Summary
This study determined the impact of different ankle braces on both sexes’ knee biomechanics during a single-leg cut. With the lace-up brace, both sexes altered knee biomechanics that may impact knee injury risk during the cut. All participants decreased peak knee internal rotation angle, while females increased peak knee abduction angle and males decreased peak knee internal rotation moment when wearing the brace during the cut.

Introduction
Ankle braces reportedly prevent injury by limiting harmful ankle motions during sports-relevant tasks [1]. Yet, limiting ankle motion may lead to knee biomechanics that increase injury risk during such tasks. During a single-leg cut, females increase peak knee abduction and internal rotation joint angle, biomechanics thought to increase knee soft-tissue injury risk, with a braced ankle [2]. However, it is unknown if ankle bracing results in similar alterations in knee biomechanics for males, or whether knee alterations differ between braces. We hypothesized that alterations in knee biomechanics during the single-leg cut would differ between ankle braces, but not sexes.

Methods
Thirty (15 M; 15 F) recreationally active participants (ht: 1.72 ± 0.07 m, wt: 71.5 ± 10.5 kg, age: 21.7 ± 2.9 years) had knee biomechanics quantified during a series of single-leg cuts. Each participant performed five successful cuts with four ankle braces: Ankle Roll Guard (ARG), ASO Ankle Stabilizer (Brace), closed-basket weave of non-elastic tape (Tape), and unbraced (Control). Each cut required participants run at 4.0 m/s ± 5%, before planting their braced (dominant) limb on a force platform and cut at 45° towards the opposite side.

During each cut, knee biomechanics were quantified from 3D trajectories of 32 retroreflective markers. Using Visual3D (C-Motion, Rockville, MD), synchronous ground reaction force (GRF) and marker data were low pass filtered using a fourth order Butterworth Filter (12 Hz). Then, filtered marker trajectories were processed to solve knee joint rotations, and knee joint moments were calculated using conventional inverse dynamics with the filtered marker and GRF data.

For analysis, peak stance (0%-100%) knee abduction and internal rotation joint angles and moments were calculated. Each variable was submitted to a RM ANOVA to test main effect and interaction between condition (ARG, Brace, Control, and Tape) and sex (Male and Female). Significant interactions were submitted to simple main effect analysis and a Hommel Bonferroni correction was used. Alpha was set at p < 0.05.

Results and Discussion
A significant 2-way interaction was observed for peak knee abduction angle (p = 0.022). Females exhibited a significant 2.5° increase in peak knee abduction angle with Brace compared to Control (p = 0.008, adjusted α = 0.0083), while males exhibited no difference between any condition (p > 0.05). The lace-up brace, which reportedly restricts both frontal and sagittal plane ankle motions [3], may lead to increased knee abduction and injury risk for females completing the single-leg cut. Males however, may decrease knee biomechanics related to injury risk when completing the single-leg cut with a lace-up brace. A significant 2-way interaction was observed for peak knee internal rotation moment (p = 0.003). Males exhibited greater knee internal rotation moment compared to females (p = 0.010), but only with ARG (p = 0.009, adjusted α = 0.025), Tape (p = 0.005) and Control (p = 0.002). Males, in fact, decreased peak knee internal rotation moment with Brace compared to Control (p = 0.006, adjusted α = 0.010) and Tape (p = 0.002). The restricted ankle motions when wearing a lace-up brace may alter knee joint moments, but currently only for males. Brace also impacted peak knee internal rotation angle (p = 0.034). But, after correcting for Type I error, the 1.6° decrease in knee rotation with the lace-up brace was not significant compared to other braces (p > 0.018, adjusted α = 0.0083).

Conclusions
Wearing a lace-up brace alters knee biomechanics during a single leg cut. However, the impact on knee injury risk may differ between sexes. Specifically, females increased peak knee abduction angle and potential injury risk, whereas males decreased peak knee internal rotation moment and potential injury risk when wearing a lace-up brace during a single-leg cut.

Acknowledgments
We would like to thank Idaho Global Entrepreneurial Mission (IGEM) for providing funding for this work.

References

Table 1: Peak knee abduction angle (KAA) and moment (KAM), and internal rotation angle (KIA), and moment (KIM) during single leg cut.

<table>
<thead>
<tr>
<th></th>
<th>ARG</th>
<th></th>
<th>Brace</th>
<th>F</th>
<th>Control</th>
<th>M</th>
<th>F</th>
<th>Tape</th>
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<th>F</th>
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<tbody>
<tr>
<td>KAA (+)</td>
<td>-6.07 (3.4)</td>
<td>-5.87 (3.1)</td>
<td>-5.63 (3.8)</td>
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<td>-6.36 (5.3)</td>
<td>-5.29 (3.1)</td>
<td>-5.44 (4.1)</td>
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<td>KIA (+)</td>
<td>4.35 (5.7)</td>
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<td>4.68 (3.7)</td>
<td>3.77 (3.6)</td>
<td>7.31 (4.4)</td>
<td>5.27 (6.7)</td>
<td>5.96 (4.3)</td>
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<td>KAM (+)</td>
<td>0.13 (0.08)</td>
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<tr>
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