

## INTRODUCTION

- Knee injuries during alpine skiing are at a higher rate now than 20 years ago<sup>1</sup>
- History of a knee injury is a major risk factor for an additional injury, clinical symptoms, knee dysfunction and knee osteoarthritis<sup>1,2</sup>
- External knee support devices have been shown to reduce the risk of secondary injury during skiing<sup>3</sup>
- It is currently unknown if a knee support device can improve clinical symptoms and knee function in professional skiers with or without a history of knee injury

## METHODS

- Participants: 88 professional ski instructors and patrollers with and without a history of knee injury from 8 ski resorts (Aspen, Beaver Creek, Breckenridge, Heavenly, Keystone, Northstar, Taos, Vail)
- Self-reported questionnaires: Knee Injury History, International knee documentation committee (IKDC), Western Ontario McMasters (WOMAC) and visual analog scales (VAS) for knee pain, knee stiffness, muscular fatigue and muscular recovery

Table 1. List of self-reported questionnaires performed at the onset and at the end of each week for three consecutive weeks of skiing. Knee support was worn under the ski pants while skiing during week 2.

Study Onset	Week 1 (No Knee Support)	Week 2 (Knee Support)	Week 3 (No Knee Support)
Informed Consent	WOMAC	WOMAC	WOMAC
Knee Injury History	VAS	VAS	VAS
IKDC			

- Knee Support: Form-fitting tights constructed of overlapping fabrics with varying elastomeric properties to facilitate multidirectional knee support (Figure 1)



Figure 1. The external knee support device worn while skiing during Week 2 consisted of a form-fitting biomechanical garment (Opedix LLC, Scottsdale, Az).

## RESEARCH OBJECTIVES

To compare self-reported measures of knee impairment, symptoms and function between professional ski instructors and patrollers with and without a history of knee injury; and whether skiing with a knee support device can influence these measures

**H<sub>1</sub>: Knee impairment and knee symptoms would be greater for skiers with compared to without a history of knee injury whereas knee function would be lower**

**H<sub>2</sub>: Skiing with knee support would improve knee symptoms and function for skiers with and without a history of knee injury**

- Dependent Variables: Total skiing time, knee impairment (IKDC score), knee function (total WOMAC score) and knee symptoms (VAS fatigue during skiing, VAS fatigue recovery after skiing, VAS knee pain during skiing and VAS knee stiffness during skiing)
- Statistics: IKDC analyzed with an ANOVA, Bonferroni post-hoc tests and Pearson correlations; all other variables analyzed with mixed factor, repeated measures ANOVA and Bonferroni post-hoc tests (repeated measure: week; fixed factors: sex, age, knee injury history ( $\alpha=.05$ ))

## RESULTS AND DISCUSSION

Table 2. Number of participants, mean ( $\pm$ SD) values for age and body mass index (BMI) with and without a history of knee injury.

Group*	N	Age (y)	BMI (kgm <sup>-2</sup> )
Knee Injury	59 (34 Men, 25 Women)	44 $\pm$ 13 (range: 21-70)	24.3 $\pm$ 3.3 (range: 17.9 - 38.7)
Control	29 (19 Men, 10 Women)	47 $\pm$ 15 (range: 21-73)	23.9 $\pm$ 2.8 (range: 19.2 - 38.4)

\*Total skiing time was not different between groups or across weeks (both  $p>.05$ )

**1** SKIERS WITH A HISTORY OF KNEE INJURY HAD GREATER KNEE IMPAIRMENT SCORES THAN SKIERS WITHOUT A HISTORY OF KNEE INJURY

- IKDC score: Self-reported measure of knee impairment was 10% greater for participants with a history of knee injury ( $83.4 \pm 11.2$ ) compared to the controls ( $91.9 \pm 7.4$ ) ( $p=.001$ )
- IKDC score was not related to the other dependent variables (total skiing time,  $r=.07$ ; fatigue,  $r=.11$ ; recovery,  $r=-.06$ ; knee pain,  $r=-.02$ ; knee stiffness,  $r=-.01$ ; total WOMAC,  $r=-.06$ . (all  $p>.05$ ))

**2** KNEE SYMPTOMS AND FUNCTION WERE EQUIVALENT FOR SKIERS WITH AND WITHOUT HISTORY OF KNEE INJURY

- No statistical main effects or interactions involving the fixed factors of injury history, sex, and age were found for any of the dependent variables (all  $p>.05$ )

**3** KNEE FUNCTION, KNEE PAIN, MUSCLE FATIGUE AND RECOVERY SCORES WERE IMPROVED 26% WHILE SKIING WITH KNEE SUPPORT

- Statistical main effects for the repeated measure of week and subsequent post-hoc analysis revealed that skiing with knee support improved total WOMAC, knee pain, muscle fatigue and recovery scores on average by 19, 26, 29 and 30%, respectively (all  $p<.05$ ) (Figure 2)

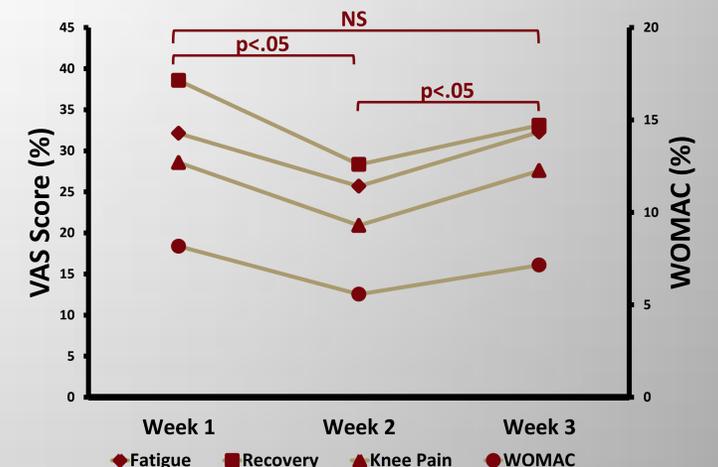


Figure 2. Dependent variables collapsed across groups measured over three consecutive weeks of skiing. Knee support was worn during week 2. Lower scores indicate less symptoms and greater function. Weeks 1, 3 > Week 2 (all  $p<.05$ ); Week 1 = Week 3 (all  $p>.05$ ).

## SUMMARY

- Knee impairment was found to be greater in the skiers with a history of knee injury but measures of knee symptoms and function were not different from the non-injured controls.
- Skiing with the knee support device improved knee function and knee symptoms including knee pain, fatigue and recovery; and these benefits were independent of knee injury history, sex and age.

## REFERENCES

1. Pećina. *Croatian Medical Journal*, 43, 257-260, 2002.
2. Ratzlaff et al. *Arthritis Research & Therapy*, 12, 1-8, 2010.
3. Sterret et al, et al. *American Journal of Sports Medicine*, 34, 1581-1585, 2006.