Author's response to reviews

Title: The effect of external ankle support on the kinematics and kinetics of the lower limb during a side step cutting task in netballers.

Authors:

Andrew Greene (andrew.greene@anglia.ac.uk)
Max Stuelcken (mstuelck@usc.edu.au)
Richard Smith (richard.smith@sydney.edu.au)
Benedicte Vanwanseele (benedicte.vanwanseele@faber.kuleuven.be)

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Author's response to reviews: see over
Reviewer 1

Major Compulsory Revisions

Lines 82-84: Is there any evidence of showing high top shoes affect lower extremity kinematics and/or kinetics during activity? If yes, it would be great to include such information in the background.

This has been included in the manuscript Lines 100-110

Lines 97-100: The high-top condition is not listed as one of the ankle support conditions in the primary objective, while the authors hypothesized that the external brace and the high-top shoes would restrict the peak ankle joint angles, range of motion (ROM) and position throughout the contact phase of the side step cut and increase the ankle joint moments (lines 100-103).

This was an oversight in the original manuscript and has been amended on line 120

Lines 155-157. Internal moments were calculated in this study. The internal moments are produced by the muscles and ligaments. Therefore, extracting internal knee valgus moment may not answer the research question appropriately.

It is acknowledged that the description of the moments calculated in this study and those used in previous studies was not explained clearly in the original manuscripts. This has been addressed extensively throughout the manuscript. This has been specifically addressed in lines 318-328, however concessions have also been made in the limitations section lines 415-426.

Lines 169-170: ‘Discrete variables were extracted from each individual trial and averaged for each player.’ What variables were extracted? Please list these variables either in the text or in a table and explain why. It will help the reader to understand what variables were analyzed.

These have been listed in lines 211-212.

Lines 174-177: There are two paired comparisons (brace & standard shoes, and high-top shoes & the standard). Was there any adjustment used to avoid Type I error? Why not use ANOVA for comparing 3 conditions?

This has been addressed and an ANOVA comparing the three conditions has been conducted. Lines 217-224

Lines 265-271: There is a methodological flaw in this argument. The INTERNAL moments were calculated in this study while EXTERNAL moments were calculated in Sigward and Powers (2007) and McLean et al (2005). The valgus moment reported in this study is actually the knee abductor moment resisting the external
varus moment generated by the GRFs. Because of this reason, the valgus values in this study cannot be used to compare to the valgus values in Sigward and Powers (2007) and McLean et al (2005).

It is acknowledged that the description of the moments calculated in this study, and those used in previous studies was not explained clearly in the original manuscripts. This has been addressed extensively throughout the manuscript. It is the internal knee varus moment that has been calculated in the current study, however it is acknowledged that this was poorly represented and described in the original manuscript. This has been specifically addressed in lines 318-345, however concessions have also been made in the limitations section lines 415-426.

Minor Essential Revisions

Lines 91-93: Please emphasize only the FRONTAL effect of the ankle braces on the ankle during a netball specific landing task without altering the mechanics at the knee.

This has been done continually throughout the manuscript at lines 88, 93, 116, 270, 273

Lines 123-126: ‘Of those players that met the inclusion criteria (25).’ (25) here is confusing. Putting 25 in front of “players” (i.e. Of those 25 players) will make this sentence more clearer.

This has been carried out: lines 143-144

Lines 165-166: All data “were” time-normalized.

This has been carried out: line 207

Lines 184-185: Why is the velocity of the sacral marker being reported here? If this velocity represents the approach velocity of the subjects, please explain it in the methods.

This has been carried out: lines178-179

Figure 1 & 2: Why use 95% confidence for the standard deviation instead of the standard deviation to represent the shaded area?

The 95% confidence intervals were calculated to show the uncertainty around the estimate of the mean measurement by taking into account the standard deviation and the number of subjects involved. It is commonplace in biomechanics research to represent timelines using 95% confidence intervals and we felt this would show the variance around the mean as well as the similarity between the three conditions times series in a clearer fashion than the Standard deviation measures, as these would be much larger and in our opinion make the figures more difficult to interpret. If the reviewer is still
uncertain about our use of 95% confidence intervals then we would consider changing in the final manuscript.

Table 2: What variables were analyzed? At each plane of the joint, there could be positive and/or negative peak moment(s). Were only the positive peak moments being studied since only positive peak moments are listed in the table?

**Both positive and negative moments were seen in all conditions. No significant differences were seen for any of the moments, positive or negative. Only the positive values were initially reported as the positive knee varus moment was being used in the discussion. All ankle and knee moments have now been included in table 2 for clarity. Line 681**

Table 3: Were only three peak GRFs being extracted? Why did the authors choose these peak GRFs?

**Peak GRF’s were extracted throughout the landing phase of the task. Only vertical GRF and Medial GRF were seen in their respective directions. The peak breaking and propulsive forces have now been included in table 3. Line 684**

Lines 230-234: Since there was no direct comparison between the use of external ankle brace and high top shoes, I do not think the latter is “not as effective as” the former.

This was an oversight in the original manuscript. The introduction and methods sections have been rectified to show comparison between the brace and the high top conditions. Lines 120, 217-224.

Reviewer 2

The manuscript described an investigation of two different external ankle supports (brace and shoes with high upper) in potentially limiting range of motion in the ankle and knee joints and possibly altering joint loading during a side step cutting task. The research topic is appropriate for the Journal and interesting to the general readership of the Journal. The manuscript was well written and the results were clearly presented.

**Major Compulsory Revisions**

The key results of the study were that the brace condition significantly reduced ankle joint ROM in dorsi-plantar flexion compared to other conditions, and no differences were observed in joint loading between conditions. My impression is that (1) the decreased ankle ROM may limit athlete performance; and (2) given that excessive joint loading (force and/or moment) is the major risk factor for joint injury, what is the benefit of using the ankle support as they do not seem to reduce joint loading? It was not clear in the manuscript why limiting joint motion is important and how reduced ROM would be associated with potential mitigation of joint injury. Please explain and clarify the importance of the study.
The study was carried out in netballers that did not exhibit or have a history of ankle injury. The intention of the study was to see firstly if the use of external ankle support mechanisms alters the range of motion at the ankle, and then to see what changes, if any, occurred in joint loading as a result of this restriction. The introduction section has been edited to try to express this more clearly. Lines 112-116.

The discussion section has been edited to provide greater discussion of the findings in relation to the target or potential target population. Lines 268-279. It is outside the scope of the study to make comment on whether ankle support braces limit athlete performance. However, no significant differences between the foot progression angles, ground reaction forces or the joint moments acting at the joint would suggest that the brace may limit unnecessary motion at the ankle through landing without changing other factors which may impact upon the performance of the task. A section has been added to describe that the findings may be beneficial to those athletes that have suffered ankle instability or recurrent ankle sprain in that they may use an ankle brace without increasing the loads acting at the other joints of the lower limb. Lines 304-316.

The Methods session has missed important info on the motion capture methodology. What kind of multi-segment foot model was used? In order to track the motion of the rear foot and fore foot, complex foot models (marker sets) need to be used. Please provide detailed info on the foot model and the corresponding analysis. In addition, what were the accuracy and repeatability in measuring rear foot and fore foot motion with shoes? These motions are important in calculating ankle joint moments. Please clarify and also justify the motion of the shoes, as measured with markers on the shoe, can be used to represent the motion of the foot, even the rear foot and fore foot.

The methods section has been edited to include all information and specific references have been provided. Lines 160-174, 568-593.

Minor Essential Revisions

Methods, lines 140-141. Please explain the ‘landing area’ clearly – a level floor was used or subjects ran from a higher floor to a lower floor? Is it better to describe as ‘step on the force platform’ rather than ‘land on’? The authors may consider of using a picture or a schematic to show and describe the task.

This has been carried out. Lines 179-180. The task was carried out as described previously in reference [27] McLean SG, Huang XM, Su A, van den Bogert AJ: Sagittal plane biomechanics cannot injure the ACL during sidestep cutting. Clin Biomech (Bristol, Avon) 2004, 19:828–838.

Reviewer 3

General comments
This study investigated the effects of ankle brace on side step cutting task biomechanics in netballers. It is apparent that the authors put a great deal of effort to conduct this study and I would like to commend them for this. However I see some issues that need to be addressed prior considering this manuscript for publication.

Major compulsory revisions

In general, the introduction does not develop the question that is being asked by the researchers. It is credible that netballers may place higher loadings both in the knee and ankle joints when wearing ankle brace support. However, the underlying rationale for this hypothesis needs to be developed within a sound theoretical framework. For example, some references used to contextualize the problem did not even investigate the effects of ankle braces or the cutting task.

It is acknowledged that this was necessary and it has been addressed throughout the introduction section and references where necessary have been clarified. Due to the lack of information relating to ankle braces being used, and especially in side stepping tasks, some references were used in an attempt to provide context and rationale, which were not directly related to the current study. Once again, all references used in an attempt to do this have had their methods and their interventions clarified. Lines 86-116

Regarding the methodology, the major flaw was the lack of control of gait speed as acknowledged by the authors. However, the authors should consider reporting these measured values to enhance the understanding about their influence on the dependent variables. Additionally, the description of the procedures taken to measure kinematics should be improved. For instance, it was not clear to me where exactly the malleoli markers were placed when the subject wore ankle braces. When did the anatomical calibration trial take place? In the beginning, in the end of the trial, both or it was never done and all markers remain during the dynamic trials? This information is important even though you referenced it. Were the malleoli marker placements reliable between conditions?

These values have been reported Lines 228-230. The methods section has been improved to provide greater detail of the procedures used throughout data collection and data analysis Lines 160-174, 196-199.

The discussion has too many assumptions and is sometimes too speculative, particularly when it refers to excessive knee joint loadings in netballers by directly comparing the present results with the literature. Due to the lack of a standard convention for measuring, scaling and reporting joint moments, any comparison of this variable across studies should be done cautiously.

The discussion has been addressed in an attempt to reduce the assumptions made throughout. In our opinion, the discussion section now discusses the current data with that in the literature more cautiously. A section has also been added to the limitations section to express this. Lines 415-426

The whole premise of the use of ankle braces was indeed to limit the mobility at the ankle joint but, particularly in the frontal plane and not in the sagittal plane that was
found in the present study. Therefore, the use of previous studies [15,16] to support the present findings seem inappropriate. For instance, Mundermann et al. (2003) didn’t even study ankle braces but custom molded foot orthotics aimed to influence ankle frontal plane biomechanics.

This has been addressed in the discussion. Lines 268-316

The authors also focused on the fact that previous studies observing differences in frontal plane ankle kinematics have used different task to assess the effects of ankle braces such as vertical landings. Likewise, the present study also cited studies which investigated different tasks such as running in a straight line to compare with the present findings.

Once again, due to the lack of studies relating to external ankle bracing and side stepping activities, studies were used in an attempt to provide context and rational to the developing argument in the introduction section. These have been identified and discussed throughout the discussion section in an attempt to prevent inaccurate claims being made against previous literature which is not directly comparable. Lines 268-316

The authors suggested that the presumably reduced demand on the ankle joint to actively brake the movement during side cutting as opposed to other tasks. Was this statement based on any evidence? Why then side cutting was chosen as the targeted task? Wasn’t because it is demanding and there is a higher risk of ankle injuries?

The side step task was selected due to its links to the development of knee injuries in female athletes. This, as well as the changes that were seen previously in the ankle ROM in netballers wearing external ankle supports during a stop landing [13] led to the question being developed. It is unknown whether the side step task is specifically demanding upon the ankle joint, but the dynamic nature of the task suggested that it was likely to put the entire lower limb of the performer under large stresses. The discussion has been edited to try and clarify the statement made relating to the reduced need on the ankle joint to brake or slow down the movement. This statement was made in comparison to a catch and stop landing which was carried out in netballers and showed that the external ankle brace condition brought about restriction of the frontal plane motion at the ankle. As the netballer is not attempting to slow their landing to a stop in the side step cutting task, so the demand to stabilise that ankle may be reduced. This has been addressed in lines 298-316

Is it fair to compare absolute joint moment data with the literature? How comparable was your procedure (marker set, reference frames, joint moment expression, etc) to the [9,23,24]. I suggest highlighting this issue of comparing these parameters due to the lack of standardized procedures across studies.

This has been addressed in lines 318-345, however concessions have also been made in the limitations section lines 415-426.

The conclusion seems not to be fully supported by the present results.
The conclusion section has been edited to provide greater clarity of the conclusions being made. Lines 444-459

Minor Essential Revisions

Line 89-91: these references do not fully support this statement either because they did not either investigated cutting maneuvers or study ankle brace support.

Due to the lack of studies relating to external ankle bracing and side stepping activities, studies were used in an attempt to provide context and rational to the developing argument in the introduction section. These have been identified and discussed throughout the discussion section in an attempt to prevent inaccurate claims being made against previous literature which is not directly comparable. Lines 92-96; 268-316

Line 104: What were the differences between joint moments and joint loadings?

This has been clarified in the text. Lines 99-110.

Line 177: replace “Wallace” by “Wallis”

This has been removed due to a repeated measures ANOVA being carried out. Lines 217-224.

Line 184-185: Was this velocity obtained for what condition? How about the comparison between conditions? This would be very informative.

This has been included. Lines 228-230.

Methods

Was there any limb dominance effects?

No, all subjects identified as right handed / footed. This has been include Lines 183-184.

How was the cutting direction at 45° controlled between conditions and across participants?

All subjects performed the task in the same laboratory, landing on the same force platform with the same target direction for all conditions. The instructions provided to all subjects were standardised and target marker for the cut direction was the same for each condition and each subject.

Was the foot orientation upon landing in the force plate monitored or controlled?
It’d be great if you report the foot progression angle (the angle of the foot in the global reference frame) between conditions to see whether the subjects were reliable placing their right foot between conditions.
Subjects were reliable in placing their foot on the force platform. This has been reported in the text. Lines 230-233

Discretionary Revisions

I think if you include the joints that are being investigated, the title would be more informative

We have not included the joints names specifically so as not to have the word ankle repeated in the title. The title has been altered to be more informative, with the new title being: The effect of external ankle support on the kinematics and kinetics of the lower limb during a side step cutting task in netballers

Line 87-88: reference needed

Reference included. Line 87

Tables

Line 550, pg 24: knee adduction/abduction is commonly used to describe the movement of the knee in the frontal plane. Knee varus/valgus is often used to describe its alignment. Nonetheless, knee adduction should be correspondent to varus, shouldn’t it?

Yes. This has been addressed throughout the text.

Line 553, pg 24: the measurement units need to be rewritten.