INTRODUCTION
In a healthy shoulder, as the humerus elevates, the scapula rotates upward and tilts posteriorly. Factors are known to influence the magnitude of this response such as the plane of elevation [1]; however, gender is rarely tested as a factor. This is remarkable, as gender is known to influence kinematic and injury outcomes at other joints, such as at the knee [2]. Therefore the purpose of this investigation was to identify how gender interacts with humeral elevation angle and humeral elevation plane to affect healthy scapular kinematics during dynamic humeral elevation.

METHODS
Healthy 3D right scapulothoracic (ST) and thoracohumeral (TH) kinematics of 15 male and 14 female right-handed university-aged volunteers were recorded at 50 Hz by an 8 camera passive optoelectric motion analysis system (Vicon, Oxford, UK). Scapular motion was recorded dynamically using a skin-mounted acromion marker cluster (AMC) [3]. Participants raised and lowered their fully extended right arm in six vertical movement planes: frontal, 30° anterior to frontal, scapular (40° anterior), 60° anterior, sagittal, and 30° medial to sagittal. ST joint angles were calculated relative to TH elevation at 15° increments between 15° and 120° according to ISB conventions [4].

4-way repeated measures ANOVAs were used to test the influence of elevation plane, elevation angle, motion phase and gender on ST protraction, ST upward rotation and ST posterior/anterior tilt. Tukey HSD was used post hoc to compare factor means when significant interactions existed.

RESULTS
No main effect of gender existed for any ST rotation. Males were more protracted at 60° of humeral elevation (2.40°). Similar differences existed beyond this position, but were insignificant. (e.g. 3.37° more protraction at 90° elevation). Males possessed significantly more posterior tilt in planes 30P (3.09°) and 120P (4.53°) (Figure 1). Males demonstrated substantially more posterior tilt at higher elevation angles; however, only at 90° of humeral elevation was the interaction significant (4.82°). The largest tilt difference between gender was observed at 120° of humeral elevation (8.62°) (Figure 2).

DISCUSSION & CONCLUSIONS
Posterior tilt at higher humeral elevation angles is typically characterized as a protective mechanism against sub-acromial impingement of the rotator cuff [1]. Thus, these results suggest that females may be predisposed to a higher risk of rotator cuff injury compared to males, particularly at higher elevations, across multiple vertical planes of humeral elevation.

REFERENCES

ACKNOWLEDGEMENTS
This work was partly supported by a Discovery Grant from the Natural Sciences & Engineering Research Council of Canada.