

# Injury incidence in qualification runs versus final runs in FIS World Cup snowboard cross and ski cross

Sophie E Steenstrup, Tone Bere, Tonje W Flørenes, Roald Bahr, Lars Nordsletten

► An additional appendices is published online only. To view these files please visit the journal online (<http://bjsm.bmj.com/content/45/16.toc>).

Department of Sports Medicine, Oslo Sports Trauma Research Center, Norwegian School of Sport Sciences, Oslo, Norway

## Correspondence to

Sophie E Steenstrup, Department of Sports Medicine, Oslo Sports Trauma Research Center, Norwegian School of Sport Sciences, PB 4014 Ullevål Stadion, Oslo 0806, Norway; [sophistруп@gmail.com](mailto:sophistруп@gmail.com)

Received 25 August 2011  
Accepted 25 October 2011

## ABSTRACT

**Background** In the International Ski Federation (FIS), World Cup (WC) snowboard cross (SBX) and ski cross (SX), the injury incidence in individual qualification runs versus final runs in heats of four athletes is unknown.

**Objective** To investigate the injury incidence in individual qualification runs versus final runs of SBX and SX.

**Methods** Injuries were recorded by the FIS injury surveillance system (FIS ISS) through retrospective athlete interviews at the end of each season during four WC seasons (2006–2010). A total of 713 athletes (345 SBX and 368 SX) were interviewed. Time-loss injuries occurring during SBX and SX competitions were included. Injury incidence was expressed as the relative injury rate (per 1000 runs).

**Results** For SBX, the injury incidence per 1000 runs in finals was 12.1 vs 6.1 in qualifications (RR 1.9, 95% CI 1.1–3.5). The injury incidence was 12.9 in finals and 4.4 in qualifications (RR 2.9, 95% CI 1.4–6.2) for SBX males and 10.5 vs 9.3 (RR 1.1, 95% CI 0.5–2.8) for females. For SX, the injury incidence in finals was 12.4 and 9.2 in qualifications (RR 1.4, 95% CI 0.8–2.3). The injury incidence for SX males was 13.6 in finals vs 8.8 in qualifications (RR 1.5, 95% CI 0.8–3.1) and 10.8 vs 9.8 (RR 1.1, 95% CI 0.5–2.6) for females.

**Conclusion** The injury incidence was significantly higher in final runs compared with qualification runs in SBX for males. For SBX females and in SX, no significant differences were found.

## INTRODUCTION

Snowboard cross (SBX) and ski cross (SX) are relatively recent disciplines. They are a motocross-inspired mixture of freestyle and alpine events, characterised by courses which include obstacles such as banks, compressions, jumps and giant slalom-type turns. SBX was added as an International Ski Federation (FIS) World Cup (WC) event in the 1996/1997 season and was included in the 2006 Olympic Winter Games (OWG).<sup>1</sup> SX was included in the FIS WC for the 2002/2003 season and was a new Olympic event in Vancouver (Canada) in 2010.<sup>2</sup>

Helmets are mandatory during all official FIS WC training and competitions.<sup>3,4</sup> Body protectors (wrist, arms, hips, etc) are not mandatory, but are usually worn under the ski/snowboard suit. Back protectors are allowed as long as the equipment does not offer an aerodynamic advantage.<sup>3,4</sup> In SBX, although the snowboard's minimal width is restricted, there is no restriction on the type of board allowed and riders use either a freestyle board or a giant slalom-type board.<sup>3</sup> In SX, unlike in alpine skiing, there is no FIS regulation on the

length of the skis or the side cut, but ski boots and bindings must be according to FIS rules.<sup>4</sup>

Torjussen and Bahr reported an injury incidence of 2.1 time-loss injuries (absence  $\geq$  1 day) per 1000 runs for WC SBX athletes.<sup>5</sup> During the 2010 OWG, 73% of female and 11% of male SBX athletes suffered an injury. However, only 40% of these injuries caused time-loss and the majority of injuries (78.9%) occurred during training.<sup>6</sup>

In WC SX events, there were 33.8 time-loss injuries per 100 athletes per season, and the injury incidence (per 1000 runs) was 16.6 for males and 21.8 for females.<sup>7</sup> During the 2010 OWG, 23% of female and 15% of male SX athletes suffered an injury, although only 23.1% of these injuries were time-loss injuries and 61% occurred during training.<sup>6</sup>

In other words, the injury risk especially in SX is high, substantially higher than moguls/dual moguls (9.2 injuries/1000 runs), slalom (4.9/1000 runs), giant slalom (9.2/1000 runs) and super-G (11.0/1000 runs).<sup>7,8</sup>

In contrast to traditional skiing and snowboarding events, SBX and SX athletes compete individually and in heats of 4. There are individual timed qualifying runs, 1 in SX and 2 in SBX. The best ranked athletes from the qualification runs advance to the final heats. The FIS rules state that there can be either 16 or 32 qualifiers to the final runs. The first two athletes advance to further heats.<sup>9</sup> In FIS WC and Olympic SBX final runs, there are 32 males and 16 females with four athletes per heat. In the SX WC, most often there were 16 female qualifiers to the final runs in the 2006/2007 season, whereas in recent seasons (including the 2010 OWG), 32 SX females qualifying to the final runs has become more common.<sup>9</sup> We do not know whether the risk of injury is influenced by having more than one athlete in the course. According to the FIS rules of contact in SBX and SX,<sup>3,4</sup> unavoidable 'casual' contact may be acceptable while intentional contact between athletes by pushing, pulling or holding another competitors' arm, leg, ski pole (SX) or other means which causes an athlete to slow down, fall or exit the course is prohibited. Blocking by intentional movements of the body or leaving the natural skiing line is not allowed.<sup>3,4</sup> Nevertheless, it could be hypothesised that competing in heats is more challenging and thereby increases the risk of injury compared with competing individually in the course. Athletes riding/skiing in heats of four may encounter some stress in relation to competing with other opponents. Whether this physical and psychological stress influences the risk of injury is unknown. Thus, the purpose of this study was to investigate the injury incidence in individual qualification runs versus final runs of SBX and

SX during four seasons of the FIS WC, including the FIS World Ski/Snowboard Championships (WSC) and the OWG.

## MATERIALS AND METHODS

### Injury recording

Injuries were recorded in the FIS injury surveillance system (FIS ISS) through retrospective athlete interviews at the end of each season during four WC seasons (2006–2010). This method was chosen because a methodological study found this to be the best method available, compared with prospective injury registration by FIS technical delegates (TD) or team medical personnel, to record injuries among WC ski and snowboard athletes.<sup>10</sup> Interviews of SBX athletes were conducted towards the end of each season in Lake Placid, USA (March 2007), Valmalenco, Italy (March 2008 and March 2009), and La Molina, Spain (March 2010). Interviews of SX athletes were conducted in Madonna Di Campiglio, Italy (March 2007), Valmalenco, Italy (March 2008), La Plagne, France (March 2009), and Sierra Nevada, Spain (March 2010). During these seasons, all athletes from the teams of Germany, Switzerland, Canada, Finland, France, Norway, Italy, Sweden and Austria were included. Complete WC teams from 13 SBX and 9 SX nations were included in addition to the 9 previously mentioned nations, for three of the seasons (2007–2010), to increase the study population. All athletes included were registered in the FIS database and had started in at least one FIS WC competition. We defined the WC season as starting on 1 November or at the first WC competition if earlier, and included the last WC competition of the season, where the interviews took place. In all SBX and SX competitions included in this study, there was a four athlete per heat format.

All interviews were conducted in person in the finishing area of the SBX and SX competitions, by physicians or physiotherapists from the Oslo Sports Trauma Research Center. However, three freestyle athletes were interviewed via telephone/email within 4 weeks of the interview dates. The interviewers filled out a standardised interview form for each athlete (Appendix 1, web only file). If the athlete reported an injury, an injury form (Appendix 2, web only file) was also completed. The injury form included information about the date and place of injury, injury circumstances, body part injured, side (left/right), injury type, injury severity and the specific diagnosis. If an athlete was not present at the competitions where the interviews were conducted (due to injury or other reason), or if the athlete did not understand English, the team coach, physician or physiotherapist was interviewed.

### Injury definition

We included only injuries occurring during qualification and final runs of SBX and SX competitions during the FIS WC, WSC or the OWG. Injuries occurring during official training, other training or outside of competition were excluded, as accurate exposure data were not available outside competition. In the FIS ISS, an injury was defined as all injuries sustained by an athlete that occurred during training or competition and required attention by medical personnel.<sup>10</sup> An injury with at least 1 day absence from training or competition was referred to as a time-loss injury.<sup>11</sup> In this study, we included only time-loss injuries.

### Injury inclusion

A total of 138 injuries were registered through athlete interviews in the FIS ISS database. We included only injuries that

were reported by the athletes, coaches or medical personnel during retrospective athlete interviews from the nations included. Nations were included if they had  $\geq 80\%$  response rate to the athlete interviews. A total of 129 injuries were reported by the nations included. We had to exclude injuries where the run-type could not be identified ( $N=21$ , SBX: 9, SX: 12). This happened, for example, when the athlete had reported the date of injury incorrectly, when the athlete could not be found on the start list of the competition or when the athlete had reported injuries that had happened outside FIS WC competitions. Thus, we included a total of 108 injuries from the 138 injuries registered in the FIS ISS database.

### Exposure registration

To calculate exposure, the number of started runs during SBX and SX competitions was counted for each athlete per competition. If an athlete did not finish or was disqualified from a run, we included the runs up to and including the run where the athlete did not finish or was disqualified. This information was obtained from the official FIS web site.<sup>9</sup> The race calendar for SX and SBX for each season was downloaded to identify the WC, WSC and OWG competitions. Athletes included were identified from the start list and his/her runs were counted manually from the qualification result list, race ladder and the final result list. The number of runs for each athlete was summed per competition, per year and for the four seasons.

### Statistics

The injury incidence was expressed as the relative injury rate (injuries per 1000 runs), with the corresponding 95% CI. Calculations were based on the Poisson model, and Z tests were used to compare injury incidence between groups. The relative risk (RR) with 95% CI was computed. A RR = 1 means that there is no difference between groups, a RR < 1 means that the event is less likely to occur and a RR of > 1 means that the event is more likely to occur. A two-tailed p-level of <0.05 was considered statistically significant.

## RESULTS

### Athletes included

A total of 713 WC SBX and SX athletes, 259 females and 454 males, were interviewed during four seasons (table 1).

### Exposure

The 713 athletes included in the study entered a total of 11 085 runs during the 2006–2010 seasons, 5672 in SBX and 5413 in SX. Of these, 3435 and 2183 were qualification runs and 2237 and 3230 were final runs in SBX and SX, respectively (table 2).

### Injury incidence

A total of 108 time-loss injuries (absence  $\geq 1$  day) were recorded among the 713 athletes included (table 2). In SBX, there were 48 time-loss injuries (females 19 and males 29) and in SX there were 60 time-loss injuries (females 23 and males 37). In SBX overall, 44% (21 of 48) of injuries occurred in qualification runs and 56% (27 of 48) of injuries occurred in final runs. In SX overall, 33% (20 of 60) of injuries occurred in qualification runs and 67% (40 of 60) of injuries occurred in finals.

**Table 1** Number of athletes interviewed in SBX and SX during four seasons (2006–2010)

Discipline & sex	2006/2007	2007/2008	2008/2009	2009/2010	Sum of four seasons
SBX					
Males	43	58	58	66	225
Females	20	36	30	34	120
Total	63	94	88	100	345
SX					
Males	48	65	57	59	229
Females	23	29	47	40	139
Total	71	94	104	99	368
Total athletes interviewed					713

SX, ski cross; SBX, snowboard cross.

**Table 2** Number of runs and time-loss injuries (absence  $\geq 1$  day) in SBX and SX qualification and final runs during the 2006–2010 seasons

Discipline, sex and run-type	Season				Sum of four seasons
	2006/2007	2007/2008	2008/2009	2009/2010	
SBX					
Qualification runs					
Males	196	650	703	647	2196
Females	92	371	363	331	1157
Sum runs					3352
Injuries qualification runs	2	5	4	10	21
Final runs					
Males	131	433	496	377	1437
Females	65	228	239	204	736
Sum runs					2174
Injuries final runs	1	11	8	7	27
Sum Injuries SBX	3	16	12	17	48
SX					
Qualification runs					
Males	127	318	440	484	1369
Females	62	130	309	313	814
Sum runs					2183
Injuries qualification runs	0	5	10	5	20
Final runs					
Males	183	378	623	657	1841
Females	99	200	491	599	1389
Sum runs					3230
Injuries final runs	3	7	14	16	40
Sum injuries SX	3	12	24	21	60

SX, ski cross; SBX, snowboard cross.

A total of 68 athletes had one unique injury during the four seasons (table 3). A total of 17 athletes had more than one injury during the four seasons. No athletes had more than four injuries.

For SBX, the overall injury incidence was higher in final runs compared with qualification runs (RR 1.9, 95% CI 1.1 to 3.5,  $p=0.019$ ) (table 4). However, while there was a significant difference between final runs and qualification runs for males (RR 2.9, 95% CI 1.4 to 6.2,  $p=0.007$ ), this was not the case for SBX females (RR 1.1, 95% CI 0.5 to 2.8,  $p=0.79$ ).

For SX, there was no difference in the overall injury incidence between finals and qualifications (RR 1.4, 95% CI 0.8 to 2.3,  $p=0.27$ ) (table 4), nor was there any difference for males (RR 1.5, 95% CI 0.8 to 3.1,  $p=0.21$ ) or females (RR 1.1, 95% CI 0.5 to 2.6,  $p=0.83$ ).

## DISCUSSION

This is the first study to examine the injury incidence in qualification and final runs of WC SBX and SX. The principal finding was that the injury incidence was significantly higher in final runs versus qualification runs in SBX for males. For SBX females and in SX, the injury incidence in final runs was not significantly higher than in qualification runs.

## Methodological considerations

All injury recording during the four WC seasons was through retrospective interviews with athletes, medical personnel or coaches. Recall bias is a challenge with retrospective interviews. However, a methodological study found that retrospective interviews were the best method compared with prospective injury registration by team medical personnel or

**Table 3** Re-injuries: number of athletes suffering one or more time-loss (absence $\geq$ 1 day) injuries during four seasons of the FIS WC

Number of injuries	SBX		SX	
	Number of athletes with injury	Overall number of injuries	Number of athletes with injury	Overall number of injuries
1 injury	32	32	36	36
2 injuries	6	12	7	14
3 injuries	0	0	2	6
4 injuries	1	4	1	4
Sum injuries		<b>48</b>		<b>60</b>

SX, ski cross; SBX, snowboard cross.

FIS TD's to record injuries among WC skiers and snowboarders.<sup>10</sup> The interviews were conducted at the end of each of the four seasons. We therefore believe that data from no individual season should have suffered more from recall bias than data from other seasons.

A total of 30 injuries were excluded from the study, nine injuries because athletes did not belong to an included nation (SBX: 5, SX: 4) and in 21 cases we could not identify the run-type (SBX: 9, SX: 12). The excluded injuries were evenly distributed between sexes (males: SBX = 7, SX = 8; females: SBX = 7, SX = 8) and between disciplines (SBX: 14, SX: 16), and we therefore do not believe that the excluded injuries have affected the results. The majority of injuries (N = 21) were excluded because we could not identify the run-type where the injury occurred. In many cases, the athlete could not be found on the start list of the race where he/she had reported the injury to have occurred, and we therefore believe that many injuries occurred in training prior to the competitions, or in training not related to the competition. In some cases, the athletes also reported injuries in competitions outside the FIS WC.

### Qualification runs versus final runs

From our data, we cannot determine why riding in heats of four gave a higher risk of injury compared with riding individually for SBX males, or why this risk was not found in SBX females or in SX. It has been assumed that more injuries happen in final runs because of external factors such as space constraints in the course and competition for the ideal line. Further, it is suggested that many injuries in SBX happen in conjunction with jumps.<sup>12</sup> Torjussen and Bahr reported that in WC SBX riders, the main mechanisms of injuries were falling at an obstacle (52%) and collisions with competitors (44%).<sup>5</sup> Although intentional contact is prohibited by the FIS rules of contact,<sup>3,4</sup> athletes occasionally are in intentional or unintentional contact with each other during heats.

How athletes cope in heats is influenced by their skiing/riding preferences. Some athletes prefer to lie behind and subsequently attempt to overtake the leading athletes, whereas others prefer to lie in front. It is thought that lying in front of the heat gives the athlete more opportunity to follow his/her ideal race line and minimises the chance of contact. Lying behind in the heat makes it more difficult for athletes to follow their ideal race line and might increase the chance of contact because several athletes are trying to overtake each other (Stian Sivertzen, Norwegian team SBX rider, personal communication, May 2011).

It has been suggested that psychological factors such as nervousness, stress, excitement, the ability to handle pressure and to make correct split second decisions about race tactics (risk

**Table 4** Injury incidence (with 95% CI) in SBX and SX qualification runs and final runs for males and females (n = 713)

Discipline and sex	Injury Incidence/1000 runs (95% CI)		
	Qualification runs	Final runs	Overall
SBX overall*	6.1 (3.5 to 8.7)*	12.1 (7.5 to 16.6)*	8.5 (6.1 to 10.9)
SBX females	9.3 (3.8 to 14.7)	10.5 (3.2 to 17.8)	9.7 (5.4 to 14.1)
SBX males*	4.4 (1.7 to 7.2)*	12.9 (7.1 to 18.7)*	7.8 (5.0 to 10.6)
SX overall	9.2 (5.1 to 13.2)	12.4 (8.5 to 16.2)	11.1 (8.3 to 13.9)
SX females	9.8 (3.0 to 16.6)	10.8 (5.3 to 16.3)	10.4 (6.2 to 14.7)
SX males	8.8 (3.8 to 13.7)	13.6 (8.3 to 18.9)	11.5 (7.8 to 15.2)

\*Significant differences ( $p < 0.05$ ) between qualification and final runs.

SX, ski cross; SBX, snowboard cross.

management) are thought to influence how athletes handle competing in heats (Jonte Grundelius, Norwegian SBX coach, personal communication, May 2011). It has been suggested that SBX may promote a risk-taking attitude for competitors to stay at the top of their sport.<sup>5</sup> In final heats, the effort will be maximal and athletes may take more risks than when riding alone because so much is at stake (Stian Sivertzen, Norwegian team SBX rider, personal communication, May 2011).

Physiological factors such as aerobic fitness, strength and explosiveness are also thought to influence how well athletes handle competing in final heats.<sup>13</sup> Athletes reaching the finals compete in 5 or 6 runs of 60 s or more, in addition to training and warm-up runs, and it is thought that fatigue might influence athlete performance in finals. Platzter *et al* reported that performance on a battery of physical tests could predict WC ranking for SBX females, although psychological factors, equipment and coordination may be more important.<sup>13</sup>

In BMX cycling, which also uses a heat format, it has been reported that crashes, often involving several participants, occurred frequently. Injuries were sustained through impact on the track and/or collisions with the rider's own or other competitors bicycles.<sup>14</sup> In horse racing (flat racing) heats, a high rate of concussions was found for jockeys. This reflects the high speeds and the fact that falls tended to occur when horses were closely bunched together.<sup>15</sup> External risk factors for WC short track speed skaters were identified to include the number of skaters (3–5) in a race and the number of people falling in a single collision.<sup>16</sup> Regarding internal factors, in mountain biking heats it was suggested that riders had an extreme nature and were 'pumped up' during final heats, enabling them to complete events even with significant injuries as long as they were mechanically able to ride.<sup>17</sup>

We cannot determine why male and not female SBX riders had a higher risk of injuries in final runs. Male sex and high speed were found to be factors associated with risk-taking behaviour among recreational skiers and snowboarders.<sup>18,19</sup> Male SBX and SX athletes attain higher average speeds compared with women.<sup>2,20</sup> We do not know, however, if speed influences the injury risk in SBX and SX and if there are speed differences between individual qualification runs and final runs.

Why many injuries occur in qualification runs is also important to consider. It is thought that attempting to qualify from preliminary rounds to final rounds may lead athletes to push themselves beyond their limits.<sup>21</sup> In the same way that athletes take risks in final runs to win the heat, athletes may take too much risk to try to advance from qualification runs. The risk of injury might be high in qualification runs because the athletes may not yet be fully acquainted with the course due to too little training time,

athletes might have difficulty judging their speed and timing onto elements, and because less skilled riders/skiers might take too much risk in qualification runs to try to qualify to the finals (Jonte Grundelius, Norwegian SBX coach and Audun Grønvold, Norwegian SX coach, personal communication, May 2011).

### Injury incidence

Torjussen and Bahr found that the injury incidence for WC SBX riders was 2.1 per 1000 runs.<sup>5</sup> This had a greater exposure rate than our current study and included warm-up and training runs. Torjussen and Bahr used an exposure factor of 13.7 runs per competition for SBX,<sup>5</sup> compared with the exposure of 2–6 runs used in this study. Compared with their study, the injury incidence of our study was higher (8.5/1000 runs).

In SBX and SX male final runs, the injury incidence per 1000 runs in our study was 12.9 and 13.6. This is higher than the previously reported for giant slalom (9.2), super-G (11.0) and moguls/dual moguls (9.2), but lower than for downhill skiing (17.2), freestyle half pipe (23.9) and aerials (19.2).<sup>7,8</sup>

### Further perspectives

Although we have identified that more injuries happen in male SBX finals, we do not know if more injuries happen early or late in finals. One could theorise that fewer injuries happen late in finals because only the most skilled athletes have qualified to the final stages, or that more injuries happen later in finals because of the athletes' fatigue and the fact that so much is at stake.

SBX athletes need 50 SBX FIS points to participate in the WC<sup>22</sup> and SX athletes need 50–100 FIS freestyle points or 50 FIS alpine points from any alpine event.<sup>23</sup> Coaches have questioned if these entry criteria should be raised. It has been suggested that some lower ranked athletes might not possess the necessary skills to cope with technical courses (Jonte Grundelius, Norwegian SBX coach, personal communication, May 2011). We do not know if the lower-ranked athletes had more injuries than higher-ranked athletes, but this should be investigated in future studies.

What athletes themselves can do regarding physical and psychological factors to minimise the risk of injury is unknown. We have little knowledge about whether physical and psychological factors can influence the risk of injury. Future studies should try to identify what the physical and psychological requirements of SBX and SX are.

We do not know if the number of athletes competing in the course at the same time influences the injury risk. In our data material, all races were held with a four athletes per heat format. It would be interesting in future studies to also examine the injury risk in competitions which have a six athletes per heat format.

Future studies should investigate whether and how course elements affect injury risk. Whether the placement and spacing between elements, the combination of elements and the width of the course affect the risk of injury is unknown.

### CONCLUSION

The injury incidence was significantly higher in final runs compared with individual qualification runs in SBX for males. This was not the case for SBX females or for SX. There were no sex differences in injury incidence. Future studies should attempt to identify injury situations and injury mechanisms in qualification and final runs of WC SBX and SX.

**Acknowledgements** We thank the International Ski Federation staff and officials for all practical support in collecting the injury data. The authors also thank the freestyle WC SBX and SX athletes, coaches and medical team personnel who participated in this study. Also, thanks to Norwegian WC team SBX and SX coaches Jonte Grundelius and Audun Grønvold, and Norwegian team SBX rider Stian Sivertzen for sharing knowledge about SBX and SX.

**Funding** The Oslo Sports Trauma Research Center has been established at the Norwegian School of Sports Sciences through generous grants from the Royal Norwegian Ministry of Culture, the South-Eastern Norway Regional Health Authority, the International Olympic Committee, the Norwegian Olympic Committee & the Confederation of Sport and Norsk Tipping AS. The FIS Injury Surveillance System is supported by the International Ski Federation and has been established through a generous grant from Don Joy Orthotics (DJJO).

**Competing interests** None.

**Ethical approval** The study was reviewed by the Regional Committee for Medical Research Ethics, South-Eastern Norway Regional Health Authority, Norway.

**Provenance and peer review** Not commissioned; externally peer reviewed.

### REFERENCES

1. LG FIS Snowboard World Cup Homepage. <http://www.fissnowboard.com> (accessed 8 Mar 2011).
2. FIS Freestyle Ski World Cup Homepage. <http://www.fisfreestyle.com/> (accessed 8 Mar 2011).
3. The International Snowboard Competition Rules (ICR). Book VI: Joint Regulations for Snowboarding. Approved by the 47th International Ski Congress, Antalya (TUR). Edition 2010 including precisions 2011. <http://www.fis-ski.com/data/document/icr-11-snowboard-clean.pdf> (accessed 20 Jul 2011).
4. The International Freestyle Skiing Competition Rules (ICR). Book V: Joint Regulations for Freestyle Skiing. Approved by the 47th International Ski Congress, Antalya (TUR), Edition 2010. <http://www.fis-ski.com/data/document/fis-freestyle-ski-icr-20103.pdf> (accessed 20 Jul 2011).
5. Torjussen J, Bahr R. Injuries among elite snowboarders (FIS Snowboard World Cup). *Br J Sports Med* 2006;**40**:230–4.
6. Engebretsen L, Steffen K, Alonso JM, et al. Sports injuries and illnesses during the Winter Olympic Games 2010. *Br J Sports Med* 2010;**44**:772–80.
7. Flørenes TW, Heir S, Nordsletten L, et al. Injuries among World Cup freestyle skiers. *Br J Sports Med* 2010;**44**:803–8.
8. Flørenes TW, Bere T, Nordsletten L, et al. Injuries among male and female World Cup alpine skiers. *Br J Sports Med* 2009;**43**:973–8.
9. FIS-SKI: International Ski Federation News Homepage. <http://www.fis-ski.com/> (accessed 15 February 2011).
10. Flørenes TW, Nordsletten L, Heir S, et al. Recording injuries among World Cup skiers and snowboarders: a methodological study. *Scand J Med Sci Sports* 2011;**21**:196–205.
11. Fuller CW, Ekstrand J, Junge A, et al. Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries. *Clin J Sport Med* 2006;**16**:97–106.
12. Bakken A, Bere T, Bahr R, et al. Mechanisms of injuries in World Cup snowboard cross. *Br J Sports Med* 2011;**45**:1315–22.
13. Platzer HP, Raschner C, Patterson C, et al. Comparison of physical characteristics and performance among elite snowboarders. *J Strength Cond Res* 2009;**23**:1427–32.
14. Brøgger-Jensen T, Hvass I, Bugge S. Injuries at the BMX Cycling European Championship, 1989. *Br J Sports Med* 1990;**24**:269–70.
15. Turner M, McCrory P, Halley W. Injuries in professional horse racing in Great Britain and the Republic of Ireland during 1992–2000. *Br J Sports Med* 2002;**36**:403–9.
16. Quinn A, Lun V, McCall J, et al. Injuries in short track speed skating. *Am J Sports Med* 2003;**31**:507–10.
17. Carmont MR. Mountain biking injuries: a review. *Br Med Bull* 2008;**85**:101–12.
18. Goulet C, Hagel BE, Hamel D, et al. Self-reported skill level and injury severity in skiers and snowboarders. *J Sci Med Sport* 2010;**13**:39–41.
19. Ruedl G, Pocecco E, Sommersacher R, et al. Factors associated with self-reported risk-taking behaviour on ski slopes. *Br J Sports Med* 2010;**44**:204–6.
20. Ski Cross versus Snowboard Cross times, speeds and percentage differences Vancouver 2010. [http://wiki.fisski.com/index.php/Ski\\_Cross\\_vs\\_Snowboard\\_Cross\\_times\\_speeds\\_and\\_percentage\\_differences\\_Vancouver\\_2010](http://wiki.fisski.com/index.php/Ski_Cross_vs_Snowboard_Cross_times_speeds_and_percentage_differences_Vancouver_2010) (accessed 15 April 2011).
21. Tomida Y, Hirata H, Fukuda A, et al. Injuries in elite motorcycle racing in Japan. *Br J Sports Med* 2005;**39**:508–11.
22. Rules for the FIS Snowboard World Cup. Edition 2011/2012. <http://www.fis-ski.com/data/document/wcrule12.pdf> (accessed 22 May 2011).
23. Rules for the FIS Freestyle Ski World Cup. Edition 2010/2011. <http://www.fis-ski.com/data/document/world-cup-rules-10113.pdf> (accessed 22 May 2011).



## Injury incidence in qualification runs versus final runs in FIS World Cup snowboard cross and ski cross

Sophie E Steenstrup, Tone Bere, Tonje W Flørenes, et al.

*Br J Sports Med* 2011 45: 1310-1314  
doi: 10.1136/bjsports-2011-090528

---

Updated information and services can be found at:  
<http://bjsm.bmj.com/content/45/16/1310.full.html>

---

*These include:*

### References

This article cites 15 articles, 11 of which can be accessed free at:  
<http://bjsm.bmj.com/content/45/16/1310.full.html#ref-list-1>

Article cited in:

<http://bjsm.bmj.com/content/45/16/1310.full.html#related-urls>

### Email alerting service

Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

---

### Notes

---

To request permissions go to:  
<http://group.bmj.com/group/rights-licensing/permissions>

To order reprints go to:  
<http://journals.bmj.com/cgi/reprintform>

To subscribe to BMJ go to:  
<http://group.bmj.com/subscribe/>