CHF458–CHF5923).

Conclusion Sledging injuries are common and may result in serious injuries. The lower extremities, trunk and head/neck are frequently injured and could be specifically protected with safety devices. Multiple injuries were statistically more frequent in women compared with men. Males were significantly more often admitted with fractures to the upper extremities, and females were more likely to sustain head injuries. The findings can help to develop data-driven measures to prevent sledging accidents in Switzerland.

INTRODUCTION

Sledging was first recorded in the 19th century in Davos, a small mountain town in Switzerland. Sledges were originally used as

WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ Sledging accidents are often attributed to high speeds and lack of proper control, resulting in collisions with obstacles or other sledgers.
- ⇒ Studies have shown that most sledging accidents occur on slopes with steep gradients and that head injuries are a common outcome, highlighting the importance of wearing appropriate protective gear.
- ⇒ Publications on sledging accidents emphasise the need for increased awareness of safe sledging practices, including proper equipment, responsible speeds and caution when navigating slopes to prevent injuries and promote safe recreational winter activities.

WHAT THIS STUDY ADDS

- ⇒ Sledging injuries are common and may result in serious injuries.
- ⇒ Multiple injuries were more common in women than in men. Men were significantly more likely to be admitted with upper limb fractures and women were more likely to be admitted with head injuries.
- ⇒ The injury severity is generally minor to moderate, and the lower extremities and head injuries are most common.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ Safety measurements during sledging should take into account not only the differences between age groups, but especially among adults gender differences and possible gender differences in sledging behaviour.
- ⇒ Due to the high number of head injuries, the use of a helmet should be considered while sledging.

transportation tools for large loads during winter. With wooden sledges, it was easier to manoeuvre the heavy load through thick snow than in wheeled carts. The sledgers rapidly realised that it was fun to ride with empty sledges after the load had been delivered.¹

Nowadays, sledging is a very popular winter activity, especially in the alpine region of Europe. This outdoor activity is now available



© Author(s) (or their employer(s)) 2023. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

Correspondence to

Dr Jolanta Klukowska-Rötzler; jolanta.klukowska-roetzler@insel.ch

at almost every ski resort, as it is an easy alternative to skiing and snowboarding, and no previous knowledge is required to go sledging. In addition, a sledging slope needs less snow coverage and can be any wide hiking route or back country road. This makes it even more practical.

Compared with sturdy and robust cargo sledges, modern recreational sledges are more flexible, smaller, lighter and easier to control. This decreases the risk of accidents and injuries.² According to the Swiss Council for Accident Prevention (BfU), there are over a million injuries each year in Switzerland during free-time activities (non-occupational injuries), including 400 000 sports injuries, 90 000 winter sports injuries and approximately 6300 sledging accidents.³

Depending on the type of sledge, manoeuvring needs practice and experience. Helmets and other protective gear are used, but not as frequently as on skiing slopes.^{3 4} Therefore, it is no surprise that injuries are often sustained during sledging.

Fortunately, most of these are minor, and some do not even need medical attention. However, a few accidents with serious injuries have consequences for the people affected. The statistics show that in Switzerland, each year, there is one fatal accident during sledging.⁵

This study aimed to examine injury patterns of patients who presented to a tertiary trauma centre in Switzerland following sledging trauma, focusing on sex differences.

METHODS

Study design

This retrospective study was conducted in the emergency department (ED) of the Insel Hospital, a University Hospital and a level 1 tertiary trauma centre located in Bern, the capital of Switzerland. In 2021, the ED treated nearly 52 000 patients and had a general catchment population of roughly 2 million.⁶

Data collection

This 10-season retrospective study included patients presented to the ED of the Insel Hospital with sledging-related trauma between 1 December 2012 and 31 March 2022. The data for this work were generated from the database of the management system of Bern University Hospital, Switzerland (Ecare, Turnhout, Belgium). We included the patients' data for the following variables: demographic data such as age, sex and nationality. Information on the process of admission to the ED, including season of consultation, time of consultation, route of admission (air rescue, ground-based ambulance, self-referral) and discharge (home, hospitalised), triage status—from non-urgent to very urgent—treatment method (conservative, surgical), admission to hospital department, stay in hospital and necessity of the trauma room and the actions taken in the ED, such as vital signs and imaging. Furthermore, we analysed the injury severity by calculating the Abbreviated Injury Scale (AIS)⁷ for the specific body regions⁸ and the Injury

Severity Score (ISS),⁹ to illustrate the severity of injury for each patient. In addition, we further classified the type of Injury, concussion, unconsciousness, intracranial haemorrhage, abrasions, sprain, skin lacerations, contusion, laceration of organs, pneumothorax, luxation, neurological deficits, fractures and vertebral injury. Finally, we also considered the time (night, day) and mechanism of the sledging accident (fall, collision, faulty slopes), the height of the fall, whether a helmet was worn and the medical costs of the treatment. All duplicated data were removed before the analysis.

Definitions

The AIS is a tool developed to rank injury severity internationally. This classifies an injury by specifically defined body regions (head, facial, neck, chest, abdominal, extremities, external), corresponding to the relative severity on a scale from 1 (=minor) to 6 (=maximal).⁷

The AIS scores for the different AIS body locations form the basis for the ISS. The ISS attempts to standardise the severity of injuries sustained during a trauma. The score is calculated by determining the AIS score for each AIS body location separately. The ISS is then generated by adding the square of the highest AIS scores for the three most severely injured locations. The ISS can range between 0 and 75 points.⁹ If any of the three AIS scores is a 6 (unsurvivable), the score is automatically set at 75.

Inclusion and exclusion criteria

We excluded patients treated for sledging traumas outside December, January, February and March, those who refused general consent and children under the age of 16 years. Children were not included, as they were admitted to a separate ED. In addition, we excluded patients who presented in the ED more than 7 days after the sledging accident (12 patients).

Statistical analysis

For the descriptive analysis, the distribution of continuous variables was described as the median and IQR, as these variables were not normally distributed. The distribution of categorical data was reported as numbers and percentages. The Mann-Whitney U test was used to compare medians for continuous variables. Categorical variables were compared using the χ^2 test or Fisher's exact test. Fisher's exact test was used when more than 20% of cells had expected frequencies of <5. Bivariable analysis was used to identify baseline and outcome variables differences between female and male patients. Variables with $p < 0.05$ were considered significant. In addition, a subanalysis according to different age groups was carried out. The statistical analysis was performed by using SPSS for Windows V.25.0 (IBM, Released 2017. IBM SPSS Statistics for Windows, V.25.0., IBM).

RESULTS

A total of 146 414 patients were admitted to Bern University in the 10 winter seasons between 2012 and 2022, of

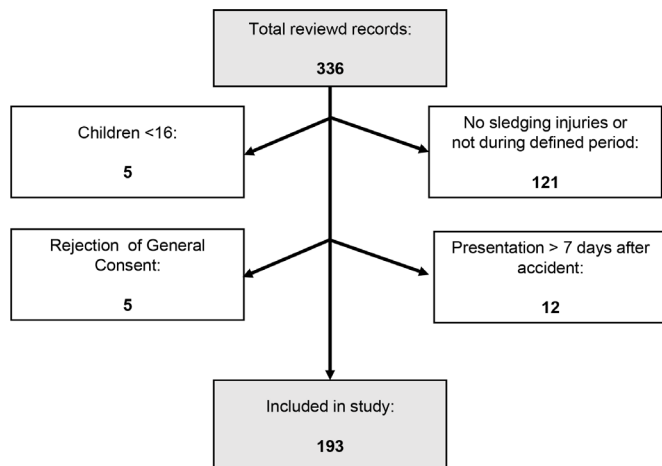


Figure 1 Flow chart illustrating the exclusion and inclusion procedure in this study.

which 198 were sledging related (0.135 %). For trauma patients only, the rate of sledging accidents during this period amounts to 1.34%.

Overall, 336 patients with sledging injuries were identified in the Ecare database between 2012 and 2022. One hundred and twenty-one patients were excluded, as their admission was unrelated to sledging, five patients were younger than 16. Twelve patients were excluded from the study because the visit was more than 7 days after the accident and was not for a first aid visit, and five patients were excluded due to disagreement with the general consent.

Finally, we included 193 patients with sledging injuries who presented in the ED of the Insel Hospital between 1 December 2012 and 31 March 2022 during December, January, February and March (figure 1).

Of the 193 patients, 85 (44%) were male, and 108 (56%) were female. The overall median age was 46 (IQR 28–65) years. The female patients were significantly younger than the male patients (30 (23–41) years vs 36 (29–46) years, $p=0.001$)¹⁰ (figure 2). Thirty-seven per cent of our study's patients ($n=?$) were not Swiss, including about 10% Americans.

The most frequently recorded mechanism of injury was a fall, with 70% ($n=134$), followed by collision (27%, $n=52$) and other mechanism on the slopes (6%, $n=3$). No significant differences were recorded between males and females for the mechanism of injury ($p=0.742$) or transport mode ($p=0.116$) (table 1).

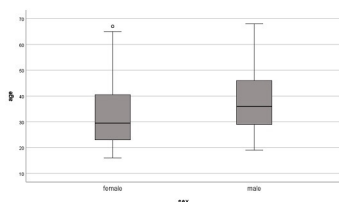


Figure 2 Age distribution between males and females presenting after sledging-related injuries. The central bar represents the median, the box the IQR and the bars the data range. The dots represent mild outlier patients.

The majority of admissions to the hospital were self-referrals (65%, $n=126$), followed by air rescues (28%, $n=53$) and ground-based ambulances (7%, $n=14$). Overall, 55 patients (29%) were admitted to the hospital, compared with 138 (72%) treated as outpatients. Nineteen of the 85 male patients (22%) and 36 of 108 female patients (33%) were hospitalised ($p=0.093$). Patients admitted to the hospital had a median length of stay of 5 (IQR 4–8) days. No difference was observed between males and females ($p=0.901$).

Lower extremities (36%), trunk (20%) and head/neck (15%) were the most frequently injured body areas. In addition, it should be underlined that 20% of all accidents were traumas with multiple body regions. The body regions were damaged to varying degrees, which the estimated AIS and ISS could characterise. The injury locations and severity are presented in table 2.

Overall, 28 patients (14%) were admitted with head injuries. Females were significantly more likely to present with head injuries than were males (AIS score 1: 5 females (5%) vs 1 male (1%), AIS score 2: 15 females (14%) 4 males (5%), $p=0.047$). Of the 21 females admitted with head injuries, 16 (76%) were ≤ 35 years. Of the 7 males admitted with head injuries, only 2 (29%) were younger than 35 years.

Males were significantly more frequently admitted with upper extremity fractures than females (17% vs 7%, $p=0.049$). The fractures to the lower extremities were equally distributed between males and females (14% vs 15%, $p=0.871$). Besides fractures, the most frequent injuries to the extremities were strains and sprains ($n=42$), followed by contusions to bones and ligaments ($n=28$).

The median ISS was 4 (IQR 1–5), without significant differences between males and females ($p=0.290$). There were 9 patients (5%) reported with an ISS greater than 16 and thus classified as severely injured. Of these, four patients were female and five males. The highest ISS was recorded for a female patient with an ISS score of 50.

Following the differences in head AIS between males and females, a significant difference was seen in concussion (8% in males vs 21% in females, $p=0.013$) and loss of consciousness after the accident (2% in males vs 10% in females, $p=0.035$). In the case of vertebral injuries, there was also a trend for increased frequency in females (18% vs 30%, $p=0.054$).

Overall, 148 patients (77%) were treated conservatively; 44 patients (23%) received surgery (table 3), but the differences between males and females were not statistically significant ($p=0.868$).

Two patients were admitted to the intensive care unit. These patients were male, 45 and 66 years old, and required ventilation.

During our study, no fatal outcome occurred, either in the ED, during hospitalisation or up to 30 days after the accident.

The total cost for all 193 patients amounted to CHF1 292 501, corresponding to a median of CHF1009 per patient (IQR CHF458–CHF5923). No statistically

**Table 1** Epidemiological and clinical characteristics of patients presented after sledging-related injuries

	Total N=193 (%)	Male N=85 (%)	Female N=108 (%)	P value*
Demographics				
Age (years), median IQR	33 (26–44)	36 (29–46)	30 (23–41)	0.001
16–25	47 (24)	13 (15)	34 (32)	0.015
26–35	68 (35)	28 (33)	40 (37)	
36–45	35 (18)	21 (25)	14 (13)	
>45	43 (22)	23 (27)	20 (19)	
Mechanism of injury				
Fall	134 (70)	61 (73)	73 (68)	0.742*
Collision	52 (27)	21 (25)	31 (29)	
Other on the slope	6 (3)	2 (2)	4 (4)	
Transportation mode				
Air rescue	53 (28)	21 (25)	32 (30)	0.116
Ground-based ambulance	14 (7)	3 (4)	11 (10)	
Self-referral	126 (65)	61 (72)	65 (60)	

The Mann-Whitney U test was used to compare continuous variables, and the χ^2 test to compare categorical variables unless indicated otherwise.
The cumulative numbers may not reach 100% due to missing values. Mechanism of injury was not documented in one case.
Statistically significant values have been highlighted in bold ($p < 0.05$).
*Fisher's exact test.

significant differences ($p=0.190$) in median costs per patient were observed between males and females (1191 (IQR CHF484–CHF6607) in females vs 837 (IQR CHF422–CHF3077) in males).

Thirty-five patients caused individual costs of over CHF10 000 each, resulting in 79.89% of the total costs. Hospitalised patients accounted for 89% of the total cost

DISCUSSION

This study examined the characteristics of sledging-related injuries that resulted in ED visits between 2012 and 2022, focusing on sex differences. During this period, we included 198 adult patients with sledging-related injuries. According to the Schweizerische Unfallversicherungsanstalt, the most frequent winter sports injuries in Switzerland occur while skiing (58%), snowboarding (12%) or playing ice hockey (11%). Sledging accidents account for 7% (6300) of all winter sports injuries in Switzerland.¹¹

While many studies have investigated injuries associated with winter sports, such as skiing and snowboarding,^{12–17} only a few studies have focused on injuries related to sledging, particularly in adult patients.^{18–21} Severe injury leading to disability is mainly suffered by adults between 17 and 64 years of age.²² More than a quarter (28.5%) of patients evaluated in our ED after sledging injuries were followed up as inpatients, with a median hospital length of stay of 5 days. One hundred and forty-eight patients (77%) were treated conservatively, and 44 patients (23%) needed surgical treatment, of whom 91% required fracture reduction.

In single studies, the severity of sledging injuries has been estimated based on ISS.^{18 21} Corra and De Giorgi found that about two-thirds of the injuries were minor (ISS<4). Severe injuries (ISS>14) occurred in only 4 of 356 cases during the study period. Sledgers with mild injuries were most often between 25 and 34 years old, while those with intermediate injuries (ISS 4–14) were between 15 and 24 years old.¹⁸ These results are in line with our findings. The median ISS in our study was 4, with half of the patients having an ISS between 1 and 5. Only 5% had an ISS of ≥ 16 .

The study by Heim *et al* was conducted in the same Swiss region between 1996 and 2009; the median ISS for sledging injuries has not changed and remains at ISS 4.²¹ This suggests that sledging-related injuries have not increased in severity.

The most frequently injured body location in Heim *et al* was the lower extremities, which is also reflected by our findings.²¹ In our study, head injuries (15%) were more frequent than in the study by Heim *et al* (9.7%). Furthermore, Heim *et al* found that upper body injuries with AIS 2 and higher occurred more frequently in younger patients. In contrast, our study has shown that upper body injuries with AIS 2 and higher were predominantly found in patients 45 years and older. The different inclusion criteria may explain these differences. Heim *et al* included all patients and did not focus on adults alone. The median age was 22 years compared with 33 years in our study. In addition, the patients in Heim's study were collected nearly 15 years ago. Differences in sledging activity and sledging designs, slope safety precautions or

Table 2 According to AIS and ISS, injury locations and severity in patients admitted after sledging-related injuries

	Total N=193 (%)	Male N=85 (%)	Female N=108 (%)	P value*
No head injury	165 (86)	78 (92)	87 (81)	0.047*
Head, AIS 1	6 (3)	1 (1)	5 (5)	
Head, AIS 2	19 (10)	4 (5)	15 (14)	
Head, AIS 3	3 (2)	2 (2)	1 (1)	
No facial injury	180 (93)	78 (92)	102 (94)	0.053*
Face, AIS 1	4 (2)	3 (4)	1 (1)	
Face, AIS 2	6 (3)	1 (2)	5 (5)	
Face, AIS 3	3 (2)	3 (4)	0 (0)	
No neck injury	182 (94)	84 (99)	98 (91)	0.076*
Neck, AIS 1	5 (3)	0 (0)	5 (5)	
Neck, AIS 2	5 (3)	1 (1)	4 (4)	
Neck, AIS 3	1 (1)	0 (0)	1 (1)	
No chest injury	159 (82)	69 (81)	90 (83)	0.956*
Chest, AIS 1	14 (7)	7 (8)	7 (7)	
Chest, AIS 2	9 (5)	4 (5)	5 (5)	
Chest, AIS 3	9 (5)	4 (5)	5 (5)	
Chest, AIS 4	1 (0.5)	1 (1)	0 (0)	
Chest, AIS 5	1 (0.5)	0 (0)	1 (1)	
No abdominal injury	154 (80)	69 (81)	85 (79)	0.866*
Abdominal, AIS 1	18 (9)	9 (11)	9 (8)	
Abdominal, AIS 2	15 (8)	5 (6)	10 (9)	
Abdominal, AIS 3	5 (3)	2 (2)	3 (3)	
Abdominal, AIS 4	0 (0)	0 (0)	0 (0)	
Abdominal, AIS 5	1 (0.5)	0 (0)	1 (1)	
No injury to the extremities	77 (40)	27 (31.8)	50 (46)	0.217*
Extremity, AIS 1	52 (27)	27 (32)	25 (23)	
Extremity, AIS 2	55 (28.5)	27 (32)	28 (26)	
Extremity, AIS 3	9 (5)	4 (5)	5 (5)	
No external injury	146 (76)	66 (78)	80 (74)	0.728*
External, AIS 1	43 (22)	18 (21)	25 (23)	
External, AIS 2	4 (2)	1 (1)	3 (3)	
Injury Severity Score (ISS), median (IQR)	4 (1–5)	4 (1–5)	4 (1–5)	0.290

The Mann-Whitney U test was used to compare continuous variables. Statistically significant values have been highlighted in bold ($p < 0.05$).
*Fisher's exact test.
AIS, Abbreviated Injury Scale; ISS, Injury Severity Score.

protective equipment may all contribute to the different findings.²¹

The age group between 26 and 35 was the most frequently injured in the present study. It is interesting that in the younger age groups (≤ 35 years), more females than males were injured, while in older age groups (≥ 36 years), more males were injured. All in all, there were more female injuries reported than male. This contrasts with the findings from another study, where more injured males were reported.¹⁸ In

an accident database from the USA, males contributed to more than 75% of injured patients. According to a study by Ashby and Cassell, men were over-represented only among patients treated as outpatients, while no sex difference was found for injuries requiring inpatient hospitalisation.²³ In our case, more women were observed among out and hospitalised patients. In the Italian study, patients with minor injuries ($ISS < 15$) were approximately equally represented, while patients with severe trauma ($ISS \geq 15$) were all men.¹⁸

**Table 3** Treatment, outcomes and case costs in patients admitted after sledging-related injuries

	Total N=193 (%)	Male N=85 (%)	Female N=108 (%)	P value*
Treatment				
Conservative	148 (77)	66 (78)	82 (77)	0.868
Surgical	44 (23)	19 (22)	25 (23)	
Hospital admission	55 (29)	19 (22)	36 (33)	0.093
Outcomes				
Mortality 30 days	0 (0)	0 (0)	0 (0)	1.000
ICU admission	2 (1)	2 (2)	0 (0)	0.193*
Ventilator requirements	1 (0.5)	1 (1)	0 (0)	0.258
Hospital LOS†	5 (4–8)	5 (4–8)	5 (3–10)	0.901
Case costs (Swiss francs), median (IQR)	1009 (458–5923)	837 (422–3077)	1191 (484–6607)	0.190

The Mann-Whitney U test was used to compare continuous variables, and the χ^2 test to compare categorical variables unless indicated otherwise.
 *Fisher's exact test.
 †For the 55 patients who were admitted to the hospital.
 ICU, intensive care unit; LOS, length of stay.

According to several international studies based on ED data, sledders most frequently suffered injuries to the head^{18 24 25} and lower extremities.^{23 25 26} The proportion of head injuries in the available studies varies between 10% and 55%, and for the lower extremities, between 12% and 63%.^{18 21 23 26 27} These differences may result from the selected study population (average age), the methodology of the studies (hospital studies, definition of the localisation) and the area and period for the study. In our study population, the body parts most at risk for injury were the lower extremities (36%), trunk (20%), followed by the head and neck (15%) and the upper extremities (10%). Special attention must be focused on the different injury patterns between males and females. Men more frequently sustained lower limbs and chest injuries, whereas women had more head injuries. The phenomenon is difficult to explain, as there were no sex differences in the mechanism of injury (fall, collision or other mechanism on the slopes). The speed at which the accident occurred and possible differences between men and women in using protective equipment may contribute to the different injury patterns. Generally, it is important to emphasise that a helmet protects the head much better. The crash test by the General German Automobile Club (ADAC) shows that the head trauma caused by the impact was reduced by more than 70 percent if a helmet was worn. The probability of a severe head injury (eg, a fracture of the cranial bone) dropped from 90% without a helmet to 10% with a helmet.²⁸ According to the ADAC, a crash similar to the one in the test is comparable to a frontal car crash at 50 km/hour, in which the head impacts an airbag or the unprotected steering wheel. The test arrangement may, therefore, also be applied for a high-speed sledging injury. The ADAC crash tests showed

that even at the rather moderate speed of 25 km/hour, serious injuries occurred even with a helmet.

It is necessary to note that our population does not include cases that ended fatally at the site of an accident. Only patients with vital signs are brought to the ED. Statistics on fatal sledging accidents can be found in the general accident statistics. The BfU reported 12 fatalities between 2000 and 2019.²⁹ This corresponds to an average of less than one death per year from sledging in Switzerland. The mortality risk during sledging per 1 million sledging hours in the years 2015–2019 in Switzerland was estimated at 0.3.³⁰ Fatal accidents may occur due to disregarding safety rules or during risky environmental conditions. For example, in 2022, a fatal accident in Switzerland occurred in which a 33-year-old female collided with a snow grooming vehicle while sledging shortly before midnight.³¹ Another study by Niedermeier *et al*, published in 2019, discussed mortality in winter sports and emphasised differences in data on fatality in recreational sledging.³² This study calculated that the fatality risk was 0.7 per 1 million days of exposure yearly in Switzerland. In Austria, the calculated mean was less than 1.6 deaths per year of sledging. This again emphasises the very low number of fatal outcomes.³²

Fifty-five of the 193 included patients (28%) admitted to the hospital account for almost 90% of the total costs. An Italian study from South Tyrol estimated the cost share for hospitalised patients at only 48%.¹⁸ These differences must be explained in the context of the structure of the hospital and the various medical costs in each country. The high percentage of costs generated by admitted patients in our study may be because patients from across the region are admitted to our hospital with severe symptoms, and minor injuries are usually treated in small

regional hospitals near sledging slopes. This hypothesis is confirmed by the much higher hospital admission rate of 29% in our study—compared with less than 12% in the Italian study. This contributes to the higher costs for admitted patients.

During the COVID-19 pandemic seasons of 2020/2021 and 2021/2022, our ED reported no significant patient increase after sledging injuries. On the contrary, the 2019/2020 season was unusually quiet, with only three injured patients in the present study. This is interesting because a study from Clos *et al* on the number of injuries in children in France during the 2020/2021 season showed an increase in sledging-related injuries.^{11 33} This may be because France closed the ski slopes during the pandemic, and people may have started enjoying alternative winter sports, including sledging. In Switzerland, most of the ski resorts stayed open during the pandemic.

Suggestions for prevention

Since data regarding protective equipment use was often unavailable in the reports, it was not possible to assess the impact of these protective measures. But—as other publications suggest—the percentage of people wearing helmets in sledging is still very low compared with skiing or snowboarding.^{34 35} Other studies have shown that children are particularly prone to head injuries.²⁷ Moreover, having the right shoes with appropriate soles for braking is essential in preventing injuries. Furthermore, appropriate clothing should be promoted on sledging slopes, especially to decrease skin lacerations. Gear for protecting the extremities, such as warm, padded winter clothing or even protectors, could also be beneficial in decreasing the number of sledging injuries, as the extremities are still the most frequent location of the body to be injured. Also, back protectors can help prevent injuries.³⁶

Another approach would be to encourage sledging on designated slopes, as these slopes must fulfil an extensive safety and security catalogue to ensure the environment is as safe as possible. Strict implementation of safety measures on sledging slopes can be a tool to prevent further traumas.

It is equally important to influence the behaviour of people who sledge. In skiing, the Federation Internationale de Ski³⁷ has developed a set of rules that are applied on all slopes where skiers are trained in safety.³⁸ These concepts have also been developed by the BfU with their rules for sledging. These can be found on designated slopes but are rarely displayed in locally popular sledging spots. These rules are easy to understand, and if they were displayed in local sledging sites or even in schools as an educational measure, this could be beneficial in preventing injuries in the coming years. Future research should concentrate on the state of sledging slopes, protective equipment and the behaviour of sledgers.

It is observed that sledging is also popular among foreign tourists, who often are not trained for this sport. More than 30% of the patients in our study were not of

Swiss nationality, of which about 10% were from other continents (America, Asia and Africa). Therefore, safety information brochures should be prepared in several languages, and rental centres should inform international tourists about safety rules, particularly the importance of using a helmet.

Limitations

This is a recent study evaluating sledging injuries in Switzerland during the last 10 years. However, this is also a retrospective study, and therefore, it is also associated with various limitations. As the University Hospital Bern is a level 1 trauma centre, it is more likely to treat severe accidents. Less severe injuries may not have been admitted to our centre and were more likely to be treated by a general practitioner. This might lead to a selection bias.

Furthermore, as this was a single-centre study, the data reflect the catchment area around Bern. Still, it does not necessarily mean that this data can be reproduced in other regions of Switzerland or other alpine regions where people practice sledging.

Finally, it is important to add that missing data on protection gear also makes it impossible to analyse the potential change in behaviour from prevention campaigns.

CONCLUSION

Sledging injuries are common and may be serious. This study shows that sledging trauma is an important topic for prevention in winter sports, especially in the alpine regions. Lower extremities, trunk and head/neck are frequently injured and could be specifically protected with safety devices. Observed patterns of injuries and ED characteristics differ between women and men. Males were significantly more often admitted with fractures to the upper extremities than females. Additional sex-specific studies in sledging must be encouraged, especially in head injuries, including prevention measures such as using a helmet.

Contributors JK-R: corresponding author, guarantor, conceptualisation, acquisition of data, design, methodology, data interpretation and writing original draft; AB: data analysis, data interpretation and writing original draft; AKE: conceptualisation, review and editing; SN: review and editing; FB: review and editing; DAJ: data analysis, visualisation, data interpretation and writing original draft, review and editing. All authors have read and approved the manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval The local ethics committee accepted and approved this study, and informed consent was waived (ID 2021-01180). No individual informed consent was obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data sharing not applicable as no datasets generated and/or analysed for this study.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID ID

Jolanta Klukowska-Rötzler <http://orcid.org/0000-0001-7956-2724>

REFERENCES

- 1 Destination Davos Klosters Tourismus- und Sportzentrum. Davoser Schlitten 2019. 2019. Available: <https://www.davos.ch/davos-klosters/portrait-image/storytelling/davoser-schlitten> [Accessed 21 Feb 2023].
- 2 Bergün Filisur Tourismus. Schlitten Oder Rodel? Was Soll ICH Wählen? 2022. Available: <https://www.schlitteln-berguen.ch/schlitten-oder-rodel> [Accessed 21 Feb 2023].
- 3 Niemann S, Bürgi F, Brügger O. *Use of protective equipment in tobogganing/sledding*. Bern: BFU, Swiss Council for Accident Prevention, 2019.
- 4 Niemann S, Bürgi F, Brügger O. *Use of protective equipment in skiing and snowboarding*. Bern: BFU, Swiss Council for Accident Prevention, 2022.
- 5 Ellenberger L, Derrer P, Niemann S, et al. *Fatal sports accidents 2000–2020*. Berne: BFU, Swiss Council for Accident Prevention, 2021.
- 6 Notfallzentrum Inselspital. Zahlen und Fakten - Universitäres Notfallzentrum. 2022. Available: <http://www.notfallzentrum.insel.ch/de/ueber-uns/ueber-die-klinik/zahlen-und-fakten> [Accessed 21 Feb 2023].
- 7 Association for the advancement of automotive medicine 2022 abbreviated injury scale (AIS). Available: <https://www.aaam.org/abbreviated-injury-scale-ais/> [Accessed 21 Feb 2023].
- 8 T. Gennarelli W. *Abbreviated injury scale (c) 2005 update 2008*. Chicago, Illinois: Association for the Advancement of Automotive Medicine, 2016.
- 9 Baker SP, O'Neill B. The injury severity score: an update. *J Trauma* 1976;16:882–5.
- 10 BFU. *Swiss council for accident prevention status 2022: Statistics on non-occupational accidents and the level of safety in Switzerland*. Berne, 2020. Available: <https://www.bfu.ch/en/the-bfu/doi-desk/10-13100-bfu-2-384-08>
- 11 Unfallstatistik UVG 2021. 2021. Available: <https://www.suva.ch/download/dokument/unfallstatistik-uvg-2021--2386-21.D> [Accessed 21 Feb 2023].
- 12 Wagner M, Pfurtsceller S, Dammerer D, et al. Emergency service assistance for injuries on Alpine ski slopes: a cross-sectional study. *Prehosp Disaster Med* 2022;37:778–82.
- 13 Consuegra A, Lutz K, Exadaktylos AK, et al. Traumatic brain injury in the elderly after a skiing accident: a retrospective cohort study in a level 1 emergency department in Switzerland. *PLoS One* 2022;17:e0273168.
- 14 Morice D, Stokes MAR, Davey J, et al. Severe anorectal injury secondary to jet ski accident: an important and increasing mechanism of injury. *Trauma Case Rep* 2022;42:100703.
- 15 Wahal N, Alabbasi A, Martetschläger F. Injuries of the shoulder in winter sports. *Orthopädie (Heidelberg)* 2022;51:896–902.
- 16 Chesler KC, Howell DR, Khodae M, et al. Are different aged youth skiers and snowboarders experiencing different injury characteristics? *Wilderness Environ Med* 2023;34:45–54.
- 17 Esser T, Gruber C, Bürkner A, et al. Traumatic brain injuries in winter sports: an overview based on the winter sports skiing, snowboarding and ice hockey. *Orthopädie (Heidelberg)* 2022;51:920–8.
- 18 Corra S, De Giorgi F. Sledding injuries: is safety in this winter pastime overlooked? A three-year survey in South-Tyrol. *J Trauma Manag Outcomes* 2007;1:5.
- 19 Chaze B, McDonald P. Head injuries in winter sports: downhill skiing, Snowboarding, sledding, snowmobiling, ice skating and ice hockey. *Neurol Clin* 2008;26:325–32.
- 20 Evans KHC, McAdams RJ, Roberts KJ, et al. Sledding-related injuries among children and adults treated in US emergency departments from 2008 to 2017. *Clin J Sport Med* 2021;31:e460–6.
- 21 Heim D, Altgeld K, Hasler RM, et al. A 13-year analysis from Switzerland of non-fatal sledging (sledding or tobogganing) injuries. *Injury* 2014;45:338–41.
- 22 BFU. Sicherheitsanalyse des Schlittens und Rodelns in der Schweiz 2012. Available: https://www.bfu.ch/media/ou4dnwis/bfu_2-105-01_bfu-grundlagen-sicherheitsanalyse-des-schlittens-und-rodelns-in-der-schweiz.pdf [Accessed 21 Feb 2023].
- 23 Ashby K, Cassell E. Injury in snow and ice sports. 2007;66:1–19.
- 24 Howell CA, Nelson NG, McKenzie LB. Pediatric and adolescent sledding-related injuries treated in US emergency departments in 1997–2007. *Pediatrics* 2010;126:517–24.
- 25 Federiuk CS, Schlueter JL, Adams AL. Skiing, snowboarding, and sledding injuries in a Northwestern state. *Wilderness Environ Med* 2002;13:245–9.
- 26 Cooper JG, Thomson JS, Cooper AJ. Sledding in childhood: just harmless fun? *Emerg Med J* 2003;20:538–9.
- 27 Skarbek-Borowska S, Amanullah S, Mello MJ, et al. Emergency department visits for sledding injuries in children in the United States in 2001/2002. *Acad Emerg Med* 2006;13:181–5.
- 28 ADAC. Rodel-Risiko: Warum Beim Schlittunfall Schwere Verletzungen Drohen. 2022. Available: <https://www.adac.de/reise-freizeit/ratgeber/tests/schlittunfall-crashtest/> [Accessed 21 Feb 2023].
- 29 BFU. Tödliche Sportunfälle 2000–2019 2020. Available: https://www.bfu.ch/media/bgdd2wk4/2020-09-21_erhebung_toedliche_nbu_de.pdf [Accessed 21 Feb 2023].
- 30 BFU. Status 2020: Sicherheitsbarometer sport DEN sport Sicherer zu Machen, ist Möglich. Available: <https://www.bfu.ch/de/die-bfu/medien/sicherheitsbarometer-sport> [Accessed 21 Feb 2023].
- 31 Kantonpolizei Wallis. Wallis: Sicheres Schlitteln. 2022. Available: <https://www.polizeiwallis.ch/medienmitteilungen/wallis-sicheres-schlitteln/> [Accessed 21 Feb 2023].
- 32 Niedermeier M, Gatterer H, Pocecco E, et al. Mortality in different mountain sports activities primarily practiced in the winter season—a narrative review. *Int J Environ Res Public Health* 2019;17:259.
- 33 Clos M, Evain J-N, Wroblewski I, et al. Serious sledding injuries in children dramatically increased during the COVID-19 pandemic. *Acta Paediatr* 2022;111:389–90.
- 34 BFU. Schlitteln Sicher in Fahrt Erhebung 2020. Tödliche Sportunfälle 2000–2019. 2021. Available: [file:///C:/Users/I0302553/Downloads/bfu_3.001.01_Schlitteln%20%E2%80%93%20Sicher%20in%20Fahrt%20\(1\).pdf](file:///C:/Users/I0302553/Downloads/bfu_3.001.01_Schlitteln%20%E2%80%93%20Sicher%20in%20Fahrt%20(1).pdf) [Accessed 20 Mar 2023].
- 35 BFU. Welche Helme Eignen Sich Zum Schlitteln? 2021. Available: file:///C:/Users/I0302553/Downloads/bfu_2.381.01_Welche%20Helme%20eignen%20sich%20zum%20Schlitteln.pdf
- 36 BFU. Schlitteln Ohne Unfall Sicher INS Tal Statt INS Spital 2022. 2022. Available: <https://www.bfu.ch/media/p2ijsugs/sicherheitstipp-schlitteln-2201-de.pdf> [Accessed 21 Feb 2023].
- 37 FIS Facts & Figures. Fis-ski.com 2022 about the International ski and snowboard Federation (FIS). Available: <https://www.fis-ski.com/en/inside-fis/about-fis/general/facts-figures> [Accessed 21 Feb 2023].
- 38 Seilbahn Schweiz. Swiss sliding, Seilbahn Schweiz, Swiss sliding, Seilbahn Schweiz. 2018. Available: https://www.bfu.ch/media/umvbeqbu/2018_verhaltensregeln_schild.pdf [Accessed 21 Feb 2023].