Gender differences in snowboarding accidents in Austria: a 2005–2018 registry analysis

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ABSTRACT

Objectives To elucidate gender differences in snowboarding accidents.

Design Retrospective registry analysis within the Austrian National Registry of Mountain Accidents.

Setting Snowboard-related emergencies between November 2005 and October 2018.

Participants All injured snowboarders with documented injury severity and gender (3536 men; 2155 women).

Primary and secondary outcome measures Gender-specific analysis of emergency characteristics and injury patterns.

Results Over time, the number of mild, severe and fatal injuries per season decreased in men but not in women. Accidents most frequently were interindividual collisions (>80%) and occurred when heading downhill on a slope. Men more often suffered injuries to the shoulder (15.1% vs 9.2%) and chest (6.8% vs 4.4%), while on slopes with higher difficulty levels (red: 42.6% vs 39.9%; black: 4.2% vs 2.5%), while snowboarding in a park (4.8% vs 2.1%) and under the influence of alcohol (1.6% vs 0.5%). Women more often sustained injuries to the back (10.2% vs 13.1%) and pelvis (2.9% vs 4.2%), on easier slopes (blue: 46.1% vs 52.4%) and while standing or sitting (11.0% vs 15.8%). Mild injuries were more frequent in women (48.6% vs 56.4%), severe and fatal injuries in men (36.0% vs 29.7% and 0.9% vs 4%). Male gender, age and the use of a helmet were risk factors for the combined outcome of severe or fatal injuries (OR (99%CI): 1.22 (1.00 to 1.48), 1.02 (1.02 to 1.03) and 1.31 (1.05 to 1.63)). When wearing a helmet, the relative risk (RR) for severe injuries increased while that for mild injuries decreased in male snowboarders only (RR (95%CI): 1.21 (1.09 to 1.34) and 0.88 (0.83 to 0.95)).

Conclusions Snowboard injuries are proportionally increasing in women and the observed injury patterns and emergency characteristics differ substantially from those of men. Further gender-specific research in snowboard-related injuries should be encouraged.

Trial registration number NCT03755050.

INTRODUCTION

Recreational winter sport activities are numerous performed in the Austrian Alps. With fairly constant skier days per season in Austria (~50 million), injury incidences in mountain winter sports are decreasing. Nevertheless, at the national level, skiing and snowboarding continuously rank among the top five causes of sport accidents. Among Austrian residents, approximately 20,000–25,000 people per year are involved in skiing-related or snowboarding-related accidents requiring hospital attention. About 20% are snowboarding related.

Snowboarding has long been predominated by men, but the rise in female participation is becoming more apparent. By 1998, the female proportion had increased to approximately 30%, obviously remaining in this range as seen in numbers from 2012 and 2019. Up-to-date literature on gender-specific differences in injury patterns remains seldom and often incidental within general injury reports or reports on particular injury types. In summary, female snowboarders seem to suffer fewer shoulder, head and facial injuries than their male counterparts. But, higher incidences in arm and knee injuries have also been reported. Furthermore, it is known that men are prone to suffer more severe as well as fatal injuries on ski slopes, while both skiing and snowboarding.
relationship is drawn to an increased risk-taking behaviour of men, not only on ski slopes but also in everyday life.18–23

To our knowledge, the following national registry analysis is the first to primarily focus on gender-specific differences in snowboarding-related accidents. Beyond mere incidences, injury severity distributions, injury patterns, emergency characteristics and risk factors for the composite outcome of severe or fatal injuries are elaborated. Using data collected nationally over a considerable period of 13 years made an extensive analysis possible.

MATERIAL AND METHODS
Data were obtained from the digital National Registry for Mountain Accidents in Austria. This registry stores anonymised data on emergencies and rescue operations in the Austrian Alps and is maintained by officers of the Alpine Police. As qualified alpinists, these officers have basic medical training (first aid and basic life support). As soon as an emergency call is made to the dispatch centre and third-party negligence may be involved, as with trauma and rarely with internal medicine cases, the Alpine Police investigates and an entry is made in the registry. For this purpose, data are mainly obtained not only on-site, but also from the hospital, if necessary. Snowboarding emergencies from initiation of the registry on 1 November 2005–31 October 2018 were extracted (figure 1). Data analysis was performed after excluding patients not injured or with missing documentation of gender and injury severity.

Data analysis included gender, age, date, activity performed prior to the accident, terrain, difficulty level of the terrain, cause of the accident, helmet use, alcohol influence, injury severity, mode of rescue, type and site of injury. A snowboard season was defined as 1 November–31 October of the following year, as this is comparable with a winter season. The term other included non-classifiable items as well as fall from heights, fall into a crevasse, avalanches and equipment failure as cause of accident; trails and glaciers as terrain. Injury severity was defined according to Austrian law: an injury was considered mild if the patient was able to resume work within 24 days and severe if any fracture, except a fracture of the nose, occurred or the patient was unable to work for at least 24 days after the accident.24

For comparison over time, data were dichotomised into two time frames (2005/2006–2010/2011 vs 2011/2012–2017/2018). In general, due to non-normal distribution, data are presented as median and IQR or count and percentage, as appropriate. The $X^2$ test was performed to detect group differences in frequencies, the Mann-Whitney U test for group differences of continuous data. With regard to injury frequencies per season, linear modelling was performed for graphical presentation. Logistic regression analysis was performed to analyse independent variables (gender, age, activity prior to accident, terrain, cause of accident and helmet use) with regard to a possible prediction of the combined outcome of severe or fatal injuries. The association was quantified by ORs adjusted for the above-mentioned variables. In order to reduce family-wise error rates and strengthen our analysis, we decided to rely on a 99% CI concerning significance. Relative risk (RR) to sustain mild, severe or fatal injuries when wearing a helmet or not was quantified, separately for all injuries and for head injuries only, by risk ratios.

Figure 1 Study flow chart.
in a gender-dependent manner. Data were stored with Excel 2019 (Microsoft, Seattle, Washington, USA) and processed with R (V.4.0.2, R Core Team, https://www.R-project.org/, Vienna, Austria) and RStudio (V.1.2.5001, RStudio, Boston, Massachusetts, USA). Patients were not involved in the conception, design or conduct of this research.

**Patient and public involvement**

Patients and/or the public were not involved in the design, conduct of this study or the reporting of this research.

**RESULTS**

**Gender distribution of snowboarding accidents over the years**

In the observed time frame, 3536 men (62.1%) and 2155 women (37.9%) were injured while snowboarding and triggered a call to the dispatch centre. When comparing the first six seasons (2005/2006–2010/2011) and the latter seven seasons (2011/2012–2017/2018), the median number of involved men per season was seen to decline significantly in total (304 (298–316) vs 241 (233–254); p=0.001) and with regard to mild (163 (139–182) vs 111 (101–118); p=0.001), severe (112 (109–117) vs 87 (85–88); p=0.026) and fatal injuries (4 (3–5) vs 2 (1–2); p=0.046; table 1). In women, however, no significant differences were present, thus giving a proportional increase in women involved in mild (39.4% (38.8%–40.4%) vs 43.4% (40.6%–47.0%); p=0.038) and severe injuries (31.5% (29.6%–33.2%) vs 35.6% (34.2%–37.6%); p=0.035; table 1). Figure 2 illustrates this relation in a season-dependent and injury severity-dependent manner. Fatal injuries were rare and amounted to a median of three (1–4) per season (men: 2 (1–4); women: 1 (0–1)).

**Emergency and injury characteristics**

Table 2 depicts general demographics and emergency characteristics. Men were older than women (24 (16–34) vs 21 (15–31); p<0.001) and more frequently involved in accidents while actively on a downhill run (83.9% vs 78.4%; p<0.001), while snowboarding in a park (4.8% vs 2.1%; p<0.001) and alcoholised (1.6% vs 0.5%; p<0.001). Accidents while snowboarding on a slope were most frequent in both genders, but men were more frequently affected on slopes with higher difficulty levels (red: 42.6% vs 39.9%; p=0.037; black: 4.2% vs 2.5%; p=0.003). Inactively standing or sitting when involved in an accident was more prevalent in women (15.8% vs 11.0%; p<0.001), as was an interindividual collision as accident cause (87.9% vs 80.8%; p<0.001). Men more often sustained injuries from falling (12.9% vs 9.6%; p<0.001) or obstacle impact (4.3% vs 1.5%; p<0.001) than did women. Injury severity differed between the two genders. Women more commonly suffered mild (56.4% vs 48.6%; p<0.001) or fatal injuries (0.9% vs 0.4%; p=0.023). Women more often required ground-bound rescue (56.1% vs 49.0%; p<0.001) and men were more often transported by helicopter (25.4% vs 22.1%; p=0.002) or were not transported at all (25.6% vs 21.7%; p<0.001).

With regard to injury characteristics (table 2), contusions, strains or sprains were more prevalent in women (45.5% vs 37.4%; p<0.001), while men more frequently sustained fractures (26.3% vs 23.5%; p=0.017), wounds (17.1% vs 11.4%; p<0.001) and dislocations (5.2% vs 3.6%; p=0.006). Head injuries were most prevalent in both genders (21%), but shoulder and chest injuries were more common in men (15.1% vs 9.2%; p<0.001) and 6.8% vs 4.4%; p<0.001) and back and pelvis injuries in women (13.1% vs 10.2%; p<0.001 and 4.2% vs 2.9%; p=0.009).

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**Table 1 Injury frequencies and female share over time**

|                     | 2005/2006–2010/2011 (n=2884) | 2011/2012–2017/2018 (n=2809) | P value |
|---------------------|-----------------------------|-----------------------------|---------|
| **Male (median n per season)** |                             |                             |         |
| All accidents       | 304 (298–316)               | 241 (233–254)               | 0.001   |
| Mild injuries       | 163 (139–182)               | 111 (101–118)               | 0.001   |
| Severe injuries     | 112 (109–117)               | 87 (85–88)                  | 0.026   |
| Fatal injuries      | 4 (3–5)                     | 2 (1–2)                     | 0.046   |
| **Female (median n per season)** |                             |                             |         |
| All accidents       | 173 (161–188)               | 151 (145–172)               | 0.252   |
| Mild injuries       | 98 (90–119)                 | 85 (75–95)                  | 0.073   |
| Severe injuries     | 51 (41–59)                  | 47 (41–49)                  | 0.667   |
| Fatal injuries      | 1 (0–1)                     | 1 (0–1)                     | 1       |
| **Female (% per season)** |                             |                             |         |
| All accidents       | 36.8 (35.2–37.5)            | 37.3 (37.1–42.4)            | 0.181   |
| Mild injuries       | 39.4 (38.8–40.4)            | 43.4 (40.6–47.0)            | 0.038   |
| Severe injuries     | 31.5 (29.6–33.2)            | 35.6 (34.2–37.6)            | 0.035   |
| Fatal injuries      | 8.3 (0–20.8)                | 33.3 (8.3–33.3)             | 0.405   |
Risk factors for severe and fatal injuries

Logistic regression analysis adjusted for gender, age, performed activity, terrain, cause of accident and helmet use (table 3) revealed male sex to be an independent risk factor for severe or fatal injuries in the observed setting (OR 1.22 (1.00 to 1.48); p=0.009). Further risk factors with increased ORs were age (OR 1.02 (1.02 to 1.03) per year; p<0.001), performing a downhill run as compared with standing or sitting (OR 1.41 (1.04 to 1.90); p=0.004), snowboarding in a park compared with on a slope (OR 1.83 (1.14 to 2.93); p=0.001), falling and obstacle impact as compared with an interindividual collision (OR 1.75 (1.27 to 2.43); p<0.001 and OR 4.11 (2.33 to 7.26); p<0.001) and the use of a helmet (OR 1.31 (1.05 to 1.63); p=0.001).

Further analysis of RRs for mild, severe or fatal injuries when wearing a helmet or not (table 4) revealed for both genders that wearing a helmet was accompanied by an increased risk for severe (RR 1.15 (1.06 to 1.25); p=0.001), but a decreased risk for fatal (RR 0.43 (0.21 to 0.91); p=0.026) and severe injuries (RR 0.93 (0.88 to 0.97); p=0.003). Gender-specific analysis showed that primarily men contributed to the mentioned significant decrease in mild and increase in severe injuries. Regarding head injuries only, counterintuitively no significant effects of helmet use on any injury severity were detectable.

DISCUSSION

A substantial decrease was detected in the total number of men involved in snowboarding accidents over the years, and a proportional increase in the number of women suffering mild and severe injuries. Fatal injuries were rare and amounted to a median of two men and one woman per season. Most snowboarding accidents were interindividual collisions and occurred during a downhill run on a slope. When comparing both genders, proportionally more men suffered injuries to the shoulder and chest, were involved in accidents caused by falling or obstacle impact, while heading downhill, while on slopes with higher difficulty levels, while snowboarding in a park and under the influence of alcohol. Proportionally more women sustained injuries to the back and pelvis, due to interindividual collisions, on easier slopes and while standing or sitting. Mild injuries were more frequent in women, severe and fatal injuries in men. Male gender, age and helmet use were independent risk factors for the combined outcome of severe or fatal injuries. With regard to helmet use, further analysis revealed that the RR for severe injuries increased, while that for mild injuries decreased with the use of a helmet in male, but not significantly in female snowboarders. When analysing both genders, the RR for fatal injuries decreased when wearing a helmet. Noteworthy, the RR for head injuries in particular was not significantly influenced by helmet use, regardless of gender.

Gender distribution of snowboarding accidents over the years

Following the initial hype in snowboarding, an inevitable increase in snowboarding accidents was also detectable until the early 2000s. Meanwhile, the number of active snowboarders seems to be quite stable, implying that the presented decrease in snowboarding accidents per season is most likely a result of decreased injury incidences. In Austria, the number of skier days per season, particularly in the observed time frame, remained more or less constant (~50 Mio), but a decreased injury incidence in mountain winter sports was reported over the
Table 2  General demographics and emergency characteristics of injured snowboarders in Austria (2005–2018)

|                      | Male (n=3536) | Female (n=2155) | P value |
|----------------------|---------------|-----------------|---------|
| **Age**              |               |                 |         |
| Median (IQR)         | 24 (16–34)    | 21 (15–31)      | <0.001  |
| **Activity prior to accident** | | | |
| Downhill run         | 2406 (83.9%)  | 1334 (78.4%)    | <0.001  |
| Standing/sitting     | 314 (11.0%)   | 268 (15.8%)     | <0.001  |
| Other                | 147 (5.1%)    | 99 (5.8%)       | 0.472   |
| **Missing**          | 669           | 454             |         |
| **Terrain**          |               |                 |         |
| Slope                | 2923 (87.6%)  | 1807 (91.4%)    | 0.261   |
| Park                 | 161 (4.8%)    | 42 (2.1%)       | <0.001  |
| Other                | 252 (7.6%)    | 127 (6.4%)      | 0.079   |
| **Missing**          | 200           | 179             |         |
| **Difficulty level of terrain** | | | |
| Blue                 | 1277 (46.1%)  | 869 (52.4%)     | 0.002   |
| Red                  | 1180 (42.6%)  | 661 (39.9%)     | 0.037   |
| Black                | 116 (4.2%)    | 41 (2.5%)       | 0.003   |
| Other                | 195 (7.0%)    | 87 (5.2%)       | 0.015   |
| **Missing**          | 923           | 343             |         |
| **Cause of accident** |             |                 |         |
| Interindividual collision | 2717 (80.8%) | 1766 (87.9%)    | <0.001  |
| Fall                 | 435 (12.9%)   | 193 (9.6%)      | <0.001  |
| Obstacle impact      | 146 (4.3%)    | 31 (1.5%)       | <0.001  |
| Other                | 63 (1.9%)     | 18 (0.9%)       | 0.005   |
| **Missing**          | 175           | 147             |         |
| **Helmet use**       |               |                 | 0.09    |
| Yes                  | 2031 (67.0%)  | 1231 (69.4%)    |         |
| No                   | 1001 (33.0%)  | 544 (30.6%)     |         |
| **Missing**          | 504           | 380             |         |
| **Alcohol influence** |             |                 | <0.001  |
| Yes                  | 51 (1.6%)     | 10 (0.5%)       |         |
| No                   | 3133 (98.4%)  | 1909 (99.5%)    |         |
| **Missing**          | 352           | 236             |         |
| **Injury severity**  |               |                 |         |
| Mild                 | 1720 (48.6%)  | 1215 (56.4%)    | <0.001  |
| Severe               | 1273 (36.0%)  | 639 (29.7%)     | <0.001  |
| Fatal                | 33 (0.9%)     | 8 (0.4%)        | 0.023   |
| Undefined            | 510 (14.4%)   | 293 (13.6%)     | 0.407   |
| **Missing**          | 0             | 0               |         |
| **Mode of rescue**   |               |                 |         |
| Ground-bound         | 1645 (49.0%)  | 1124 (56.1%)    | <0.001  |
| Helicopter           | 854 (25.4%)   | 443 (22.1%)     | 0.002   |
| No rescue            | 861 (25.6%)   | 435 (21.7%)     | <0.001  |
| **Missing**          | 221           | 108             |         |
| **Type of injury**   |               |                 |         |
| Contusion/strain/sprain | 1324 (37.4%) | 981 (45.5%)     | <0.001  |

Continued
past decades.\textsuperscript{2,3} Besides improved slope preparation and technical gear, higher acceptance of personal protection equipment may be pivotal.\textsuperscript{3,27,28} Confirming the latter and partially explaining the pronounced decline in mild injuries in this study, helmets have particularly reduced mild head injuries (eg, lacerations)\textsuperscript{28,29} and hip pads have reduced the overall risk of injury in recreational snowboarders.\textsuperscript{27}

Unexplained remain the observed gender differences in injury decline. The absolute number of mild injuries decreased less steeply in women than in men and the number of severe injuries even rose. However, the overall proportion of female participation in snowboarding seems to have been quite stable (~30%) since the late 1990s\textsuperscript{8–10} and so has the total number of active snowboarders per year.\textsuperscript{1} A proportional increase in female snowboarders does not seem causative leaving an altered risk profile over the years as possible explanation. In men, fatalities declined as well, but in women, they were too rare to detect any changes over time. A decreasing incidence of traumatic and non-traumatic deaths on Austrian slopes was recently described elsewhere.\textsuperscript{1}

### Emergency and injury characteristics

A rather young age and a male predominance, as described in this study, are well known with regard to active snowboarders.\textsuperscript{5–7} Due to the nature of this study, the analysed accidents are preselected towards those that triggered a distress call. Compared with in-hospital or self-reporting studies, a bias towards more severely injured, or towards accidents, where official documentation might be crucial for legal reasons or insurance claims, seems evident. A study from Los Angeles, California reported that even among severely injured snowboarders (Injury Severity Score >15) merely 80% used emergency medical services to reach the emergency department.\textsuperscript{30} Interindividual collisions and accidents occurring during a downhill run on a slope were most prevalent in this study. In contrast, an in-hospital interview study from France revealed that falls were the most frequent injury mechanisms (54%)

| Table 2 | Continued |
|---------|-----------|
|         | Male (n=3536) | Female (n=2155) | P value |
| Fracture | 930 (26.3%) | 506 (23.5%) | 0.017 |
| Wound/lesion | 603 (17.1%) | 245 (11.4%) | <0.001 |
| Concussion | 271 (7.7%) | 178 (8.3%) | 0.419 |
| Dislocation | 183 (5.2%) | 78 (3.6%) | 0.006 |
| Internal | 57 (1.6%) | 22 (1.0%) | 0.064 |
| Polytrauma | 38 (1.1%) | 17 (0.8%) | 0.285 |
| Other | 41 (1.2%) | 13 (0.6%) | 0.421 |
| Site of injury | | | |
| Head | 748 (21.2%) | 452 (21.0%) | 0.872 |
| Back/spine | 360 (10.2%) | 283 (13.1%) | <0.001 |
| Knee | 313 (8.9%) | 207 (9.6%) | 0.338 |
| Shoulder | 533 (15.1%) | 198 (9.2%) | <0.001 |
| Lower leg | 245 (6.9%) | 123 (5.7%) | 0.069 |
| Forearm | 182 (5.1%) | 116 (5.4%) | 0.699 |
| Wrist | 133 (3.8%) | 101 (4.7%) | 0.088 |
| Chest | 239 (6.8%) | 95 (4.4%) | <0.001 |
| Pelvis | 102 (2.9%) | 90 (4.2%) | 0.099 |
| Thigh | 168 (4.8%) | 85 (3.9%) | 0.152 |
| Hand | 123 (3.5%) | 83 (3.9%) | 0.465 |
| Upper arm | 89 (2.5%) | 72 (3.3%) | 0.609 |
| Entire body | 64 (1.8%) | 47 (2.2%) | 0.326 |
| Neck | 59 (1.7%) | 47 (2.2%) | 0.165 |
| Ankle | 56 (1.6%) | 38 (1.8%) | 0.606 |
| Foot | 66 (1.9%) | 34 (1.6%) | 0.421 |
| Abdomen | 51 (1.4%) | 30 (1.4%) | 0.877 |
| Hip | 30 (0.8%) | 28 (1.3%) | 0.1 |

Bolded entries mark the significant results.
followed by collisions with other persons or obstacles (18%). Self-reporting data from Austria indicated that as many as 87% of all injuries were caused by self-inflicted falls.

Snowboard-associated injuries typically include shoulder and upper more than lower extremity injuries, but also head and spine as well as chest and abdomen injuries. Unfortunately, literature on gender-related differences in the course and consequences of snowboarding accidents is scarce. In general, men are prone to suffer more severe as well as fatal injuries on ski slopes. Furthermore, shoulder injuries, particularly dislocations, but also facial bone fractures are more prevalent in snowboarding men. Regarding women, this study was able to show that back and pelvic injuries are more frequent.

The male prevalence in terrain parks in this study also confirms previous results. Our data show higher rates of fractures and dislocations in men and more contusions, strains or sprains in women. The picture of men being more prone to suffer injuries while actively heading downhill, on more difficult slopes and more often under the influence of alcohol perfectly fits the perception of an increased risk-taking behaviour of men, not only on ski slopes but in everyday life.

### Table 3 Logistic regression predicting severe or fatal injuries when involved in a snowboarding accident

| Gender          | Crude OR (99% CI) | Adjusted OR (99% CI) | P value |
|-----------------|-------------------|----------------------|--------|
| Male versus female | 1.39 (1.15 to 1.68) | 1.22 (1.00 to 1.48) | 0.009  |
| Age             |                   |                      |        |
| Per year        | 1.02 (1.01 to 1.03) | 1.02 (1.02 to 1.03) | <0.001 |
| Activity        |                   |                      |        |
| Standing/sitting | Reference         |                      |        |
| Downhill run    | 1.64 (1.23 to 2.20) | 1.41 (1.04 to 1.90) | 0.004  |
| Terrain         |                   |                      |        |
| Park versus slope| 2.15 (1.41 to 3.27) | 1.83 (1.14 to 2.93) | 0.001  |
| Cause of accident|                 |                      |        |
| Interindividual collision | Reference       |                      |        |
| Fall            | 1.95 (1.46 to 2.60) | 1.75 (1.27 to 2.43) | <0.001 |
| Obstacle impact | 4.25 (2.43 to 7.43) | 4.11 (2.33 to 7.26) | <0.001 |
| Helmet          |                   |                      |        |
| Yes versus no   | 1.23 (1.00 to 1.52) | 1.31 (1.05 to 1.63) | 0.001  |

Patients with undefined injury severity excluded.

### Table 4 Relative risk for mild, severe or fatal injury when wearing a helmet and involved in a snowboarding accident

| Helmet yes versus no | Injuries, all types (n=4108) | Head injuries only (n=918) |
|----------------------|------------------------------|----------------------------|
|                      | Relative risk (95% CI)       | P value                    |
| Male injury severity |                              |                            |
| Mild (n=2574)        | 0.88 (0.83 to 0.95)          | <0.001                     |
| Severe               | 1.21 (1.09 to 1.34)          | <0.001                     |
| Fatal                | 0.52 (0.23 to 1.19)          | 0.122                      |
| Female injury severity |                               |                            |
| Mild (n=1534)        | 0.98 (0.91 to 1.06)          | 0.678                      |
| Severe               | 1.05 (0.90 to 1.22)          | 0.515                      |
| Fatal                | 0.23 (0.04 to 1.27)          | 0.093                      |
| Male and female injury severity |   |                            |
| Mild (n=4108)        | 0.93 (0.88 to 0.97)          | 0.003                      |
| Severe               | 1.15 (1.06 to 1.25)          | 0.001                      |
| Fatal                | 0.43 (0.21 to 0.91)          | 0.026                      |

Patients with undefined injury severity and missing information on helmet use excluded.
Risk factors for severe and fatal injuries

Besides male gender, predisposing factors for severe or fatal injuries included heading downhill as compared with standing or sitting, riding in a terrain park as compared with on a slope, falling or obstacle impact as compared with interindividual collision and also helmet use. Terrain park injuries have been previously described as being more severe, mainly due to falls after aerial manoeuvres. Collisions with objects and other persons were responsible for half of all traumatic deaths in a 10-year analysis conducted on Austrian ski slopes. The paradox of protective gear, like helmets, seemingly increasing injury rates has been addressed before. In general, helmets have been shown to reduce the risk of head injuries. However, conflicting data have also been published. A study from Canada reported no reduction in head injuries despite increased helmet use. Baillie et al also reported that the effects of helmets on traumatic brain injury are limited. Specifically concerning head injuries, no effects of helmet use on the occurrence of mild, severe or fatal injuries were evident in this study, regardless of gender. Sulheim et al analysed the effect of helmet use on head injuries in skiing and snowboarding over a 10-year period from 2002 to 2011. While the odds for head injury were clearly reduced in 2002, the effect was attenuated in 2010 and even absent in 2011. They concluded that this unexpected change may be due to new skiing trends. A more recent study even indicated a relationship between helmet use and an increase in general injury severity. Referring to all injury types, mild and fatal injuries were reduced by helmet use, while the odds for severe injuries were increased in our data. Gender-specific analysis revealed that particularly men were responsible for the observed effect. A reduction in mild injuries has also been concluded from previous studies, showing that particularly lacerations, bruises and face trauma were reduced among helmet wearers. The association between an increased risk for severe injuries and helmet use has been demonstrated in other studies and finds its justification in a false sense of safety and consequently a riskier behaviour on the ski slopes. Important, helmet users were shown to typically have specific characteristics (eg, male gender, younger age, expert skiing skills). These conclusions were drawn in 2010. The proportion of people wearing a helmet in our data increased from 47% (2005/2006–2010/2011) to 89% (2011/2012–2017/2018). It seems likely that helmet-related user characteristics have altered over time, now including a broader range of skill levels, age groups and genders. Thus, conflicting results regarding helmet use and injury risk together with an association with risk-taking behaviour may be partially explained. Moreover, as men are known to tend to riskier behaviour, gender-specific analyses as performed in this study may be the key.

The main limitation of this study certainly includes a possible selection bias, due to the chosen setting. The analysed accidents were preselected to include those that triggered emergency calls to dispatch centres. A bias towards more severely injured or towards accidents where official documentation might be crucial for legal reasons or insurance claims seems evident. Missing in-hospital data impeded more precise identification of injuries. Furthermore, as neither the overall number nor the gender distribution of active snowboarders per season was known, exact incidences as well as proportional involvements could not be calculated. Finally, the validity of the study may be attenuated by its retrospective design.

CONCLUSION

The share of mild and severe snowboard injuries in women is increasing, and the observed injury patterns and emergency characteristics differ substantially to those of men. Male gender is a risk factor for severe and fatal injuries and also responsible for an increased OR regarding severe injuries when wearing a helmet. An elevated risk-taking behaviour may be responsible. Further gender-specific research in snowboarding-related injuries should be encouraged.
