Author's response to reviews

**Title:** Lumbar position sense and the risk of low back injuries in college athletes: a prospective cohort study

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**Author's response to reviews:** see over
Editor,
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RE: Lumbar position sense and the risk of low back injuries in college athletes: a prospective cohort study

Dear Editor,

Enclosed please find our revised manuscript, which we would like you to consider for publication in BMC Musculoskeletal Disorders. We responded to all of the reviewers’ comments and incorporated most of their suggestions in the revised manuscript. Our point-by-point responses are attached.

Sincerely yours,

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Referee 1: Nicolaos Strimpakos

1) Please put the means and SD of AE and VE in text or in a new table as it is difficult to compare with other studies only from figures or abstract.

Done. We constructed Table 2 to address this comment.

2) However, the tests they used for proprioceptive assessment from sitting position by moving the lower trunk are not similar with the athletic functional tasks where an injury could be happen so may be not sufficient enough to detect proprioceptive impairments in athletes. I strongly recommend that the authors have to recognise that limitation before conclude that there are no proprioceptive deficits in athletes with LBI.

We already addressed this limitation in our discussion:
“It is possible that other planes of motion can be affected more by LBP than the transverse plane used in our study. However, it should be noted that a number of the positive studies documented impairment in this plane [25-27]. So it would be expected that if impairment exists, it would also be found in the transverse plane of motion.”

3) Line 7: change rotatores to rotators

Done.

4) Line 12: change proprioception to proprioceptive

Done.

5) Line 18: change disruption to deficiency

Done.

6) Line 21 & 23: I think you have to put the date also after the name

Done.

7) Line 17-20: the hypotheses have to be written clearly

Our hypotheses were as follows:
1) athletes with a history of LBI would demonstrate less accurate and precise trunk repositioning and higher motion perception thresholds.
2) athletes with poor trunk PS would have a higher risk of sustaining a LBI than athletes with more accurate and precise trunk PS.

8) Line 23: how did you identify that the vertical pivot axis was through L4/L5 segmental level?

We modified the sentence to read:
“Subjects were positioned in the apparatus so that the vertical pivot axis coincided with the imaginary line drawn between the apex of the iliac crest and greater trochanter”.

9) Line 11: the 10 trials were randomized only once at the beginning for the direction (eg the first five trials left and the rest right) or all of them were randomized?
All 10 trials were randomized for direction.

10) Line 17: why you choose 20 degrees for the test? Did you check the ROM of the subjects?

We found empirically in preliminary studies that the 20 degrees angle could be achieved by all subjects without discomfort. However, this angle is irrelevant as it was the neutral (i.e. 0 degrees) position that the subjects were instructed to reproduce.

11) Line 19: the instrument was able to move in very slow rate (0.1 degrees) but you decided to use 1.00/sec for passive motion. Why you didn’t use slower rate?

Both Parkuhrst and Burnett (1994) and Timela et al. (1999) used 1 degree/second passive movement in the transverse plane. These references were inserted into the sentence indicated.

12) Line 5: the authors recorded only the trials in which the subject correctly identified the direction of motion. Why? The false identification of direction is an indication of proprioceptive impairment. Did you consider that?

Parkuhrst and Burnett (1994) warned about obtaining undesirable score variation when combining the motion perception threshold and directional motion perception tests. An examiner should instruct a subject to focus on one test or the other, but not on both. We expanded the indicated sentence to read as follows:
“To avoid undesirable score variations from combining the MPT with directional motion perception, in only those trials, in which subjects correctly identified the direction of motion, was the degree of rotation recorded [30].”

13) Line 9&10: did you check if there were differences in reliability between healthy subjects and subjects with LBI? The reliability indices for AE and VE were quite low in order to identify significant differences in proprioception between subjects.

No. Our ICC scores reflected all subjects. The reliability indices were sufficiently high to detect significant gender differences and testing modes (active vs. passive). There is no reason to believe that differences between subjects would have been missed if they existed.

14) Line 1: what test did you use for normal distribution?

We added that the Anderson-Darling test (Minitab, Inc.) was performed.

15) Line 13: The aims of this prospective study were to examine whether 1) there are..... 2) impaired proprioception.....
We decided to maintain the structure of the sentence to maintain parallelism.

16) Line 20-22: did you find any correlation between history and subject characteristics and proprioception error? If any it would be useful to discuss that in the discussion section

None of the variables correlated with proprioception error.

17) Did you do any subgroup analysis for subjects with recurrent LBI? Are there any differences with healthy subjects?

Yes, and no significant differences were found.

25) In figures 2 and 3 the VE is higher than AE that means that the variability of the subjects’ performance around their mean response is greater than their ability to return to the actual target. This is in accordance with some studies but also in contrast with other back and neck proprioception studies (Strimpakos et al, 2006; Koumantakis et al, 2002). Please can you comment on that?

It is difficult to compare these data because most of the experimental conditions differed between these studies. For example, neck vs. lumbar spine, target vs. neutral position reproduction, sitting vs. standing posture, etc.

**Referee 2: Alison McGregor**

1) My key concern is whether the research methodology is fully assessing proprioception or not. It would seem to be only assessing one component of proprioception ie joint position sense and as such I think this must be reflected in the discussion and subsequent conclusions.

We addressed this concern by replacing the term “trunk proprioception” with “trunk position sense” in the entire manuscript.

2) Further you final study groups have very small numbers in terms of the HxLBI and LBI groups how does this influence your findings and the study power?

Power of our study was sufficiently high to detect significant gender differences and testing modes (active vs. passive). There is no reason to believe that differences between subjects would have been missed if they existed.

3) In procedures we need a protocol depicting what was done when ie reviews, groupings etc - a flow diagram perhaps would be a useful summary. This way we will know what measurements and questionnaires were completed when and by whom.
We do not believe that a flow diagram is warranted. The study had a very simple design. All athletes were tested first and then followed for 2-3 years. Groupings based on LBI are presented in Table 2.

4) Also why did you focus on the transverse plane?

We followed the protocol described by Taimela et al. (1999), who found differences between patients with LBP and healthy controls. We mentioned that: “this protocol has the advantage in that it isolates proprioception to trunk sensory receptors, while other inputs from lower extremities, vision, and the vestibular system are removed.”

5) I think you need to make the methods clearer particularly your descriptions of the equipment and how they work. You mention resolution but not precision or accuracy.

The accuracy obtained from the calibration curve was 0.35 degrees. We believe that statistical differences smaller than our inaccuracy are clinically insignificant. We added this information in the manuscript.

“… and the accuracy obtained from the calibration curve was 0.35°.”

6) Line 5-6 on page 7 I am not clear what this means, how many attempts did people have to achieve this and is this valid?

Parkuhrst and Burnett (1994) warned about obtaining undesirable score variation when combining the motion perception threshold and directional motion perception tests. An examiner should instruct a subject to focus on one test or the other, but not on both. We expanded the indicated sentence to read as follows:

“To avoid undesirable score variations from combining the MPT with directional motion perception, in only those trials, in which subjects correctly identified the direction of motion, was the degree of rotation recorded [30].”

7) Under data analysis how was the neutral position defined by the equipment or the person?

The neutral position was defined by the person.

8) Also what were the criteria for your different classification groups and who actually classified each subject?

The classification was based on low back injury status, which we described as follows:

“Our operational definition of an injury was any LBP that caused the athlete to seek medical attention (physician, athletic trainer, or physical therapist) and to miss at least 3 days of participating in their sport or training routine. All inclusion and exclusion criteria were based on self-reported data, which were verified with training room and team physician records.”
9) I am confused by the follow up period. Did it vary per subject or did you review them all over 2-3 years.

We inserted the following explanation:
“It varied slightly for each athlete due to the time elapsed between the testing session and graduation from college.”

10) In the results page 8 line 18 what are these criteria, similarly line 13 why could these athletes not be reliably classified?

For the criteria of injury, please see point #8.

Those athletes who reported low back pain or injury, but could not be confirmed by training room or physician records, were not included in the analysis. We removed the word “reliably”.

11) Very few actually got an injury so do you think the study has adequate power?

Please see point #2.

12) What was the effect of multiple episodes compared to single line 17 page 8.

We did not look at this factor in our study.

13) These errors seem large when considering the ranges you present or have I misunderstood this?

These errors are in line with previous studies.

**Referee 3: Kornelia Kulig**

1) Is the name of you laboratory “Rehabilitations ….. “?

We corrected this mistake.

2) Is Dr. Greene still missing in action?

No, we now have his correct affiliation.

3) Page 3, line 3: Regarding the statement “interaction between afferent and efferent loops”, doesn’t a single loop consist of both an afferent and efferent neuron?

We agree with the reviewer and felt the sentence was confusing. We removed the sentence.

4) Page 5 You have carefully mentioned more than once that you have aligned the vertical pivot axis though L4-L5. I am curious, what were your landmarks?
We modified the sentence to read:

“Subjects were positioned in the apparatus so that the vertical pivot axis coincided with the imaginary line drawn between the apex of the iliac crest and greater trochanter”.

5) Page 6, line 3: Cutaneous input during the testing procedure would seemingly be an additional cue to the athlete that the trunk was moving. A stronger argument is needed here or in the discussion to convince the reader that the athletes were sensing positional changes primarily through proprioception, rather than through their cutaneous receptors.

Cutaneous receptors provide an important proprioceptive input. As such, they are an integral part of the proprioception process.

6) Page 6, line 6: Delete the words “the use of”.

We deleted the indicated phrase as suggested, but also modified the sentence to read:

“Auditory cues produced by the stepper motor were masked by background noise from a buzzer.”

7) Page 8, even though you have not conducted repeated measures, it would have been more reassuring if you would have collected the test-retest measurements on separate days. Can you really call the comparison of the first 5 and last 5 measures ‘test-retest’

We changed the phrase “test-retest repeatability” to “within-session repeatability”.

8) Page 8, line 13: The term “reliably” suggests statistically determined. Please reword.

We removed the term “reliably”.

9) Page 8, 1st line 17-18: Remove the statement “according to our criteria”.

Done.

10) Page 8, lines 18-22: Statements regarding variables not included in the primary analysis should be omitted and can be included in the discussion.

We believe that it is good to alert the readers early on and explain why these results will not be presented. No changes were made.

11) Page 9, line 2: Before the statement: “trunk repositioning error”, insert the phrase: “axial plane”.

Done.

12) Page 10, You are very careful about not overstating the role of the unique characteristics of the athletic and young population you have studied. Is the proprioceptive literature on athletes limited to the single study on gymnasts?

To our knowledge, this is the only study comparing athletes and non-athletes.
13) Page 12, second paragraph, You may want to add that the repositioning error is within the SEM, and therefore negligible

In this paragraph, we discuss clinical significance. It is independent of the size of actual experimental differences and/or SEM.

14) Page 19, paragraph 4: Perhaps training by the athlete minimizes the effect of injury on proprioception, or assists in the recovery of proprioception after injury. Consequently, the findings of your study should only be generalized to an athletic population.

We removed the indicated paragraph.

15) Table 1: Rather than NA, a line through the cell is recommended (###).

We used the symbol: “—“

16) Table 2: Remove “*” before “Repeatability”

“*” refers to the footnote.

17) Add P-values to figures 2 and 3.

P-values were added to the captions.

18) Figure 1. Review, there seems to be a shift in the descriptive text

Descriptive text was corrected.

19) Check the spelling of your references.

Corrected.