

# Lower extremity injuries in snowboarding – A focus on injured anatomical structures

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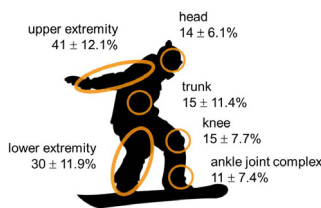
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## Introduction

Snowboarding is one of the premier alpine winter sports. The Sporting Goods Manufacturers Association (SGMA) states a 3 year increase of 19.8% to a total number of 8.196 000 snowboarders in the winter season 2009 / 2010 in the USA [1]. In the European market, 12.6 Mill snowboarder days in France 1999 and 11.8 Mill snowboarder days in Austria were estimated for the winter season 2010 / 2011; with snowboarders representing 23% of all alpine winter sport participants [2,3].

A risk for injury is associated with snowboarding. Epidemiological studies illustrate injury rates of approximately four injuries per 1000 days in recreational snowboarding as well as 6.3 injuries per 1000 days in professional snowboarding [4,5]. With regard to the anatomical location of injury, literature shows that lower body injuries are slightly less common than upper body injuries. Lower extremity injuries account for 19% - 52% of all injuries in recreational and for 42% of all injuries in professional snowboarding, respectively [5] (Figure 1).



**Figure 1.** Anatomical location of injuries in snowboarding. Data are based on (n) epidemiological studies and represent the average of values derived from bibliographical references (head n=28; upper extremity n=30; trunk n=29; lower extremity n=31; knee n=26; ankle joint complex n=26)

Little is known regarding preventive measures for lower extremity injuries in snowboarding. To overcome this, information about the injured anatomical structures is needed which serves as a basis for the development of specific preventive measures. So far, few studies have looked at injured anatomical structures within the lower extremities in snowboarding in detail. Some studies have been published with a focus on ankle injuries (in particular the fracture of the lateral process of the talus), knee ligament injuries as well as hip dislocations [6,7,8,9]. Recently, Ishimaru and colleagues [10] investigated the types and patterns of lower extremity injuries. Regarding the injured structures, they concentrated on the description of the site of lower leg fractures. However, an overall as well as a detailed description of injured anatomical structures is still missing.

Therefore, the purpose of this epidemiological study was to analyse injured anatomical structures within the lower extremities in snowboarding. Based on that, links to injury mechanisms as well as to the development of preventive measures could be drawn.

## Method

Data were analysed based on the statistics of the Central Office for Statistics under the Federal Law for Accident Insurance (UVG, Switzerland). This statistic includes a 5% random sample of all registered non-occupational accidents of the working population in Switzerland, which covers about 4 Mill. persons between 16 and 64 years of age. Because of the well-defined selection process, weighted sample statistics are used as unbiased estimators for injuries in the whole working population. This reflects the epidemiological situation in whole Switzerland and allows the detection of injury key aspects.

Because of the specific objective for the present statistic only sample statistics were calculated. Data in the current study cover all lower extremity snowboarding injuries from 1995 to 2010. Injuries to the hip, thigh, knee, shank, ankle joint complex (AJC) as well as foot were analysed separately. Injuries were classified in accordance to the International Statistical Classification of Diseases and Related Health Problems (ICD 9) [11].

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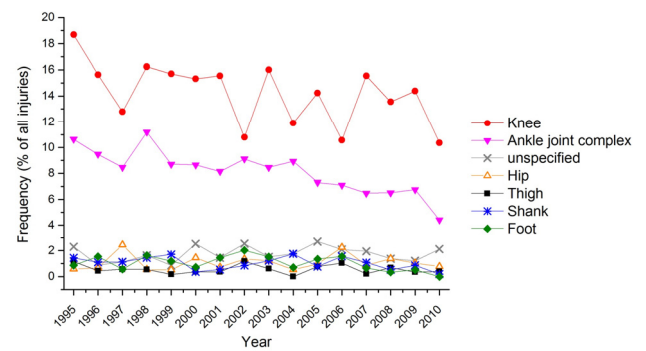
## Results

A total of 2391 lower extremity injuries were analysed. This represents a number of 27.6% of all snowboarding injuries in Switzerland and is in line with data presented in literature (Figure 1).

**Table 1: Top lower extremity (LowEx) snowboarding injuries in Switzerland**

| Rank | Specification | Region | Diagnosis (ICD 9 coding)                       | Frequency (%)   |                       |
|------|---------------|--------|--|-----------------|-----------------------|
|      |               |        |  | of all injuries | of all LowEx injuries |
| 1    | specified     | Ankle  | Sprains / strains of; ankle                    | 3.9             | 14.3                  |
| 2    |               | Knee   | Contusion of; knee                             | 3.2             | 11.5                  |
| 3    |               | Knee   | Sprain / strain medial collateral ligament     | 2.1             | 7.7                   |
| 4    |               | Knee   | Tear of medial cartilage or meniscus of knee   | 1.3             | 4.8                   |
| 5    |               | Knee   | Sprains/strains; cruciate ligament; anterior   | 0.9             | 3.3                   |
| 6    |               | Ankle  | Sprains/strains; tibiofibular ligament, distal | 0.9             | 3.2                   |
| 7    |               | Hip    | Contusion of; hip                              | 0.5             | 1.9                   |
| 8    |               | Thigh  | Contusion of; thigh                            | 0.5             | 1.7                   |
| 9    |               | Ankle  | Fracture; medial malleolus, closed             | 0.4             | 1.5                   |
| 10   |               | Ankle  | Contusion of; ankle                            | 0.4             | 1.4                   |
| 1    | NOS           |        | Sprains /strains of; knee and leg              | 5.4             | 19.6                  |
| 2    |               |        | Injury, other; knee, leg, ankle, and foot      | 1.0             | 3.5                   |
| 3    |               |        | Sprains and strains of ankle and foot          | 0.7             | 2.6                   |

Table 1 shows the Top 10 injuries to the lower extremities as well as the Top 3 not otherwise specified injuries (NOS). The main injured anatomical regions are the knee as well as the AJC.



**Figure 2:** Frequency of lower extremity injuries from 1995 - 2010

About ¼ of all injuries in snowboarding affect the knee and the AJC with 14.1% and 8.1%, respectively. However, a decreasing injury frequency can be seen in particular for the AJC (Figure 2). The main type of injury related to both - knee and AJC - is sprain and strain followed by contusion to the knee and fractures to the AJC (Figure 3).

|      | % of all injuries | % of all LowEx injuries |             |
|------|-------------------|-------------------------|-------------|
| Knee | Sprain / strain:  | 10.6                    | 38.2        |
|      | Contusion:        | 3.2                     | 11.5        |
|      | Luxation:         | 0.3                     | 1.1         |
|      | Fracture:         | 0.03                    | 0.1         |
|      | <b>Σ:</b>         | <b>14.1</b>             | <b>50.9</b> |
| AJC  | Sprain / strain:  | 6.3                     | 22.7        |
|      | Fracture:         | 1.4                     | 4.9         |
|      | Contusion:        | 0.4                     | 1.4         |
|      | Luxation:         | 0.1                     | 0.3         |
|      | <b>Σ:</b>         | <b>8.1</b>              | <b>29.3</b> |

**Figure 3.** Type of injury for the knee and the AJC (image credit: opensim 2.0)

## Discussion & Conclusion

The study identified injured anatomical structures within the lower extremities in snowboarding. The data confirm the knee and the AJC as the most frequent injury locations and sprains and strains as the most frequent injury type regarding both - knee and AJC.

It is important to consider that the presented analysis comprises limitations: Firstly, the UVG statistic originally used the ICD 9 and changed to ICD 10 in 2008. This causes discrepancies mainly regarding the assignment and hence the congruence of the specific injury pattern (diagnosis) and influences the injury frequency. Furthermore, the UVG data base does not consider children as well as adolescents (<16 years) and contain a high number of unspecified injuries.

However, the study reveals injured anatomical structures in detail. In the next step, data will be linked to known injury mechanisms detected by cadaver studies [6,7,12]. Based on this, equipment related measures to prevent lower extremity injuries in snowboarding can be developed. This could comprise technical measures concerning the board-binding-boot unit as well as protective devices (PPE) such as ankle or knee orthosis.