

# Snow sports helmets

## Purpose and key messages

Snow sports, in particular skiing and snowboarding, are very popular nowadays. These sports are being practised in Europe by several millions of people at all ages. People like snow sports because it makes great fun and it is healthy, relaxing and sociable.

But certainly snow sports also hold a risk of injury due to an accident or to overexertion. Fortunately, there are many possibilities to prevent injury, for instance by making sports infrastructures and equipment safer, by respecting the rules and by promoting proper exercise and training methods.

It is evident that the best thing is to *avoid that an accident or injury may happen*. However, there is no sport without risks and therefore wearing protective gear like snow helmets is essential in view of *reducing the severity head injuries*, in case an accident occurs.

This briefing note has been prepared for policy makers responsible for sports, education and public health and for decision makers in winter sports businesses delivering products, services and facilities to sportsmen and women, both at national and at local level. This note informs about injury risks and in particular about the role of snow helmets in reducing the severity of head injury.

Key messages in this policy briefing are:

- Snow sports hold a significant injury risk of injury. Children and young people are more at risk. There is no major difference in injury risks between snowboarders and skiers.
- More than 50% of all severe and fatal injuries in snow sports are related to the head.
- As other types of injuries are decreasing, such as lower leg fractures owing to better binding systems, head injuries in snow sports is taking a larger share in the total number of snow sport injuries.
- Snow sports helmets, if worn properly, will reduce the impact of a collision or crash and thus reduce the severity of injury outcome. The protective effect is estimated to be within a range of 21 to 45%.
- Fortunately, helmet wearing rates are increasing: Germany, Austria and Switzerland are respectively reporting 40%, 63%, 76% helmet wearing rates now. Switzerland is even reporting a 95% helmet wearing rate among children.

- There is quite some controversy as to whether or not helmet wearing should be enforced by legislation, as it could discourage snow sports participants from practising their sports.
- However, the high level of acceptance of helmet wearing also provides the right momentum for making helmet wearing obligatory in order to further reduce the severity of head injuries in snow sports.
- As children are more at risk of head injuries than other age groups, helmet wearing for children to age 15 should be made obligatory in snow sports, at least in schools and in snow sport camps.
- Legal steps to a full mandatory requirement for helmet wearing on slopes, as already in place in Italy and Austria, are still subject of a broader political debate but should not be shunned.

## Snow sports injuries

Each year thousands of people get injured in snow sports and require hospital treatment in Europe. In Austria for instance, in winter 2008/2009 around 46.000 skiers and 12.000 snowboarders were treated in hospitals after an injury in snow sports<sup>1</sup>. In France, 108.000 skiers and 31.000 snowboarders were injured in the very same season<sup>2</sup>. Germany reports around 50.000 injuries annually<sup>3</sup>. Based on data collected in 13 EU-countries<sup>4</sup>, it is estimated that in the entire EU-region there are each year 300.000 snow sport related injuries that require medical treatment in hospital, including 170.000 ski-injuries and 90.000 snowboard injuries.

Countries outside the EU-region also report similar statistics. In Switzerland, every year about 70.000 citizens require medical treatment after an injury incurred in skiing or snowboarding, and another 10.000 sledging injuries are being reported. In addition, around 30.000 foreign guests get injured on the Swiss slopes<sup>5</sup>. The total number relates to an annual average of around 3.5 injuries per 1.000 skier-days in Switzerland. In Norway, an average injury rate for skiers and snowboarders of 1.5 per 1.000 skier or snowboarder-days is being reported<sup>6</sup>. In the USA (Vermont<sup>7</sup>) and Canada<sup>8</sup> 1.9, respectively 2.5 injuries per 1.000 skier days are being reported over one season. Children and young people are more at risk than adults. In the age range 6 to 18 the injury risk seems to be almost twice as high as compared to adults<sup>9</sup>. The lack of experience and necessary skills as well as the use of inadequate equipment are a few of the



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factors contributing to an increased risk in young people.

Fortunately, *fatal* injuries are less common on snow pistes, as rates are reported of 0.25 to 0.29 fatalities per million skier-days in Switzerland up to 0.75 fatalities per million skier-days and 0.53 fatalities per million snowboarder-days in the USA<sup>10</sup>. Yet, the same risk factors are involved in both fatal and non-fatal head injuries, and therefore the same principles are applying in view of preventing head injury.

### Head injuries in snow sports

Based on different studies from Switzerland, Germany, Austria, Norway and Canada the proportion of head injuries is being estimated at 15 % for ski injuries and 16% for snowboard injuries (see Table). The hospital-based injury data gathered in the European Union (IDB) reports an 11% proportion of ski-accidents to result in a head injury and 7% for snowboard-injuries.

Studies show that the proportion of head injuries suffered while sledging is also around 15% of the total number of injuries<sup>12</sup>. For severe injuries from sledging the head injury related proportion raises to even 55%<sup>13</sup>. The proportion of head injuries is in children higher than in other age groups<sup>14</sup>. Some studies even suggest an almost three times higher risk for skiers and snowboarders under the age of 35 to suffer a head injury compared to the age group of 35 and older<sup>15</sup>. The risk of a child suffering a head injury is

increased because of their smaller over all body size and weight compared to the head.

There are also considerable differences in type of injury for men and women. Whilst women suffer knee injuries significantly more often than men, men suffer more frequently head injuries<sup>16</sup>. One study suggests that the risk of head injuries in men is 2.2 times higher in comparison to female snow sports participants<sup>17</sup>.

In snow sports, the majority of head injuries are lacerations and contusions. A more detailed analysis of data on Swiss statistics<sup>18</sup> showed that open head wounds, particularly to the face, accounts for almost 33% of the recorded head related skiing and snowboarding injuries. Another 32% of injuries involve contusions of head, face or neck. Around 20% of injuries are concussions.

Another study indicates that, while most of the injuries treated in a trauma centre may be mild, one out of ten patients suffer severe brain injury. Collision with a tree or other stationary object (skier-tree) and collision with another skier are predominant mechanisms for severe injuries<sup>19</sup>. Head injuries are, with a proportion of 60%, the main cause of snow sports related injury deaths<sup>20</sup> and of severe injuries resulting in permanent disability<sup>21</sup>.

Swiss statistics on rescue services provided to people injured in snow sports, show a fairly *constant proportion of head injuries* over the last 8 seasons<sup>22</sup>. This, in spite of the observed increase in snow helmet

Proportion of injuries in snow-sport according to part of body: bfu estimate <sup>11</sup>				
Part of body	Skiers		Snowboarders	
	Proportion (%)	Range (%)	Proportion (%)	Range (%)
Head / Neck	15	13-17	16	13-17
Torso / Spine	15	15-19	15	15-20
Shoulder / Upper arm	20	17-23	20	18-22
Elbow / Lower arm	5	3-6	10	8-12
Wrist / Hand	10	10-23	20	15-25
Hip / Thigh	8	7-10	4	3-5
Knee	25	20-30	15	13-18
Lower leg / Ankle / Foot	15	12-18	13	10-15

Source: bfu



wearing rates among snow sportsmen and -women. Some studies even report an increase in the proportion of head injuries in the 1970s up to the 1990s<sup>23</sup>, but it is evident that in that period changes in boot-binding technology and the emergence of carving skis have led to a reduction in other injury mechanisms, and therefore increased the relative proportion of head injuries: with the reduction in the proportion of lower leg injuries, other proportions are automatically increased. An increase in the proportion of head injuries may be also due to improvements in detecting clinical symptoms of traumatic brain injury, an increase in risk taking behaviours such as jumps and acrobatic manoeuvres and excessive speed<sup>24</sup>. Other factors that may contribute to increased risk of a head injury are: density of traffic on selected piste sections, piste preparation, stability of the snow covering as a result of icing, technical snow, extreme mechanical compaction by machines and the effect of carving skis. The emergence of snow parks that may carry a higher risk of collision and head injury, is another factor that may counter the positive effect of increased helmet-wearing rates<sup>25</sup>.

## Protective effect of helmets

### *Is the European standard adequate?*

The protective effect of a snow sports helmet is evident: first of all, in case of a crash or fall accident, it reduces the impact force on the head, and secondly it provides resistance against penetration of objects into the skull. A helmet can of course not provide complete protection against any type of head injury. It is important that a helmet fits as snugly as comfort allows and that the chin straps are always tightly fastened.

In Europe and North-America standards are published for snow sports helmets. In the European Union and Switzerland, only helmets that fully meet the EN 1077 norm requirements are permitted onto the market. The European (EN 1077)-standard for 'Helmets for alpine skiers and snowboarders' specifies requirements as to helmets' construction (including field of vision), impact-dampening properties, penetration resistance and adjustment properties as well as labelling and information<sup>26</sup>. As the 'test heads' that are prescribed for compliance testing, consist of a solid mass, it is not pos-

sible to draw any conclusions on the movement of the brain inside the skull; hence it is not clear as to what extent snow sports helmets actually protect against concussions.

The protective effect is partly dependent on the impact speed of the head against an obstacle or the ground. The European norm (EN 1077) permits an impact speed of 5.42 m/s (approx 20 km/h or 12 mph), so that the impact does not exceed a maximum acceleration of 250 g on the test head form. On wide, smooth and groomed pistes of medium difficulty an average speed of about 40 km/h can be reached<sup>27</sup>. However, on medium-difficulty pistes in Switzerland skiers move forward with an average speed of around 30 km/h<sup>28</sup>. Children move at an average speed of around 19 km/h, with a range of approx. 6 to 46 km/h<sup>28</sup>.

It must be noted that the head impact speed is often unrelated to the speed of the snow sports participant, as in the majority of falls the initial impact is not to the head. Therefore the maximum levels of impact speed on which current international standards are based upon, may be quite adequate for ensuring sufficient impact absorption in the majority of cases.

### *Does helmets reduce injury severity?*

The protective benefits of snow sports helmets have been the subject of a number of studies and a recently published meta analysis indicates that helmet wearers are suffering 21% to 45% less head injuries than those not wearing a helmet<sup>30</sup>. This wide range is due to different sub-sets of population taken into consideration: some studies only investigated certain age groups while others only took into account only severe injuries that required hospitalization. Evaluations of the IDB data bank on snow sports participants receiving hospital treatment between 2002 and 2008 (4595 persons injured) suggest a reduction of the risk of a concussion by half when a helmet is worn: the proportion of cases of concussion among helmet wearers is 2.3%, for non-helmet wearers 5.8%.

These results can be influenced by other factors than helmet wearing. As helmet wearers may be by nature more safety-conscious and they also may ski or snowboard more carefully than non-helmet wearers<sup>31</sup>. But, helmet wearers could also be lulled into a false sense of safety and become more



inclined to take more risks ('risk compensation effect'): some studies show that helmet wearers ski or snowboard faster than non-wearer<sup>32</sup>. Other studies indicate that snow sports participants who assess themselves as risk-taking skiers and snowboarders are more likely to wear a helmet than those who are careful skiers and snowboarders<sup>33</sup>.

After all, it can be concluded that, although the risk compensation effect cannot be completely excluded, a possibly increased willingness to take more risks on slopes while wearing a helmet, does not outweigh the protective effect of a snow sports helmet<sup>34</sup>.

### More neck injuries?

It is also important to note that wearing a helmet does not increase the risk of suffering an injury in the neck area. An international review concludes that a snow sports helmet does not increase the frequency and severity of injuries to the cervical spine<sup>35</sup>. Neither it increases the frequency of neck and other injuries, provided that the helmet is chosen to suit age and activity and is worn correctly<sup>36</sup>. There are no studies available as to the protective effect of a snow sports helmet while sledging but, as the impact mechanism is similar it should provide the same level of protection.

To summarise, it can be safely concluded that snow sports helmets provide a significant protection to skiers and snowboarders.

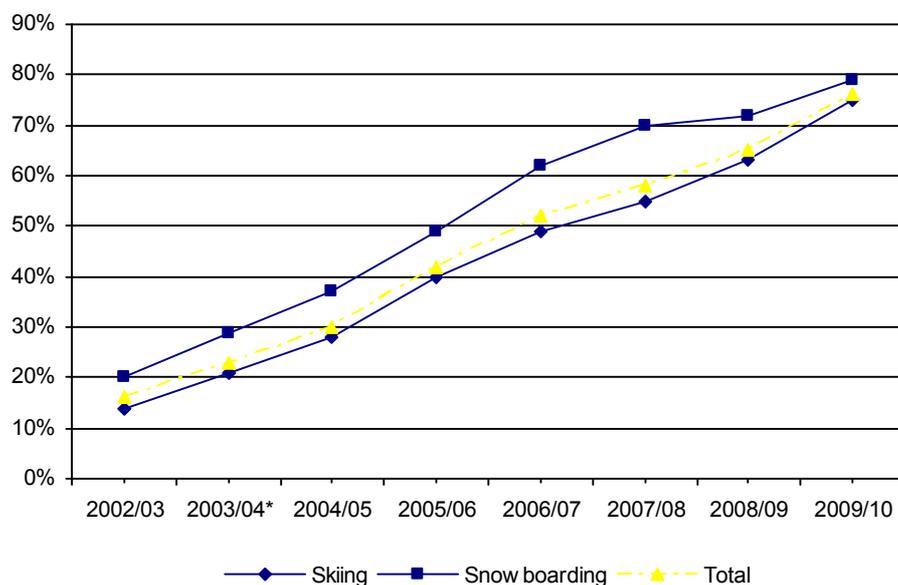
These helmets reduce the impact of a collision or crash and thus reduce the severity of injury outcome. Snow sports helmets are estimated to reduce head injuries by a factor of 21% to 45%<sup>37</sup>.

### Increased acceptance of ski helmets

Over the past few decades, public and private organisations have been active in making skiers aware of the injury risks and preventative measures to take. These measures relate to promote the rules of conduct to be respected, proper exercise and warming up before entering the piste, use of proper equipment and protective gear, and so on.

A decade ago, hardly anyone wore a helmet while skiing or snowboarding. Today, more and more snow sportsmen and -women protect their heads with a helmet. The overall rate of helmet wearers in Switzerland has increased from 16% in winter 2002/2003 to 76% in winter 2009/2010 (see Figure). Germany, in winter 2007/2008, 40% of skiers wore a helmet<sup>38</sup>. Austria recorded an overall helmet-wearer rate of 63% in winter 2008/2009<sup>39</sup>. In Switzerland, a rate of 95% has already been reached for children and youngsters to age 1740<sup>40</sup>. France report helmet wearing in children at an average rate of 65% in 2008<sup>41</sup>.

Helmets used in % according to type of sport and winter season



\* No data available. Mean value from adjacent seasons used.



Helmet promotion campaigns have undoubtedly contributed to a significant increase in helmet wearing rates. This also means that time is now mature for introducing more stronger obligations for snow slope operators, snow sport instructors, and for the sportsmen and women to ensure that snow helmets are being worn while actively engaged in snow sports. These obligations can be part of the set of rules of conduct, protocols for professionals and local operators or laid down in a national decree making helmet wearing mandatory.

In some Scandinavian countries, cable car operators do not allow children to enter their premises and cable cars if these children are not equipped with an proper helmet.

In several countries helmet wearing is already compulsory for skiing and snowboarding. The law for compulsory helmet wearing for children to age 14 came into force in Italy on 1 January 2005<sup>42</sup>. Unfortunately no figures are available as to the rate of helmet wearers in Italy. In Austria, the province of Lower Austria was the first to issue in March 2009 a legal requirement to wear a helmet came for children to age 15. Today, seven out of the nine provinces in Austria have rules for helmet wearing in place.

There is quite some controversy as to whether or not helmet wearing should be enforced by legislation, as it suggested, without any evidence, that a legal obligation would discourage snow sports participants from practising their sports.

## Recommendations



As snow sports helmets provide substantial protection to main parts of the head, helmet-wearing should be strongly recommended for snow sports like skiing, snowboarding and sledding.

An increasing number of people are wearing helmets while enjoying snow sports. Today, in many European countries over 50% of all snow sportsmen and women are wearing a helmet. The high level of acceptance of helmet wearing creates the right momentum for sustained

promotion efforts and for encouraging new measures by slope operators and authorities.

As it is in the business interests of all stakeholders, particularly local authorities, slope operators and instructors, to ensure a maximum level of safety on slopes, they have to take up their role in promoting snow sports helmets within the area of their responsibility. Many measures lend themselves to the promotion of helmet wearing, including continued mass-media campaigning and by target-group-oriented information in cooperation with the relevant professionals and stakeholders in snow sports. This will make sports participants more aware of the risk of injury in snow sports and the importance of using proper protective equipment such as snow helmets.

In training courses and in tuition material for future snow sports instructors, the issue of wearing proper protective gear should be well profiled. This is of major significance as snow sports instructors are important opinion leaders and, through their direct contact with beginners and the inexperienced, can readily stress the importance of wearing protective gear. Helmet wearing should also be compulsory for professionals that are in direct contact with snow sports participants on slopes, i.e. for snow sports instructors, piste patrollers and piste-rescue service personnel.

Providers of rental snow sports equipment should be encouraged to also offer, free of charge or at discount price, helmets to customers that are renting other equipment and gear. Snow sports participants would thus be encouraged to protect themselves. Cable cabin operators should advertise their services with helmet wearing clearly featured as essential element in the rules of conduct on the slopes. Other incentives should be considered such as offering passengers that are wearing a helmet, a fare reduction or a free ride. In local areas or regions where a high proportion of helmet wearers, a further increase compliance can be achieved by cable car operators denying people that are not equipped with helmets access to the slopes, starting with parents with un-helmeted children.

As children are more at risk of head injuries than other age groups, helmet wearing for



children to age 15 should also be made obligatory while in snow sports schools and in school snow sports camps. Legal steps to a full mandatory requirement as to helmet wearing on slopes are still subject of a broader political debate but should not be shunned.

In conclusion, the evidence of snow helmet effectiveness is undoubtedly present and an

increasing number of snow sport participants are already enjoying in a safe manner the benefits of this challenging type of sport.

It is now time for more targeted measures encouraging even more snow sports participants to wear a helmet and to ensure that by the end of this decade there is no exception to the rule that everyone wears a helmet while being actively engaged in snow sports.

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