Injuries Among Competitive Snowboarders at the National Elite Level

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Background: Little is known about injury risk or the pattern of injuries among competitive snowboarders.

Purpose: To describe the incidence and pattern of injuries among female and male snowboard athletes at the highest national level.

Study Design: Descriptive epidemiology study.

Methods: This study consists of 2 parts: prospective registration of injuries at snowboarding national cup events and the national championships during the 2002 season, as well as a retrospective interview of the participants during the national championships in March 2002. All injuries that resulted in missed participation were recorded. Exposure was recorded as the number of runs in all disciplines.

Results: In the prospective study, the competition incidence was 4.0 ± 0.7 injuries per 1000 runs (n = 32 injuries). Back (22%), knee (16%), and hand/wrist injuries (9%) were the most common. The incidence for the different disciplines was 14.2 ± 5.3 per 1000 runs for big jump, 6.1 ± 1.8 for snowboardcross, 3.1 ± 0.9 for halfpipe, and 1.9 ± 1.9 for giant slalom. The retrospective interview (n = 163 athletes, 83% response) revealed 84 acute time-loss injuries during the season; knee (16%), back (13%), head (13%), and hand/wrist injuries (12%) were the 4 most common injury types. The overall competition incidence was 3.4 ± 0.6 injuries per 1000 runs (6.6 ± 3.0 for big jump, 5.8 ± 1.7 for snowboardcross, 2.1 ± 0.7 for halfpipe, and 6.6 ± 4.7 for giant slalom). No injury was recorded in parallel slalom in either study.

Conclusion: The incidence of injuries is high among competitive snowboarders at the elite national level. The injury pattern is different from the panorama seen among less experienced athletes, with fewer wrist injuries and more knee injuries.

Keywords: epidemiology; skiing; snowboarding; incidence; prevention

Snowboarding has experienced tremendous growth since its introduction, and the sport continues to grow. In 2002, the number of participants worldwide was estimated to be 4 to 7 million (Rene Hansen, Burton Snowboards, personal communication, 2003). In Norway, the total number of snowboarders is estimated to be 200 000 to 300 000, with yearly sales figures of approximately 20 000 snowboards (Halvor Engen, snowboard distributor, personal communication, 2003).

One consequence of the remarkable growth of snowboarding is that the share of inexperienced snowboard participants is high; another is a significant increase in snowboard injuries. In Albany, New York, injuries increased almost 10-fold from 1994 to 1998.[13] In Europe, the Swiss Ski Lift Association reported more than a 5-fold increase in the number of snowboard injuries from 1990 to 1999.[26] At the 1994 Olympic skiing venue in Lillehammer, Norway, there was a 10-fold increase in hospital-treated snowboard injuries from 23 in 1995 to 239 in 2000, whereas there was only a small increase in alpine skiing injuries (Roar Rønning, personal communication, 2000).

However, it is not known if the high number of injuries is a characteristic of the sport or just a consequence of the recruitment of large numbers of beginners over a short period of time. In general, novice participants are more prone to be injured,[§] and first-time snowboarders are as likely to be injured as first-time skiers.[28] On the other hand, if skill level is not accounted for, snowboarders have been shown to have almost a 4-fold higher injury rate than alpine skiers.[32]

Although national and international semiprofessional and professional tours have been established and snowboarding has been an Olympic discipline since the 1998 Nagano Olympic Games, little is known about the injury risk or pattern of injuries among competitive snowboard-

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§References 1, 4, 5, 9, 20, 25, 26, 33, 37, 42.

ers. In several studies in which all levels of recreational snowboarders were included, injuries to the wrist represented more than 20% of all injuries.[5,14,20,25,33] This injury type appears to be more frequent among inexperienced snowboarders.[4,5,20,25,33] The pattern related to other body parts is more diverse, with knee injuries accounting for between 3% and 23% of all injuries and injuries to the back and chest accounting for between 2% and 16% of all injuries.[1,4,5,20,25,30,31,33]

Retrospective studies on the injury pattern among elite snowboarders carried out from 1993 to 1996 concluded that upper extremity injuries are frequent (range, 16%-51%)[6,7,34] and that the proportion of lower limb injuries ranges from 20% to 39%.[6,7] The risk of injury among professionals has been estimated to be 0.8 injuries per 1000 snowboarding hours.[34] However, the injury pattern among elite snowboarders may be entirely different from that of recreational snowboarders or beginners, considering the significant differences in riding styles between these groups. For instance, it can be hypothesized that elite snowboarders suffer fewer wrist fractures because of their higher skill level, increased awareness of risk situations, and falling technique learned after several years of practice. Several authors have suggested these factors to reduce the injury risk, with fewer incidents from unexpected falls or uncontrolled landings after jumps, leading to a different injury pattern.[1,4,13,38,41] On the other hand, the riding style of elite performers with greater speed during competition and warm-up, spectacular jumps, and the introduction of new tricks in the freestyle disciplines may be expected to lead to high-impact injuries.[6,7,34] Also, because competitive snowboarding consists of several disciplines with different characteristics, such as parallel slalom, giant slalom, snowboardcross, halfpipe, and big jump, the injury risk and injury patterns may be expected to differ between disciplines.

Thus, the aim of this study was to estimate the injury incidence and describe the pattern of injuries among skilled snowboard athletes competing at the national elite level.

METHODS

This study consists of 2 separate parts: a prospective injury registration at 22 national tour events during the 2001-2002 season and a retrospective survey based on athlete interviews at the national championships at the end of the season. A total of 322 female and male athletes had obtained a valid license to compete at this level, according to records from the official insurance company, Norwegian Brokers. The national tour included the parallel slalom, giant slalom, snowboardcross, halfpipe, and big jump disciplines.

Prospective Study: National Tour Events

The injury registration was carried out at 22 of the 24 national tour events by medical staff providing coverage at the events (physician and/or physical therapist, assisted by paramedics). The patients were followed up by telephone by 1 of the authors (J.T.) after the event to obtain information on time loss and final diagnosis. Acute injuries were recorded based on the following injury definition: any injury causing cessation of the athlete's participation in competition or training for at least 1 day after the day of the incident. All injuries corresponding to the definition were recorded using a standard form containing the following information: (1) date of injury, (2) whether the injury took place during official training before competition or during competition, (3) whether the injury was a new injury or a reinjury, (4) whether the athlete continued the race after the incident, (5) the discipline executed during the incident and injury mechanism, (6) injury type (concussion, contusion, sprain, strain, dislocation, fracture, skin abrasion/wound, other), (7) anatomical location and side, (8) protection gear used, and (9) diagnosis. In addition, the time to return to activities was recorded as the time it took until the athlete was fully able to participate in training and competition. Injury severity was graded according to the duration of time loss from training and competition as minor (1-7 days), moderate (8-21 days), or serious (>21 days). Severity was also recorded using the Abbreviated Injury Scale (AIS).[22]

Separate reports were collected from judges, technical delegates, and the results service to estimate exposure for halfpipe and big jump competitions. For the qualification and final runs, exposure was recorded based on the fixed format. For the official precompetition warm-up period, the results service and the technical delegate estimated exposure from the number of participants and the duration of the official training sessions. For the giant slalom, parallel slalom, and snowboardcross disciplines, the number of training runs per participant was fixed and reported by the technical delegate.

Retrospective Survey: National Championships at Hafjell and Lillehammer

A total of 196 snowboarders took part in the national championships event. All athletes and team captains were required to attend a technical meeting, where they were informed about the purposes and procedures of the study. They were encouraged to contact the investigators for a 5- to 10-minute interview during the day. Moreover, they were informed that participation was voluntary and assured that the information provided could not be traced back to the athlete or his or her team. For each athlete, all acute injuries and the detailed competition program for the 12-month period from the end of the previous season through April 1, 2001, were recorded during a structured interview. In addition to the national cup and national championship events, riders had taken part in regional and international competitions, which were also recorded. A standard form was used, which included data on injuries during competition and training, as well as competition exposure. Training exposure was not reported. For each injury the athlete had sustained, the same information as for the prospective study was collected. In addition, infor-

TABLE 1
Prospective Study: Exposure, Number of Injuries, and Incidence Recorded at 22 of the 24 National Tour Competitions During the 2001-2002 Season

	Exposure (Runs)		Injuries		Incidence (Injuries per 1000 Runs)	
Discipline	Women	Men	Women	Men	Women	Men
Giant slalom	134	396	0	1	0.0	2.5
Parallel slalom	284	772	0	0	0.0	0.0
Halfpipe	1225	2926	3	10	2.4	3.4
Big jump	64	429	3	4	46.9	9.3
Snowboardcross	411	1379	4	7	9.7	5.1

mation was requested on the type of activity (whether the injury occurred during competition or warm-up), snowboard training, or other training (strength, conditioning, or other activity). Competition exposure was recorded as the number of events in each discipline attended by the athlete. Total competition and warm-up exposure for each athlete (the total number of runs in each discipline) was computed as the number of events multiplied, with the average number of runs recorded in the prospective study for each discipline (giant slalom, 2.0 runs per athlete per event; parallel slalom, 4.4; halfpipe, 7.9; big jump, 5.1; snowboardcross, 5.3). No attempt was made to estimate training exposure.

Statistics

Injury incidence (± standard error) was reported as the number of time-loss injuries per 1000 runs during competition. A Mantel-Haenszel test for person-time data was used to compare injury incidence between disciplines, age groups (junior vs senior), and genders.[11]

RESULTS

Prospective Study

A total of 1465 athlete participations and 8020 runs were included in the 22 competitions covered by the prospective study. The halfpipe discipline accounted for the greatest share of runs, whereas big jump accounted for the lowest (Table 1). A total of 32 acute time-loss injuries were recorded (Table 2). There were 7 back injuries; of these, 6 were contusions and 1 was a vertebral compression fracture (Figure 1 and Table 2). Furthermore, 5 knee, 5 shoulder, 4 chest, 4 head, and 3 arm/wrist injuries were recorded (Figure 1 and Table 2); 1 of these was a radius fracture. The most severe injuries were a hip dislocation by a female athlete in a big jump competition (AIS score, 3) and a shoulder dislocation by a male athlete in a halfpipe competition (AIS score, 3). The rest of the injuries were graded AIS 1 (n = 15) or AIS 2 (n = 15). There were 15 minor (1-7 days time loss), 10 moderate (8-21 days time loss), and 6 serious (>21 days time loss) injuries (the duration of time loss was unknown in 1 case). None of the injuries reported were reinjuries.

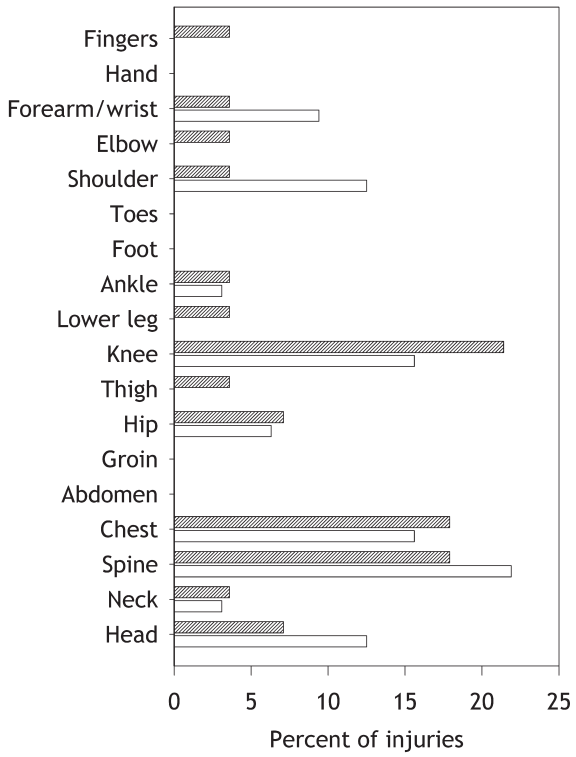

Figure 1. Acute competition injuries. Distribution of all acute injuries during competition and official warm-up from the retrospective survey (n = 28; hatched bars) and prospective study (n = 32; open bars) by body location.

The total injury incidence for all disciplines was 4.0 ± 0.7 per 1000 runs (Table 1). The incidences for the different disciplines were 14.2 ± 5.3 per 1000 runs for big jump (n = 7 injuries), 6.1 ± 1.8 for snowboardcross (n = 11, not significant vs big jump), 3.1 ± 0.9 for halfpipe (n = 13, $P < .001$ vs big jump), and 1.9 ± 1.9 for giant slalom (n = 1, $P < .05$ vs big jump). No injury was recorded for the parallel

TABLE 2
Prospective Study: Overview of the 32 Injuries Recorded at the National Tour Competitions[a]

Injury Number	Gender	Class	Region	Injury Type	AIS Score	Time Loss, d	Mechanism
1	Female	Junior	Knee	Contusion	1	1-7	Landing BJ
2	Female	Junior	Back	Contusion	1	1-7	Obstacle SBX
3	Female	Junior	Chest	Contusion	1	8-21	Landing HP
4	Female	Junior	Chest/ribs	Fracture	2	8-21	Landing HP
5	Female	Junior	Head	Contusion	1	1-7	Collision athlete SBX
6	Female	Junior	Hip	Contusion	1	1-7	Landing BJ
7	Female	Junior	Knee	Sprain	2	1-7	Obstacle SBX
8	Female	Junior	Wrist	Sprain	2	8-21	Landing HP
9	Female	Senior	Back	Contusion	1	8-21	Obstacle SBX
10	Female	Senior	Hip	Dislocation	3	Rest of the season	Landing BJ
11	Male	Junior	Ankle	Sprain	2	8-21	Landing HP
12	Male	Junior	Back	Contusion	1	1-7	Obstacle SBX
13	Male	Junior	Back	Contusion	1	1-7	Landing HP
14	Male	Junior	Chest	Contusion	1	1-7	Landing BJ
15	Male	Junior	Head	Wound	1	1-7	Landing HP
16	Male	Junior	Head	Contusion	2	8-21	Landing HP
17	Male	Junior	Knee	Contusion	1	1-7	Landing BJ
18	Male	Junior	Knee	Sprain	2	1-7	Landing HP
19	Male	Junior	Knee	Sprain	1	1-7	Obstacle SBX
20	Male	Junior	Neck	Strain	1	8-21	Landing HP
21	Male	Junior	Wrist	Fracture	2	1-7	Landing BJ
22	Male	Junior	Wrist	Fracture	2	>21	Landing HP
23	Male	Senior	Back	Fracture	2	>21	Obstacle SBX
24	Male	Senior	Back	Contusion	1	1-7	Obstacle SBX
25	Male	Senior	Back	Contusion	1	>21	Gate ALP
26	Male	Senior	Chest/ribs	Fracture	2	8-21	Obstacle SBX
27	Male	Senior	Head	Contusion	2	1-7	Landing HP
28	Male	Senior	Shoulder	Dislocation	3	8-21	Landing HP
29	Male	Senior	Shoulder	Fracture	2	>21	Landing BJ
30	Male	Senior	Shoulder	Fracture	2	>21	Between obstacles SBX
31	Male	Senior	Shoulder	Dislocation	2	>21	Obstacle SBX
32	Male	Senior	Shoulder	Dislocation	2	8-21	Landing HP

[a]AIS, Abbreviated Injury Scale; BJ, big jump; SBX, snowboardcross; HP, halfpipe; ALP, alpine.

slalom discipline. There was no difference in injury incidence between junior and senior athletes or between genders.

Retrospective Survey

Of the 196 registered competitors during the national championships, 163 took part in the interview (response rate, 83%). Based on the number of competitions they reported having taken part in, the total competition exposure was estimated to be 8195 runs (Table 3). A total of 84 acute time-loss injuries were reported during the season, including 13 knee (16%), 11 back (13%), 11 head (13%), 10 chest (12%), 10 lower arm/wrist (12%), and 8 shoulder injuries (10%) (Figure 1).

The most severe injuries reported were a shoulder dislocation (AIS 3) by a male athlete who fell on an obstacle (rail) in a snowboard park and an elbow dislocation (AIS 3) by a female rider training on a trampoline. The rest of the injuries were graded AIS 1 (n = 32) and AIS 2 (n = 50). There were 38 minor, 26 moderate, and 20 serious injuries.

Of the 84 acute time-loss injuries, 56 (67%) occurred outside competition and 28 (33%) during competition or official warm-up for competition. Of the 56 training injuries, 50 (88%) occurred while training on snow and 6 (11%) during other types of training. The total number of injuries that could be related to a specific discipline during either training or competition was 66 (Table 4). The remaining injuries on snow occurred during free riding.

The total injury incidence during official warm-up and competition was estimated to be 3.4 ± 0.6 injuries per 1000 runs. The incidences for the different disciplines were 6.6 ± 3.0 per 1000 runs for big jump (n = 5), 5.8 ± 1.7 for snowboardcross (n = 12, not significant vs big jump), 2.1 ± 0.7

TABLE 3
Retrospective Survey: Exposure, Number of Injuries, and Injury Incidence Through the 2001-2002 Season as Recorded Through Interviews With 163 of the Participants at the National Championships

	Exposure (Runs)		Injuries		Incidence (Injuries per 1000 Runs)	
Discipline	Women	Men	Women	Men	Women	Men
Giant slalom	84	218	1	1	11.9	4.6
Parallel slalom	218	564	0	0	0.0	0.0
Halfpipe	1148	3152	4	5	3.5	1.6
Big jump	147	605	1	4	6.8	6.6
Snowboardcross	494	1566	5	7	10.1	4.5

for halfpipe (n = 9, $P < .05$ vs big jump), and 6.6 ± 4.7 for giant slalom (n = 2, not significant vs big jump) (Table 3). No injury was recorded for the parallel slalom discipline.

DISCUSSION

The main finding of this study was that the incidence of injuries among competitive snowboarders was high. The estimate for the overall incidence during competition (which includes official training runs) was very similar between both parts of the study: 4.0 injuries per 1000 runs in the prospective study and 3.4 per 1000 runs in the retrospective survey. Most previous studies on alpine skiing and snowboarding have been conducted on recreational skiers, with the results usually reported as the number of injuries per 1000 skier days. Instead, to allow a more relevant comparison between disciplines and with other elite athletes, we have chosen to report the incidence per 1000 runs. To our knowledge, there are only 2 previous studies, both from elite international alpine skiing, that have used a similar approach to estimate exposure and report injury incidence. Compared to the alpine races of the 1994 Winter Olympic Games at Lillehammer,[10] where the incidence was estimated to be 1.9 per 1000 runs, the incidence found in the present study is high. On the other hand, our results are comparable to the junior world championship in Voss, Norway, in 1995, where the total injury incidence for all disciplines was 4.0 injuries per 1000 runs (8.3 per 1000 runs for the downhill event).[3] However, it should be noted that because both of the studies mentioned were based on only 1 event and just a handful of injuries were recorded,[3,10] the margin of error is considerable. Larger studies are needed from a similar competition level to compare injury incidence between the various snowboard and alpine skiing disciplines.

When interpreting the results from an epidemiological survey such as the present one, there are some limitations that must be kept in mind. First, in the prospective study the main source of error is injuries that may have gone unrecorded by the health personnel on site. Riders may have sought medical assistance elsewhere, especially for minor injuries that may have led to significant problems and time loss only during the days after the incident. The retrospective interviews during the national championships at the end of the season were included in addition to the injury registration at the events to make sure that such injuries were detected. However, the retrospective approach also has some limitations. One of them is recall bias; the athletes may not have remembered all of the injuries they had suffered during the previous season, especially minor injuries that may have been underreported. The other limitation is that the athletes who were not able to compete at national championships because of injury

TABLE 4
Retrospective Survey: Distribution of Injuries for the 66 Incidents That Occurred Either During Training or in Competition That Could be Related to a Specific Discipline: Halfpipe, Snowboardcross, Big Jump, and Giant Slalom[a]

	Discipline			
Injury Location	Half-pipe	Snow-board-cross	Big Jump	Giant Slalom
Head	2	1	8	0
Neck	0	1	0	0
Shoulder/clavicle	1	2	2	0
Upper arm	1	0	0	0
Elbow	1	0	0	0
Forearm/wrist	3	0	3	0
Fingers	1	1	0	0
Chest, inner organs	3	2	3	0
Abdomen	0	0	0	0
Spine	1	2	6	1
Groin	1	0	0	0
Hip	1	0	2	0
Thigh	0	0	1	0
Knee	1	4	3	2
Lower leg	0	1	0	1
Ankle	1	0	1	0
Foot	0	1	1	0
Toes	0	0	0	0
Total	17	15	30	4

[a]No injury was recorded during the parallel slalom discipline.

were not available for interview; we "surveyed the survivors." This approach may lead to an underestimation of severe, season-ending injuries such as ACL injuries and serious fractures. On the other hand, these would most likely be detected in the prospective study. Because the retrospective study includes injuries and exposure from regional and international events the riders had taken part in during the season, the figures reported for injuries and exposure cannot be directly compared between the retrospective and prospective study. Also, some athletes who participated in the national tour did not take part in the national championships, and their injuries and exposure were therefore not included in the retrospective interviews. The data can be compared with the insurance claims recorded by the official insurance company, Norwegian Brokers, which handles the mandatory starting licenses. After the 2001-2002 season, they had registered claims for 4 knee (2 of these were ACL injuries), 3 forearm/wrist, 4 clavicle/shoulder, 2 arm, 1 elbow, and 2 head injuries. Because we do not have access to personal data, we cannot check these cases against our records, but the injury pattern is similar to that we recorded. Also, the number of competition runs and injuries is similar between the 2 studies, which leads us to conclude that by using 2 different approaches, we have reached reliable estimates of the injury risk among competitive snowboarders.

Although we found no gender difference in injury incidence and no difference between juniors and seniors, the results indicate that the injury risk may differ between disciplines. Notably, no injuries were recorded in the parallel slalom event, and the injury risk for the halfpipe event appeared to be somewhat lower than for the other disciplines. However, these results should be interpreted with caution because the number of injuries and exposure recorded for each discipline is low. For instance, the extremely high incidence observed in the big jump discipline for the women in the prospective study (46 injuries per 1000 runs) is based on only 2 competitions with 3 injuries. For the same reason, care should be taken when comparing the injury patterns between disciplines.

Nevertheless, when examining the overall injury pattern, the results are somewhat different from those of previous investigations on recreational snowboarders, with a lower proportion of wrist fractures and a higher proportion of knee, chest, and back injuries.[1,4,20,25,30,31,33] In competition, injuries to the wrist accounted for only 9% of the injuries recorded in the prospective registration and 4% in the retrospective interview (1 wrist fracture in either study; data not shown). When out-of-competition incidents were included, the proportion of wrist injuries increased to 11%, but this still represents only half as many wrist injuries as the figures seen in studies on recreational snowboarders. It is likely that the reason is the experience of the competitive snowboarders (80% reported more than 50 days of snowboard practice per year, and 71% had competed for more than 1 season; data not shown). Edge control and general skills prevent competitive snowboarders from falling backward and causing injuries to the wrist,[20,25,33,37] whereas novice snowboarders unintentionally catch the snow by the down-valley edge and fall backward or forward (described as the "opposite edge phenomenon").[27,36]

The other main difference between the current injury distribution and that previously reported from recreational snowboarding is a relatively higher proportion of knee injuries in the competitive group. We found knee injuries to account for between 16% and 21% of all injuries (incidence between 0.6 and 0.7 per 1000 runs). This proportion is about twice as high as that reported for the recreational level.[1,4,20,25,30,31,33] In this sense, elite snowboarding displays the same trend as that seen in alpine skiing,[31] in which knee injuries account for 20% to 36% of injuries among both elite and recreational skiers.[‖] Studies have shown that jumping promotes injuries for both recreational[5,20,24,41] and professional snowboarders.[6,34] The fixation of both feet is assumed to protect against knee injuries,[1,5,30,31,33,37] but it is likely that this effect will be reduced as the impact energy and torsion forces increase with the higher and more spectacular jumps seen among elite performers.

Back and chest injuries account for 38% and 36% of injuries in the prospective and retrospective study, respectively. Not surprisingly, these injuries occurred in snowboardcross (2 chest and 2 back injuries in the prospective study), big jump (3 chest and 6 back injuries), and halfpipe (3 chest and 1 back injuries), which is in correspondence with findings showing that jumping promotes injuries to the spine[5,41] and chest.[24] One suggestion is that the fixed position of the lower extremities restricts movement in a way that predisposes the athlete to chest injury.[31]

Head injuries were infrequent: 13% and 7% of all injuries during competition in the prospective and retrospective studies, respectively, and 14% when all training on snow was included. Because head injuries represent up to 26% of all injuries among recreational participants,[1,4,5,25,27,28,30,31,39] these figures are moderate. One explanation may be that helmet use is mandatory in the national cup events in all disciplines except parallel slalom. That there were no head injuries in the alpine disciplines supports the suggestion that jumping is an important injury mechanism and also contributes to the increase in the incidence of head injuries.[5,27]

The most likely explanation for the relatively high incidence of injuries is the development of the sport in a direction of more extreme performance and more extreme snow constructions. The combination of speed and jumps seen in the freestyle disciplines (halfpipe, big jump) and in the motocross-inspired discipline of snowboardcross may promote a risk-taking attitude to stay on top.[1,25,41] Further development of the sport may cause even more frequent and more serious injuries. The increasing speed and load may contribute to more frequent high-impact and high-torsion injuries when falling after spectacular maneuvers in the air.[31] In particular, this is the case in the halfpipe and big jump, where jumping is the essence and the judging criteria reward height and rotations (named "spins" and "flips"). The introduction of "super pipes," in which the height of the wall exceeds 5 m, is part of this development.

[‖]References 2, 8, 12, 17, 19, 21, 23, 29, 39, 40.

One danger that snowboarders are aware of is the "disaster," an uncontrolled landing at the edge of the platform, resulting in a fall from the top down to the flat bottom and potentially causing high-impact injury to any part of the body (Petter Levin, Norwegian National Halfpipe team captain, personal communication, 2003). The injury risk can also be assumed to increase from changes in the other disciplines, for example, snowboardcross, where new obstacles, higher jumps, and greater speed will likely characterize the sport in the future.

To prevent an even higher injury risk—both in terms of numbers and severity—several actions have been suggested. Based on studies of recreational snowboarders, proper fitting of the equipment with attention to the angle and position of bindings as well as choice of boots and board length are thought to be important.[4] Soft boots have been claimed to be beneficial for beginners.[4] Technical training programs are widely recommended,[1,4,5,9,13,18,27,30,41] although studies on skiers have concluded that regular ski instruction does not reduce injury risk.[15,16,23,35] Nevertheless, more experienced snowboarders have a lower injury incidence.[23] Safety equipment is widely recommended, especially helmets[13,25,27,28,31,34] and wrist guards.[¶]

Competitive snowboarders should be prepared to cope with the increasing demands for strength, endurance, and general fitness through appropriate training. A preseason assessment of physical condition can be beneficial.[18] Furthermore, specific training for each discipline to improve movement skills, balance, and coordination is recommended. Gymnastics, including trampoline exercise, is essential to prepare for the big jump and halfpipe disciplines. Video recordings can increase awareness and ability to correct poor riding technique. Snowboard facilities should be properly maintained, and adequate construction of the pipe, jumps, and other obstacles is important. Recently, safety equipment has progressed, providing lightweight helmets, back protectors, elbow pads, wrist guards, padded gloves, and hip, knee, and shin pads. Even padded jackets and sweaters, similar to what is used in motocross, are available. Although there is no evidence proving their efficacy, it seems reasonable to suggest that helmet, back protectors, and hip pads should be used by halfpipe, big jump, and snowboardcross athletes. In the same way, alpine participants should wear a helmet, padded gloves, and knee and shin pads protecting from collisions with the gates.

In conclusion, the incidence of injuries is high among competitive snowboarders at the elite national level. The injury pattern is different from the panorama seen among less experienced athletes, with fewer wrist injuries and more knee injuries.

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