SUMMARY

Previous research highlighting gender differences in knee mechanics during cutting were questioned due to these studies typically disregarding the effects of participant characteristics on cutting technique. When males and females were matched for sport, true skill level and lower limb anthropometry, previously-reported gender differences in knee kinematics and moments were no longer evident during the execution of a cutting manoeuvre.

INTRODUCTION

Females typically incur a 4-6 fold increase in ACL injuries compared to males in sport [1], particularly when performing abrupt deceleration tasks such as cutting manoeuvres [2]. Despite the plethora of research attempting to identify and explain why females sustain more non-contact ACL injuries relative to their male counterparts, the exact mechanism responsible for this gender bias is yet to be determined. It has been reported that females tend to display increased knee abduction and decreased knee flexion, as well as increased knee valgus and knee extensor moment during cutting compared to males [3-6]. However, as most of these previous studies failed to match their male and female participants properly for sport, skill level and lower limb anthropometry, it is unknown whether these gender differences were real or simply due to differences between the cohorts in non-gender related factors. Therefore, the purpose of this study was to identify whether male and female athletes, who were matched for sport experience, true skill level and lower limb anthropometry, displayed differences in the biomechanical parameters characterising technique when they performed an unanticipated cutting manoeuvre.

METHODS

Participants: 15 male (20.8 ± 1.5 yr) and 15 female (19.8 ± 1.0 yr) Touch Football players, who had no previous lower limb injuries or surgeries, were recruited. To ensure the participants were properly matched for sport and skill level, only current representative or 1st-2nd grade players who competed in mixed-gender Touch teams were deemed eligible. Participants were also matched for age and lower limb anthropometry (Table 1).

Movement: After familiarisation and warming up, each participant performed 10 successful unanticipated cutting trials off their right foot. All cutting tasks were executed between 35-60° from the original direction of motion and a light signal, activated 1 m before the participant reached the force platform, indicated whether the participant performed a cut or straight line run.

<table>
<thead>
<tr>
<th>Variable (mm)</th>
<th>Males</th>
<th>Females</th>
<th>Diff</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pelvis width</td>
<td>299 (19)</td>
<td>298 (29)</td>
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<td>Hip width</td>
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<td>359 (20)</td>
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<td>Thigh girth</td>
<td>549 (53)</td>
<td>539 (41)</td>
<td>10.0</td>
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<tr>
<td>Shank girth</td>
<td>369 (26)</td>
<td>357 (24)</td>
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<td>0.22</td>
</tr>
<tr>
<td>Thigh length</td>
<td>397 (19)</td>
<td>400 (20)</td>
<td>3.0</td>
<td>0.68</td>
</tr>
<tr>
<td>Shank length</td>
<td>424 (24)</td>
<td>411 (6)</td>
<td>13.0</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Data Collection: During each trial three-dimensional kinematic data were sampled at 200 Hz (OPTOTRAK 3020, Northern Digital Inc. Canada) from 14 infrared-emitting smart markers secured to each participant’s right lower limb. Ground reaction force data were simultaneously collected from two adjacent, calibrated force platforms (1000 Hz, 400 x 600 mm, Model 9281B, Kistler, Switzerland) embedded in the floor.

Data Analysis: Kinematic and kinetic data were filtered using a 4th order Butterworth filter (f = 14 Hz). Each participant’s technique during the weight acceptance phase of the cutting cycle, defined from initial foot-ground contact (IC) to the first trough in the vertical ground reaction force trace [4], was then analysed. Knee joint angles were determined at the time of IC and the peak resultant ground reaction force (Fg). The internal knee joint moments were then obtained using the filtered kinematic and kinetic using inverse dynamic analyses. Peak knee moment and knee moment at Fg, normalised to height and mass (N.m.kg⁻¹.m⁻¹) to account for between-gender differences between these variables, were then calculated. All analyses were conducted using Visual3D software (Version 4, C-Motion Inc., USA).

Statistics: Data for the tallest, heaviest male and shortest, lightest female were discarded to match the male and female participants as closely as possible. Means and standard deviations of all kinematic and kinetic data were calculated to characterise each participant’s cutting technique. Independent t-tests (p ≤ 0.05) were then used to
determine whether there were any significant differences between the means of each gender for the kinematic and kinetic data (SPSS, IBM Corporation, NY, Version 7).

RESULTS AND DISCUSSION
In contrast to previous research [3], we found no between-gender differences in knee flexion or knee abduction at IC or FR during the unanticipated cutting task. That is, the female participants in the current study did not display a lower limb alignment during cutting that has been characterised in the literature as “high risk” for ACL injury [7].

It has been repeatedly reported that increased knee loading via increased knee valgus and knee extensor moments contribute to an increased ACL injury risk in females [5, 6]. However, there were no significant differences between the two gender groups in these knee moments at the time of the FR (see Figure 1). Interestingly, females recorded a significantly greater peak knee extension moment. This greater peak knee extension moment displayed by females has been previously reported [1] and may be indicative of an increased quadriceps activation, potentially increasing anterior shear loading. Additionally, males and females in the present study displayed similar peak knee adduction and external rotation moments during cutting.

CONCLUSIONS
It was concluded that, when male and female athletes were matched for sport, true skill level and lower limb anthropometry, previously reported gender differences in knee mechanics during an unanticipated cutting manoeuvre were no longer evident.

ACKNOWLEDGEMENTS
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REFERENCES

Figure 1: Peak knee extension moment and knee extension moment at FR for males (n = 14) and females (n = 14) during the weight acceptance phase of a cutting manoeuvre.