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The Prevalence of Previous Serious Knee Injuries in Freestyle World Championship Skiers

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Abstract: Previous major knee injuries among the participants in the FIS Freestyle World Championship 2001 in Whistler/Blackcomb, Canada were recorded. Ninety-five skiers answered the questionnaire (response rate: 63%). Forty-seven percent of the skiers reported mean 1.6 previous serious knee injuries (range 1-5), female skiers with a significant higher prevalence than males. Thirty percent of the women and 24% of the men ($p = 0.49$) had suffered 1-3 ruptures of the anterior cruciate ligament (ACL) of the knee. There was no significant difference between the disciplines (mogul and aerial skiing) in the prevalence of any type of knee injury.

In conclusion, nearly half of the responding FIS freestyle World Championship skiers had previously sustained one or more major knee injuries and still returned to such a high level of athletic performance. One fourth of the skiers had sustained one or more former ACL ruptures. The prevalence of previous serious knee injuries over all was significantly higher among female than among male skiers.

Keywords: knee injuries, skiing injuries, skiing safety, prevalence, gender, freestyle, skiing, mogul skiing, aerials

Freestyle skiing consists of mogul and aerial skiing. In freestyle mogul skiing the skier rides down a steep slope with irregular bumps (moguls) that are passed under time constraint. Mogul skiers exhibit a different pattern of muscle activation, a larger range of hip- and knee- angle movements, shorter time of movement cycles and higher hip and knee angular velocity than the traditional alpine racers [1]. In addition to the two required jumps, the skis are partly off the snow between the moguls, yielding repetitive _____

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landings with high levels of impact and torsional loads (Figure 1). Aerial freestyle skiers reach a speed of about 65 km/h entering the prebuilt jumps (called kickers) from where they do up to three somersaults and five 360 degree twists, having a vertical drop of 10-12 m before landing in a steep downhill which is made soft in advance by chopping the snow (Figure 2).

Knee injuries represent a severe problem in alpine skiing. In general, a serious knee injury, like meniscal tears, ligament ruptures (knee sprains grade 2 and 3) and articular cartilage injuries, often causes long periods of absence from sport, and increases the risk of long-term adverse effects – such as abnormal joint dynamics and early onset of degenerative joint disease [2]. Although the overall injury incidence in alpine skiing has



Figure 1 - Mogul skiing differs from traditional alpine skiing involving larger range of hip and knee angular movements, higher hip and knee angular velocity and repetitive landings with impact and torsional loads to the knees.



Figure 2 - The aerial skiers do up to 3 inverted somersaults and up to 5 full twists, descending 10-12 meters before landing.

declined over the past 25 years, the incidence of grade 3 knee sprains has increased alarmingly during the same period. Deibert et al [3] found a four-fold increased incidence of anterior cruciate ligament (ACL) injuries over a 12-year period, a figure supported by other research groups [4,5]. The incidence of ACL ruptures has reached the level of ruptured medial collateral ligaments (MCL), each accounting for 15-20% of all skiing injuries [5,6]. A previous study has shown that 45% of all injuries in World Cup Freestyle skiing are knee injuries [7]. The rate of high-level competitive skiers returning to their sport after major knee injuries is unknown, but a previous study has shown that 31% of alpine Olympic racers have sustained an ACL injury during their career [8]. The purpose of the

present study was to determine the prevalence of previous serious knee injuries among freestyle World Championship skiers.

Material and Methods

At the FIS Freestyle World Championship 2001 a questionnaire was distributed through national team leaders to the 151 skiers participating. The biographical details of the skiers, their nationality, discipline (moguls or aerials) and the number of years World Cup skiing was registered. The skiers were asked if they had ever sustained a major knee injury. The definition of a “serious” or “major” knee injury may vary in the literature. However, in the present study we defined a “serious” or “major” injury as a knee injury excluding the skier from regular training activity for at least 20 days [8-10]. Given such an injury, the skiers were asked during what kind of activity the injury occurred, whether the skier had been examined by a magnetic resonance imaging (MRI) scan or arthroscopy, if so, what the findings were and whether a reconstruction had been performed in the case of a torn ACL. Simultaneously, similar questionnaires were distributed to the team coaches as well, asking them the same information about their skiers, in order to verify the information given by the athletes. Most of the questionnaires were returned during the week of the championship, while the remainder were returned afterwards.

The data were analysed with the SPSS software package using Chi-square test to compare the prevalence of injuries between gender and disciplines, and independent sample t-tests to compare continuous variables between groups. An alpha level of less than 0.05 was considered significant.

Results

Ninety-five of the 151 World Championship skiers completed and returned the questionnaires, giving a response rate of 63%. The responders consisted of 55 men and 40 women, aged 18–36 (mean 24.7). Sixty-two of the responders (65%) were mogul skiers, whereas 33 (35%) were aerial skiers, reflecting the relative number of participants in the two disciplines. Forty-five (47%) of the responding skiers, twenty-four women (60%) and 21 men (38%; $p = 0.035$), reported a total of 74 former major knee injuries excluding them from regular training for at least 20 days. The number of major knee injuries among the previously injured skiers ranged from 1 to 5 (mean 1.6), with the majority of the injured skiers (60%) having suffered only one injury (Table 1). Twenty-nine (39%) of the injuries were verified by MIR. Twenty-five (26%) of the skiers, twelve women (30%) and 13 men (24%; $p = 0.49$), reported a total of 34 former ACL injuries, accounting for 46% of all knee injuries. The number of ACL injuries ranged from 1 to 3, with 7 (28%) of the 25 ACL-injured skiers having suffered more than one ACL rupture (mean 1.4). Some of the ACL injured skiers reported additional occasions of knee injuries as well. Three men and three women, all mogul skiers, had sustained bilateral ACL ruptures, whereas three skiers (12% of those with ACL rupture) had suffered a graft rupture of the reconstructed ACL in one knee (Table 2). Five of the 34 torn ACLs were not reconstructed. In four of these cases the skier had not been examined by arthroscopy. One of the ACL injuries not reconstructed or

arthroscoped had been verified by MRI. Sixty-seven (91%) of the 74 knee injuries involved either the

Table 1 - Number of skiers with previous major knee injuries categorized according to discipline and gender and the number of injuries suffered.

Discipline and gender	One injury	Two injuries	Three injuries	Four injuries	Five injuries	Total
Moguls men (n=36)	10	3	0	1	1	25 injuries in 15 skiers
Moguls women (n=26)	6	7	2	0	0	26 injuries in 15 skiers
Aerials men (n=19)	4	1	1	0	0	9 injuries in 6 skiers
Aerials women (n=14)	7	1	0	0	1	14 injuries in 9 skiers
Total (n=95)	27	12	3	1	2	74 injuries in 45 skiers

n = total number of skiers in each category; injured and non-injured skiers.

Table 2 - Number of skiers with previous ACL injuries categorized according to discipline and gender and the number of ACL injuries suffered.

Discipline and gender	One injury	Bilateral injuries	Two injuries in one knee (re-rupture)	Three injuries (re-rupture in one knee)	Total
Moguls men (n=36)	6	2	0	1	13 ACL injuries in 9 skiers
Moguls women (n=26)	4	2	0	1	11 ACL injuries in 7 skiers
Aerials men (n=19)	3	0	1	0	5 ACL injuries in 4 skiers
Aerials women (n=14)	5	0	0	0	5 ACL injuries in 5 skiers
Total (n=95)	18	4	1	2	34 ACL injuries in 25 skiers

n = total number of skiers in each category; injured and non-injured skiers.

ACL, the articular cartilage, the menisci, the MCL or combinations of these. Nineteen (56%) of the 34 ACL injuries were combined with either injuries to the articular cartilage, meniscal tears or MCL injuries. Eighteen skiers reported articular cartilage injuries, 15 in combination with an ACL injury. Nineteen skiers (20%) reported isolated MCL injuries, whereas 10 reported isolated meniscal tears (Figure 3). Seven “other” injuries (9%) did not involve the above mentioned four structures.

Forty-eight percent of the mogul skiers reported previous major knee injuries compared to 46% of the aerialists ($p=0.78$). The mean number of injuries per injured skier was 1.7 in mogul skiing and 1.5 in aerial skiing, but the numbers were not significantly different. Furthermore, there was no significant difference between disciplines nor genders in the prevalence of any of the specific types of injuries. The mean number of years World Cup skiing in the group of skiers with previous knee injuries was 5.7 years compared to 3.2 years for those without previous knee injuries ($p<0.001$). Thirty-four percent of the injuries occurred during freestyle skiing competitions, 45% during freestyle training and 21% during other activities.

Discussion

In the present study the response rate was 63%. Similar studies of elite athletes in other sports are lacking, except in alpine skiing where a response rate of 21% has been reported [8]. The term “serious” or “major” knee injury in this study is defined as a self-reported injury to the knee that restricted training activity for at least 20 days. The definition of this term, however, may vary from study to study, thus complicating the comparison process. The diagnoses given in this study are self-reported as well. However, the diagnosis of an ACL rupture was verified by the skier confirming ACL reconstruction in all but 5 cases. One of those 5 cases was verified by arthroscopic examination, and another by MRI scan. Skiers at this level seem to be very aware of their knee status, making the self reported diagnosis more reliable.

The main finding in this study was that nearly half (47%) of the responding freestyle World Championship skiers had suffered one to five previous major knee injuries. Furthermore, one fourth (26%) of the skiers had previously suffered one to three ACL ruptures, some of them reporting additional injuries as well. These high figures agree with previous reports of the prevalence of former serious knee injuries in elite alpine skiers [8]. The prevalence of former major knee injuries was significantly higher in women than in men. This is in agreement with most reports of skiing injuries [11-13].

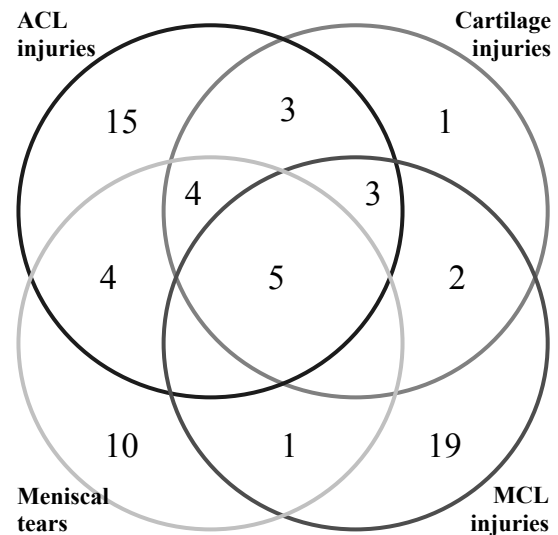


Figure 3 - The sixty-seven injuries involving different combinations of injury to the ACL, the cartilage, the meniscii and the MCL.

However, there was no significant difference in the prevalence of former ACL injuries or any other specific knee injury between male and female skiers. This is in disagreement with reports of the incidence of ACL injuries both in alpine skiing as well as in other non-contact and contact sports [8,14-16]. However, our numbers are small and need to be interpreted with care.

In the present study, ACL injuries accounted for 46% of the knee injuries. This proportion is lower than the corresponding 72% found by Ekeland et al. among elite alpine skiers [8]. In a previous study among freestyle skiers that also included minor injuries, 7% of all injuries during one season were ACL injuries, accounting for 16% of the knee injuries [7]. In that same study isolated MCL injuries accounted for 69% of the knee injuries, whereas the present study found that 20% of the knee injuries were isolated MCL injuries. The definition of an injury in the previous study was one which made the skier stop skiing the day it occurred, whereas the definition of the present study was exclusion from skiing or training for at least 20 days. Grade 1 MCL injuries often excludes the skier from skiing less than 3 weeks, which may explain the different findings of these two studies.

Of the 25 skiers reporting a former ACL injury, three skiers (12%) had suffered a re-rupture of the reconstructed ACL graft. In comparison, the incidence of ACL re-ruptures in female European handball players is 22% [17]. Again, our figures must be interpreted with care, since the numbers are small. Besides, the true figures for re-ruptures among freestyle skiers may not have been detected in this study, since a re-rupture might be an occasion causing the skier to quit. Anyhow, figures from different sports are not easily comparable. A higher incidence of ACL ruptures and re-ruptures in one sport compared to another might be due to different gender distribution within the two populations, different sport specific knee demands and/or different sport specific ACL injury mechanisms in the two sports.

In the present study, fifty-six percent of the ACL injuries were combined injuries. These figures appear similar to alpine recreational skiing where MCL injuries in combination with ACL injuries are common and meniscal tears occur in approximately 50% of ACL injuries [18].

The prevalence of former major knee injuries was not significantly different in the two disciplines moguls and aerials, neither as a total nor for any specific knee injury type. The mean number of previous injuries per skier was not significantly different between the two groups either. This appears in contrast to a previous study, where the injury risk in general was found to be significantly higher in aerials than in mogul skiing [7]. But again, the numbers in each category of the present study are small.

The freestyle skiers reporting a former knee injury had been involved in World Cup skiing significantly longer than those skiers with no former injury. This is not surprising, since the more experienced skiers have been exposed to injuries for a longer period of time. Thirty-four percent of the reported injuries occurred during freestyle competitions whereas 45% occurred during freestyle training. Since the skiers spend much more time training than competing, these numbers probably do not reflect the true injury risk in competition compared with training [9].

Conclusion

Nearly half of the responding FIS freestyle World Championship skiers had previously sustained one or more major knee injuries and still returned to such a high level of athletic performance. One fourth of the skiers had sustained one or more former ACL ruptures. The prevalence of previous serious knee injuries over all was significantly higher among female than among male skiers, although the prevalence of any specific type of knee injury, such as former ACL injuries, did not show significant difference between genders.

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