

GENDER DIFFERENCES IN KNEE INJURY EPIDEMIOLOGY AMONG COMPETITIVE ALPINE SKI RACERS

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ABSTRACT

A questionnaire was sent in 1995 to all members of the Vermont Alpine Racing Association and several New England NCAA Division I ski racing programs. A total of 1010 surveys were sent and 404 responses were received. The survey included questions regarding the racer's age, gender, number of years spent ski racing, injury to knee(s), surgery to knee(s), and reinjury to a surgically reconstructed anterior cruciate ligament (ACL) requiring subsequent surgery. Only injuries that occurred during alpine skiing were included. One-quarter of respondents (27%) reported a history of a knee injury. Female racers were 2.3 times more likely to have sustained a knee injury than male racers. More impressively, one in five female alpine racers (22%) reported an ACL disruption, and females were 3.1 times more likely to sustain an ACL injury in comparison to their male counterparts. Of the athletes who had surgery to reconstruct their ACL, approximately one-third (36%) required subsequent surgery to the same knee. One in five (22%) ACL reconstructions failed, requiring additional surgery to the same ACL. Females reported a higher rate of reinjury to an ACL graft than males (27% vs. 13%), but this was not statistically significant.

INTRODUCTION

The rise of female participation in athletics has resulted in an awareness that gender differences exist in the epidemiology of sports injuries^{1,5,7}. Female athletes have been shown to be at increased risk for severe knee ligament injury in competitive sports such as basket-

ball, soccer, and handball. The role that gender plays in the epidemiology of knee injury in competitive alpine skiing has not been researched as extensively. The only study on the topic, reported in 1985, found that female racers had a higher incidence of knee and ACL injuries than their male counterparts². This suggests that gender differences do exist in the epidemiology of knee injury among competitive alpine ski racers^{1,2,5,7}.

Competitive alpine ski racing imparts tremendous forces on the knee and ski racers constantly face the threat of significant injury. The knee is the most common joint injured^{2,9,10}. After an alpine ski racer sustains an injury to his or her knee, the prognosis for return to competition is unclear. A study of ACL reconstructions in world class skiers between the 1979 and 1984 ski seasons reported a reinjury rate requiring subsequent reconstruction of 8%. This study did not report the incidence of reinjury by gender, nor was there data regarding non-world class ski racers⁴.

Given the limited data in the literature regarding gender's effect on the incidence of knee injuries among competitive alpine ski racers, the goal of this project was to retrospectively analyze gender differences in three areas: 1) incidence and nature of knee injuries, 2) incidence of ACL injuries, and 3) incidence and nature of recurrent knee injuries in ACL reconstructed knees.

MATERIALS AND METHODS

During the summer of 1995, 1010 surveys were sent to all members of the Vermont Alpine Racing Association (VARA) as well as several New England NCAA Division I ski racing programs. VARA is the organization that monitors competitive alpine ski racing in Vermont, and all Vermont alpine racers are members. The inclusion of only VARA members and several New England colleges assured that the sample population would be located in a single geographic area with similar ski conditions and environment. The survey included questions regarding the athlete's age, gender, race program, years spent ski racing, injury to knee(s), surgery to knee(s), and any reinjury requiring further surgery. Only injuries that occurred on snow while skiing were included in the study. The data was collected and statistically analyzed using chi-square analysis.

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RESULTS

There were 404 respondents to 1010 surveys. The response rate was equal for males (40%) and females (40%). The average male respondent was 20.5 years old, started ski racing at ten years of age, and had raced for 11 years. Similarly, the average female respondent was 19.8 years old, started ski racing at nine years of age, and had raced for 11 years. The average male with an ACL injury had raced for 7.8 years and was 17.7 years old at the time of first ACL injury. The average female with an ACL injury had been racing for 8.5 years and was 17.0 years old at the time of first ACL injury.

Twenty-seven percent (110) of all respondents reported a knee injury. Forty-one percent (66) of females reported a knee injury compared with 18% (44) of males. The proportion of females to males sustaining a knee injury was 2.3 to 1 ($p < 0.001$). Thirteen percent (54) of all respondents reported an injury to their ACL. Twenty-two percent (36) of females and 7% (18) of males had sustained an ACL disruption. Thus, females were 3.1 times more likely to have sustained an ACL disruption than their male counterparts ($p < 0.001$). ACL disruptions accounted for 49.1% of all knee injuries. They accounted for 54.5% of female knee injuries and 40.9% of male injuries. The difference was not statistically significant.

Thirty-six percent (16) of the 45 respondents who had their ACL reconstructed required subsequent surgery to the same knee. Some reported multiple procedures. The difference between males (6 of 15 or 40%) and females (10 of 30 or 33%) who required subsequent surgery was not statistically significant.

Twenty-two percent of respondents (10) with an ACL reconstruction required revision ACL surgery. Among female respondents with prior ACL reconstructions, 27% (8) required revision surgery compared with 13% (2) of the males. This difference was not statistically significant. The proportion of all respondents with a surgically reconstructed ACL who required a subsequent surgery to a meniscus in the same knee was 13% (6); 17% (5) for females and 7% (1) for males. Neither of these findings was statistically significant.

DISCUSSION

Competitive alpine ski racing places high demands on the knees of its participants. It is a unique sport where males and females train and compete together on the same trails, at the same time, and with the same equipment. Their exposure, environment, ability level, and extrinsic risks are virtually identical. The sport, therefore, provides an excellent forum for the evaluation of gender's effect on the epidemiology of knee injuries.

Knee Injuries

There is little data in the literature regarding knee injury epidemiology among competitive alpine ski racers. We found that slightly more than one-quarter of the respondents reported an injury to the knee. Similarly, Ellman et al. noted that 28.5% of alpine racers reported a knee injury². The population studied by Ellman et al., like ours, was based on VARA members. When analyzed by gender, we found that female ski racers were 2.3 times more likely to have sustained a knee injury of any kind when compared to males ($p < 0.001$).

ACL Injuries

The effect of gender on injuries was most notable for ACL injuries. ACL tear was the most common knee injury reported in our study for both males and females. Female ski racers were 3.1 times more likely to have sustained an ACL disruption when compared to male racers ($p < 0.001$). Twenty-two percent of female respondents reported an injury to their ACL compared with 7% of the males. Likewise, Ellman et al. reported an ACL injury rate of 18% for female alpine racers and 3% for male racers². Thus, female competitive alpine ski racers, as in other sports, appear to be at a higher risk for sustaining an ACL disruption than their male counterparts.

Overall, 49% of the knee injuries reported in our study involved the ACL. This value is less than studies of recreational skiers which have reported that up to 60% of knee injuries involved the ACL⁶. We found that the ACL was involved in 55% of female and 41% of male knee injuries. These values are consistent with a study of recreational alpine skiers reported by Greenwald et al. from 1989-1995 which showed 55% of female knee injuries involved the ACL versus 43% of the male knee injuries³.

Reinjury

Slightly more than one in three respondents in our study who underwent ACL reconstruction had subsequent surgery to the same knee. No statistically significant difference was noted between genders.

The ACL was the most common site of reinjury among both male and female respondents. One in five ACL reconstructions failed, requiring revision surgery. This is a substantially higher percentage than the 8% ACL reinjury rate reported by Steadmann et al. among world class competitive alpine ski racers between 1979 and 1984⁴.

We found that females reported a higher incidence of ACL reinjury with 27% requiring a second surgery to reconstruct the ACL compared to 12% of the male respondents. The difference, however, was not statisti-

cally significant. The failure to demonstrate statistical significance may be secondary to the lack of sufficient statistical power given the low number of ACL reinjuries, especially among the male population.

The second most common reinjury reported was meniscal tear. Thirteen percent of the respondents who underwent ACL reconstruction reported having subsequent meniscal surgery. No statistical difference was noted between males and females.

Proper selection criteria are essential to the success of any study. We attempted to reduce the effect that confounding variables might have produced by selecting competitive alpine skiers who have similar training, experience, exposure, and equipment. By including only VARA members and collegiate teams in New England, the conditions and environment were essentially the same for all subjects. Specific demographic characteristics were also monitored between male and female participants to whom the survey was sent. Both groups were matched for age, years of ski racing experience, age at the time of first ACL injury, and age at the time of questionnaire administration. Finally, the response rate, while only 40%, was essentially equal for both males and females. Thus, it was felt that gender difference found to be statistically significant were representative of the population studied.

Certain variables not addressed that may have had an effect on our response rate and results include recall bias, drop out bias, and selection bias. Respondents who had an injury in the past may have been more enthusiastic about returning the questionnaire, resulting in an artificially inflated percentage of injured athletes. This should not have had an effect on the ratio of male to female injuries assuming that males and females were equally enthusiastic given their near identical response rates. Athletes who had had an injury and then decided not to continue competition prior to the study would not have been included. This probably had its greatest effect on reducing the number of severe or reinjured racers responding, assuming that an athlete who has had a severe or multiple injuries is more likely to retire from the sport.

Overall, the results support the growing literature demonstrating females to be at increased risk for knee injuries in multiple sports. Future epidemiologic work will need to address both gender's role in reinjury as well as prospective analysis of potential risk factors associated with knee injuries.

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