

# Severe and polytraumatic injuries among recreational skiers and snowboarders: incidence, demographics and injury patterns in South Tyrol

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**Background** Alpine skiing and snowboarding are popular winter sports. The practice of these sports is related to traumatic injuries, some of which are severe and/or life threatening.

**Objectives** To identify the incidence, injury patterns and associated risk factors of severe and polytraumatic injuries in South Tyrol.

**Materials and methods** During four consecutive winter seasons (2001–2005), data of every patient referred to our emergency department (Bolzano-Bozen) after a skiing or snowboarding accident were collected. One hundred and five patients with an Injury Severity Score of 16 or higher were identified (90 skiers, 15 snowboarders). Statistical descriptive analyses were carried out by producing frequency tables. Chi-square test was performed to verify possible association between injury severity and type of sport. Risk factors for severe injuries were evaluated using logistic regression with robust variance estimators.

**Results** Traumatic brain injury was the most common injury observed (51 cases), followed by vertebral injury (45 cases); 63% of the patients reported two or more associated injuries. We observed significant associations between severe spine injuries and the following risk

factors: snowboarders who reported more severe injuries than skiers [odds ratio=5.89, 95% confidence interval (CI)=1.31, 26.44], age classes of 40–50 years and over 60 years showed an OR of 8.10 (95% CI=1.87, 35.06) and 5.16 (95% CI=1.27, 21.01), respectively, with respect to age class (20–40 years).

**Conclusion** Severe traumatic injuries occur among skiers and snowboarders, and preventive measures such as the use of helmets and educational programs, are necessary. *European Journal of Emergency Medicine* 19:69–72 © 2012 Wolters Kluwer Health | Lippincott Williams & Wilkins.

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## Introduction

Skiing and snowboarding are popular winter sports that are enjoyed by several hundred million people worldwide [1]. Equipment and performance technology have been improved over the years and their accessibility to the general public has also been increased. Therefore, it is not surprising that a great number of traumatic injuries have been observed [2,3]. Sometimes these injuries are very severe or even life threatening [4]. The Province of Bolzano-Bozen (Italy), better known as South Tyrol, encompasses a large mountain area in the northern part of Italy with 16 ski resorts that attract winter sports fans from all over the world. Many data have been published about orthopaedic injuries observed among skiers and snowboarders [5–7], but there are few studies describing the aspects of severe polytraumatic injuries that do occur in these winter sports [8–11]. The aim of this study was to identify the injury patterns associated with severe polytraumatic recreational skiing and snowboarding injuries in South Tyrol, and to analyse their demographics in the attempt to detect possible risk factors.

## Materials and methods

The regional hospital of Bolzano-Bozen is the only Tertiary Trauma Care Centre of the region. All patients with a suspected traumatic brain injury (TBI) or suspected chest/abdominal injuries are referred, by a protocol, to our Emergency Department (ED). During four consecutive winter seasons (from December 2001 to April 2005), for every patient referred to our ED after a skiing or snowboarding injury, the following data were collected on admission: date of birth, sex, place of residence, as well as the date, time, location and type (collision/fall) of injury.

These data were collected without taking the National Health System Documentation into account; according to the Italian law on privacy, they were used only for the purpose of this study. Ethics committee approval was not required for this kind of study. Type of injury and Injury Severity Score (ISS), according to Baker *et al.* [12], were retrospectively assigned: their values were calculated on ED and hospital charts. Patients with an ISS of 16 or higher were included in the analysis.

As it was impossible to obtain a reliable number of skier days for the whole region (16 ski resorts are managed by different companies and ski-lift tickets are extremely heterogeneous, ranging from seasonal to hourly tickets), the incidence of severe injuries was calculated on the number of skiers transported by the ski-lift facilities of the region (number of uphill rides), obtained from the publications of the Institute of Statistics of the Province of Bolzano-Bozen [13,14].

Statistical descriptive analyses were carried out by producing frequency tables for the four outcomes and other variables involved in the study. Chi-square test was performed to verify possible association between injury severity and type of sport. Risk factors for severe injuries were evaluated using logistic regression with robust variance estimators. The limit of significance for tests and model parameters was fixed at a *P* value of less than 0.05. All the analyses were carried out using Stata/IC 10.1 for Windows on an Intelx86 machine (StataCorp LP, Texas, USA).

## Results

During the period of the study, 3405 injured skiers and 1037 injured snowboarders were evaluated at our ED; 105 individuals (90 skiers and 15 snowboarders, 85.7% and 14.3%, respectively) had an ISS of 16 or more. We detected a mean ISS of 25.9 (standard deviation = 8.0) for those patients who presented an ISS > 15. The range of their ISS varied from 16 to 50.

The prevalence of severe injuries (with respect to all injuries) was 2.64% and 1.45% for skiers and snowboarders, respectively (*P* = 0.04).

The average number of people transported by the ski-lift facilities of the region was 114 580 000 uphill rides per year and the rate of severe injuries was 0.2294 per million uphill rides per year, with no statistically significant difference among the seasons.

Demographic variables associated with different injuries are shown in Table 1.

There was no dependence between the ISS level and day of injury; ISS level and time of injury (morning vs. afternoon) were not dependent as well. Sixty-six patients (63%) showed two or more major injuries, whereas 39 (37%) reported a single major injury. TBI was the most frequent injury in our patients, followed by spinal injuries. No association was found among different injury patterns.

Among TBI the most common injury observed was brain contusion with intraparenchymal bleedings (48%), followed by subarachnoidal hemorrhagia (35%), acute subdural haematoma (12%) and epidural haematoma (5%). In some patients more than one TBI was present at the same time. Fractures of the skull and/or facial fractures were associated with TBI in 34 out of 51 cases (67%). Among vertebral injuries, in six (13%) cases we observed a dorsal spinal cord injury and in five (11%) cases a cervical spinal cord injury, both associated with permanent neurological disability. The remaining patients sustained vertebral fractures without spinal cord involvement. The most common abdominal injury was spleen rupture (40%), followed by kidney injuries (29%), liver rupture (26%) and pancreas injury (5%). In two patients liver and kidney injuries were associated. Most of the thorax trauma (23 out of 27) showed association of serial ribs fracture with pneumo/haematothorax and lung contusion. Only in four cases was serial ribs fracture the only thoracic injury observed. The most frequent extremities injury was shoulder/humerus fracture and/or dislocation (35%), followed by forearm/wrist fracture (34%), femur fracture (27%) and leg fracture (4%).

The odds ratios (OR) from the logistic regression are shown in Table 2. There were significant associations between severe vertebral injuries and some risk factors; in particular, snowboarders reported more severe injuries than skiers [OR = 5.89, 95% confidence interval (CI) = 1.31, 26.44]. Moreover, age classes of 40–50 years and over 60 years showed an OR of 8.10 (95% CI = 1.87, 35.06) and 5.16 (95% CI = 1.27, 21.01), respectively, with respect to age class of 20–40 years; conversely, age class of

**Table 1 Descriptive statistics: absolute frequencies (and percentages) of demographic variables associated with main injuries**

	Traumatic brain injuries (N=51)	Vertebral injuries (N=45)	Extremity injuries (N=26)	Thorax, abdomen and pelvic injuries (N=44)
Sex				
Female	8 (15.7)	9 (20.0)	5 (19.2)	6 (13.6)
Male	43 (84.3)	36 (80.0)	21 (80.8)	38 (86.4)
Age (years)				
Under 20	14 (27.5)	4 (8.9)	7 (26.9)	13 (29.5)
20–40	20 (39.2)	12 (26.7)	11 (42.3)	13 (29.5)
40–50	2 (3.9)	11 (24.4)	1 (3.9)	6 (13.6)
50–60	8 (15.7)	8 (17.8)	3 (11.5)	5 (11.5)
Over 60	7 (13.7)	10 (22.2)	4 (15.4)	7 (15.9)
Residence				
Local residents	8 (15.7)	6 (13.3)	5 (19.2)	4 (9.1)
No local residents	43 (84.3)	39 (86.7)	21 (80.8)	40 (90.9)
Type of sport				
Snowboard	6 (11.8)	7 (15.5)	3 (11.5)	6 (13.6)
Ski	45 (88.2)	38 (84.5)	23 (88.5)	38 (86.4)

**Table 2 Odds ratios (95% CI) associated with probable risk factors (robust logistic regression)<sup>a</sup>**

	Traumatic brain injuries	Vertebral injuries	Extremity injuries	Thorax, abdomen and pelvic injuries
Sex				
Male	1.02 (0.33, 3.17)	0.76 (0.21, 2.80)	0.80 (0.24, 2.67)	1.44 (0.50, 4.21)
Type of sport				
Snowboard	1.22 (0.36, 4.20)	5.89 (1.31, 26.44)*	0.49 (0.12, 2.05)	0.81 (0.24, 2.80)
Residence				
Local resident	0.62 (0.18, 2.12)	0.65 (0.20, 2.13)	1.26 (0.36, 4.38)	0.39 (0.12, 1.28)
Age (years)				
Under 20	1.32 (0.43, 4.06)	0.14 (0.03, 0.64)*	0.92 (0.29, 2.94)	1.52 (0.50, 4.62)
40–50	1.78 (0.50, 6.36)	8.10 (1.87, 35.06)**	0.14 (0.02, 1.25)	0.66 (0.18, 2.45)
50–60	1.08 (0.28, 4.12)	2.79 (0.69, 11.30)	0.47 (0.11, 2.08)	0.76 (0.21, 2.69)
Over 60	2.70 (0.79, 9.28)	5.17 (1.27, 21.01)*	0.63 (0.16, 2.49)	0.66 (0.18, 2.38)

CI, confidence interval.

<sup>a</sup>Reference individual is a non Bolzano-Bozen resident skier: female aged 20–40 years.

\* $P < 0.005$ .

\*\* $P < 0.05$ .

0–20 years showed an OR of 0.14 (95% CI = 0.03, 0.64) with respect to age class of 20–40 years.

In-hospital mortality was 1.2% (two out of 105 patients). The patients' outcome could not be taken into account in this study, because most of the patients (84%) were not local resident, and the majority of them, were transferred to their place of residency after emergency treatment and/or clinical stabilization, so their follow-up status was not available.

## Discussion

Although there is evidence that severe injuries among recreational skiers and snowboarders are rarely detected [8], preventive measures are still needed. These injuries are burdened with very high medical costs for their treatment in the acute phase and also for the long-term disability that they often lead on to. In our study and in other reports, TBI and vertebral injuries represent the most common injuries among severely injured skiers and snowboarders [3]. The higher severity of snowboarding injuries compared with skiing ones has already been reported [3,11]. Snowboarding has become increasingly popular over the past several years and the difference between ski and snowboard patterns of injury is well known. However, contrasting results have been reported for severe injuries, in particular, for those with regard to the central nervous system [9,15]. Snowboarders have their feet parallelly fixed on the board and they tend to fall either forward or backward. High-speed backward falls are probably responsible for severe vertebral injuries both because of direct impact on the spine and because of neck hyperextension.

In this study, a significant relationship between injuries and helmet use/nonuse could not be identified because of poor documentation. However, there is a growing body of evidence that shows the benefits of helmets for TBI prevention [16–18]. Nevertheless, how to promote a widespread helmet uptake it is still under debate, as the legislation alone does not seem to be effective. A multi-faceted approach made up of educational programs, financial

incentives and role modelling from ski instructors and patrollers will probably be the best way to spread helmet use among skiers and snowboarders [19]. Although several spine protection devices are available in the market, there is a lack of scientific evidence that these devices do have a protective role in the prevention of spine or thoracic and abdominal injuries. Spine and spinal cord injuries in motor vehicle crashes are a function of chance in speed and energy dissipation with respect to the direction of a crash [20]. High speed is always a key factor in severe polytraumatic injuries among skiers and snowboarders. As there is no evidence of the usefulness of spine protectors to make skiers aware of the risk of high-speed collisions, the only preventive measures that can be suggested are the educational programs. Owing to the high percentage of vertebral injuries observed among severe skiing and snowboarding injuries, further focused research on spine protection is certainly needed.

Recent epidemiology data demonstrated that senior skiers are at higher risk of severe injuries [3,13]. This has also been observed in this study, as far as vertebral injuries are concerned. It is well known that polytraumatic injuries in elderly patients bear a mortality rate that is almost double with respect to young patients. Therefore, a particular preventive and informative effort should be targeted to this population.

## Limitations

The data of this study were collected between 2001 and 2005. Since January 2005, the Italian government has imposed the use of helmets for skiers and snowboarders under the age of 14 years. Therefore, it is probable that the incidence of severe TBI among this population has decreased over the following years. Moreover, improvements of the technical equipment will have probably affected the pattern of severe injuries over the following years. The relative incidence of severe injuries connected to the two sports activities could not be calculated, as ski-lift tickets are sold undifferentiated and there is no way to estimate the relative presence on the slope of snowboarders and/or skiers. The study lacks in outcome data,

because most of the patients were nonlocal residents and their long-term follow-up was not available.

## Conclusion

Severe and polytraumatic injuries among recreational skiers and snowboarders are rare. As these injuries are burdened with very high medical and social costs, preventive measures are still needed. TBI and vertebral injuries are the most common injuries among severely injured skiers and snowboarders. Spinal injuries are related to snowboard practice and over 40-year-old athletes have a major risk of spinal injuries with respect to younger skiers. Although the use of helmets has been proven to be effective in preventing TBI, there is no scientific evidence that spine protection devices can prevent vertebral injuries.

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### Conflicts of interest

There are no conflicts of interest.

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