Peer Review File

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Reviewer A

The paper describe a comparison of IMUs and a gold standard system for motion analysis. This is a fair study to perform – but many researchers have done this already. It is therefore very important that the authors clearly motivate what this study contributes with, that is not already known. The authors should therefor also address previous literature in the field, preferably reviews, that analyse IMUs for motion analysis of upper body motion. There are several recent ones that should be addressed, and I cannot find any of them in the reference list. Specific comments are found below.

- **Comment 1:** Row 19 - Background: Our study aims to validate a commercially available inertial measurement unit system against a standard laboratory-based optical motion capture system." This is too broad. Clarify that you want to validate if the system is valid for shoulder measurements in a clinical context.
    - Reply 1: We have specified that the aim of our project is to validate the system for shoulder measurements in a clinical context in line 21.
    - Changes in text: Background: Our study aims to validate a commercially available inertial measurement unit system against a standard laboratory-based optical motion capture system for shoulder measurements in a clinical context

- **Comment 2:** Row 71 – "shoulder joint kinematics as part of routine clinical practice." Please explain which clinical routines you refer to here. Give examples at least on when shoulder range needs to be examined clinically, in relation to which diseases, and what gold standard method is then used (goniometer?). Are there any clinical routines that include shoulder examination in an optical motion laboratory?
    - Reply 2: We have cited the clinical examination of patients with rotator cuff injuries using a goniometer as an example for range of motion testing in the routine clinical setting. (Lines 72 to 73). We also elaborated on why we believe IMUs may become a better alternative, although the current practice is to use a goniometer for manual measurements. (Lines 72 to 77).
    - Changes in text: If the accuracy of IMUs is found to be comparable to that of OMC systems found in kinematic labs, the portability of IMUs would allow accurate evaluation of shoulder joint kinematics as part of routine clinical practice. For example, the clinical examination of patients with rotator cuff injuries usually involves RoM testing (6). The current practice is to measure shoulder RoM using a goniometer, which has been shown to have a minimal

clinical difference of 22° compared to the gold standard (7). We believe that IMUs may present a superior alternative with increased accuracy, collection of real-time data, and simultaneous gathering of other kinematic parameters aside from RoM.

- **Comment 3:** Row 73 – the sentence "The XCLR8 IMU (XCLR8 Technologies Private Limited, Singapore) consists of a gyroscope, accelerometer, and magnetometer to assess motion." This sentence should be removed or moved to the method part.
    - Reply 3: We have removed the sentence from the introduction and moved it to the methods section from lines 123 to 124.
    - Changes in text: NA

- **Comment 4:** Row 109: "Kinematic data from the Cortex software is filtered (50 Hz)" – Please explain which kind of filter you have used. I suppose you mean a lowpass filter? Commonly, a lowpass filter on about 5-10 Hz is used since marker movements faster than that are considered as noise. Why did you use 50 Hz?
    - Reply 4: We apologise for an error in the frequency of lowpass filter mentioned in the original text. Upon further clarification among authors and checking of experimental post-processing records, we have confirmed the type and frequency of the low pass filter used. This information has been added into the text in lines 106-107.
    - Changes in text: Kinematic data from the Cortex software is filtered through a low band-pass Butterworth filter with a frequency of 6Hz and converted into joint angles using MATLAB® (R2019a, Mathworks Inc., Natick, MA, USA).
- **Comment 5:** Row 109 – is the filtering procedure equal for both systems? The data should be filtered in similar way so that the comparison of the data output is fair.
    - Reply 5: Unlike the kinematic data in the optical motion capture system, the data collected from the IMU does not undergo a filter. Therefore, the filtering procedure is unfortunately not the same for both systems. We thank the reviewer for highlighting this for improvement in the development of our study protocol for future studies involving the IMU.
    - Changes in text: NA
- **Comment 6:** Row 115: you analyse glenohumeral joint motion (upper arm in relation to thorax). However, in the introduction you discuss the glenohumeral, acromioclavicular, scapulothoracic and sternoclavicular joints, and you also have markers on scapula as described in the method part (but no IMU on the scapula). This is inconsistent. Please rephrase the introduction to motivate why you focus on only glenohumeral joint motion, so this is clear to the reader.
    - Reply 6: We have removed the section of shoulder motion involving the glenohumeral, acromioclavicular, scapulothoracic and sternoclavicular joints to avoid confusion. We have clarified the reasons for focusing specifically on

the GH joint in the introduction section as suggested by the reviewer (lines 62 to 66)

- Changes in text: While shoulder motion is produced by a combination of movements across several joints, many common shoulder pathologies such as rotator cuff syndrome, adhesive capsulitis, and shoulder dislocations usually involve the glenohumeral joint. Therefore, it is of particular importance to develop a portable, and accurate method of assessing kinematics of the glenohumeral joint. The complexity of the shoulder joint movement leads to difficulties in accurate measurement of joint kinematics without laboratory equipment.

• **Comment 7:** Row 109-128: there are no information about which markers that were used to construct segment coordinate axes and joint angles. Please add this.

- Reply 7: We have added the vector definitions used to construct the coordinate axes (thorax and humerus) into Supplementary Table 2 and referenced this in the text (line 116). Methods for deriving joint angles from the rotation matrices can be found in lines 125-126.
- Changes to text: NA (See Supplementary Table 2)

• **Comment 8:** Row 121: what is Theta here? I guess an arbitrary angle, please add this information.

- Reply 8: We have defined theta as an arbitrary angle in lines 115 to 116 for clarification.
- Changes in text: The following rotation matrices shows the rotation of the coordinate systems, where θ is an arbitrary angle:

• **Comment 9:** Row 123: it should be Ry-Rx-Ry in the equation, now it reads Rx(delta)Ry(beta)Rx(alfa)

- Reply 9: We have edited the equation to reflect the correct order of variables. (Line 123).
- Changes in text: NA (See equation in line 123)

• **Comment 10:** Row 134: Why only 20 Hz? How was this data filtered/resampled for comparison with gold standard data?

- Reply 10: We have clarified the reason for choosing 20Hz frequency as bluetooth transmission at 20Hz was the most effective way to send the data from the sensor-phone-unity avatar without causing any visual delays in the real time human avatar on the android device (Lines 134-137). The method for data filtration is addressed in the comment 5.
- Changes in text: The frequency of 20Hz was chosen as it was the most effective way to send data from the sensor-phone-unity avatar without causing any visual delays in the real-time human avatar shown on the android mobile device.

- **Comment 11:** Row 130-139: there are little information about how data from this system is handled, given that the optical data methodology (at least the part on how angles are calculated) is described in detail. Is data in form of quaternions or rotation matrices? How were sensor axes aligned with anatomical axes? How well are the axes of the optical system and the IMU system are aligned? How do you ensure this?
    - Reply 11 (a): The data collected from the IMU is in form of quaternions (line 137). Referencing our reply to comment 20, we acknowledge that more detailed information could be provided on the calculation methodology for the IMU system. However, as the developer of the IMU software has classified the algorithm as proprietary information, we are unable to elaborate further. Therefore, no edits to the text have been made to address this part of the comment.
    - Changes in text (a): NA
    - Reply 11(b): Regarding the alignment of the axes of the optical system and the IMU, we thank the reviewer for highlighting inaccuracies that can be derived from misalignment of the optical system and IMU system. We tried to collect kinematic data of the two systems simultaneously to reduce differences stemming from variability in RoM demonstrated by the participant. However, we failed to consider methods to ensure alignment of axes between the two systems. While we cannot improve on the experimental protocol for this study, we can improve on future studies. This point has been discussed in the limitation section.
    - Changes in text (b): Lastly, we assumed that the axes of the OMC and IMU systems would be aligned throughout RoM.

- **Comment 12:** Row 159: "Bland-Altman analysis quantifies the amount of agreement between two methods of measurement by providing an interval where 95% of the differences between both methods are found" – this is not clearly explained. How is this calculated? What does the 95% limit refer to? How is it defined?
    - Reply 12: We have elaborated on the methodology for Bland-Altman analysis in hopes that it is now clearer to the reader. (Lines 162 – 168). We have also explained the reason why 95% is chosen as the default LoA. (Lines 163-165).
    - Changes in text: Bland-Altman analysis quantifies the amount of agreement between two methods of measurement by constructing LoA. These limits are calculated by using the mean and standard deviation of the differences between two measurements. In Bland-Altman analysis, the limits of agreement are defined as 95%, as the authors recommended that 95% of data points should lie within 2 standard deviations of the mean difference. The results of this analysis are conventionally displayed graphically using a scatter plot, in which the Y axis shows the difference between two paired measurements, and the X axis represents the average of these measurements (10,11).

- **Comment 13:** Row 174 – You write that "For extension and external rotation movement, there was an error in data capture for one male subject." Can you explain what error you mean here; drift, error in the subject's performance or in the optical data or in the IMU data?
    - Reply 13: We were unable to process the data for one male subject as the data file had become corrupted during the conversion from raw motion data recording in Cortex to joint angles in MATLAB. We have clarified that the error involved data using the OMC system in lines 179-180.
    - Changes in text: For extension and external rotation movement, there was an error in OMC system data capture for one male subject.

- **Comment 14:** Row 208-218: There are several recent reviews that discuss and analyse IMU validity to measure shoulder and upper body motion. Please add at least 2 of those and discuss your results in relation to those as well.
    - Reply 14: We have discussed our results in relation to 3 studies: Höglund et al. (lines 200-204), Morrow et al. (lines 212-219), and De Baet et al. (lines 220-234).

      Citations added: (1) Höglund G, Grip H, Öhberg F. The importance of inertial measurement unit placement in assessing upper limb motion. Med Eng Phys. 2021;92:1-9. doi:10.1016/j.medengphy.2021.03.010, (2) De Baets L, van der Straaten R, Matheve T, Timmermans A. Shoulder assessment according to the international classification of functioning by means of inertial sensor technologies: A systematic review. Gait Posture. 2017;57:278-294. doi:10.1016/j.gaitpost.2017.06.025
    - Changes in text: Please refer to the line numbers quoted in the above reply.
- **Comment 15:** Row 216: "We recommend that clinicians requiring kinematic outcomes with higher levels of accuracy consider alternate measurement systems or test additional protocols prior to using the IMU." This should be rephrased, it is vague and also I cannot see how you can draw this conclusion from your study. You could for example write something like "We recommend further studies on patient groups to reveal if meaningful clinical differences in shoulder movement can be measured with the current system".
    - Reply 15: We have edited this sentence as per the reviewer's suggestion in lines 227-229.
    - Changes in text: We recommend further studies involving various patient groups to reveal if meaningful clinical differences in shoulder RoM can be measured with the current system.

- **Comment 16:** Row 225: Muir et al. reported minimal clinical difference of 22° for the standard goniometer during shoulder external rotation, which is comparable to our result of 22.27° (17). Use "Equal" instead of "comparable".

- Reply 16: We have removed this sentence because the reference to this paper has been moved to the introduction section (see comment 17).
- Changes in text: NA

• **Comment 17:** Row 225: The section “Comparison between IMU sensors and standard goniometers” should be shortened and/or moved to the introduction instead. You have not examined gonimeters in your current study, so the large section about gonimeters compared to IMUS is not correct to include in the discussion. Part of this section could be moved to the introduction to state what is already done and to motivate why the current study is of interest to perform. Perhaps the discussion section could be named something like “Inertial sensors as a clinical tool” or “IMUs as part of clinical implementations” with a shorter discussion on how IMU:s could be used as a clinical tool. (But I don’t think your study analyse any of this as you have no patient measurements, so a few sentences would be enough).

- Reply 17a: We agree with this comment. We have moved the citation of Muir et al.’s study to the introduction to show that current clinical practice involves the use of goniometers, which has shown to have a MCD of 22 degrees in shoulder RoM testing (lines 73-75).
- Changes to text (a): The current practice is to measure shoulder RoM using a goniometer, which has been shown to have a minimal clinical difference of 22° compared to the gold standard (7).
- Reply 17b: We have changed the main point of this section to discuss the benefits of IMU in the setting of remote rehabilitation, especially in view of the COVID-19 pandemic which has disrupted a lot of in-person patient interaction. We have also added additional points on how IMUs provide the possibility of real-time data acquisition which can have applications in disease treatment (line 262-271).
- Changes in text (b): It is simple to envision the application of IMUs as a data-logging tool to collect information on joint kinematics. The recorded information can be used to monitor activities and symptoms of disease progression, or in recent literature has been used to train machine learning algorithms to classify episodes of epilepsy or analyse activities of stroke patients. However, another major advantage of IMUs is its ability to provide real-time information concurrent to IMU signal acquisition. This opens the possibility of treating a disease in addition to symptom monitoring using previously captured data. For example, inertial devices have been used in detection and correction of gait abnormalities in various patient groups such as Parkinson’s disease and drop foot syndrome (19,20). We hope that IMUs may be implemented in a similar fashion during rehabilitation to treat musculoskeletal pathologies.

• **Comment 18:** Row 259: explain” Furthermore, due to voluntary nature of participation in our study, we were only able to obtain healthy, male participants.” Please rephrase. Are not female or patients able to participate voluntarily?

- Reply 18: While the participation in this study was opened to all students in the university, only male participants had volunteered at the end of the recruitment period. Therefore, we were unable to analyse any data from female participants. We have rephrased this sentence as suggested by the reviewer (Lines 275-277).
- Changes to text: Furthermore, all participants who volunteered for our study were males. Hence, we were unable to gather any data in the female population.

• **Comment 19:** Figure 4: The Bland-Altman plots should be better explained; Average between measurements on the x-axis; I suggest instead “mean shoulder angle (°). y axis I suggest “Error in shoulder angle (°)” (I suppose you define the optical system as gold standard, so the difference is defined as an error). Also, write out what the red lines stands for.

- Reply 19: Additional explanation for the Bland Altman analysis has been included in the methods section (see comment 12). We have edited the X-axis and Y-axis labels as suggested by the reviewer. We have included an explanation in the caption for the dashed red lines.
- Changes in text: Figure 4 - Regression analysis describing the correlation of measurements for shoulder joint angles between inertial measurement unit (IMU) and optical motion capture (OMC) systems for flexion (A), extension (C), external rotation (E), and abduction (G). Bland-Altman plots demonstrating the difference for joint angles between IMU and OMC system for flexion (B), extension (D), external rotation (F) and abduction (H). The dashed red lines represent the 95% limits of agreement corresponding to 2 standard deviations of the mean difference.

Reviewer B

General comments

The authors conducted a validation study to assess accuracy of a commercially available inertial measurement unit (IMU) for assessment of shoulder movements by comparing with an optical motion capture (OMC).

Healthy young men were fitted with both methods and instructed to move their shoulder joints in four directions, collecting data simultaneously.

Based on the errors between the two methods, the authors concluded that the IMU measurements were acceptable and the results are expected to be used in tele-rehabilitation.

I think this study has potential and novelty in that it adapts the IMU to measure shoulder joint which is difficult joint to evaluate.

However, I recommend that this paper is not enough to be accepted without major revision.

Major comments

Comment 20: There is a lack of description of the method for the measurement of IMU, which is the main measurement of this paper (line 130-138). While OMC method is explained in detail, the authors only mentioned that "quaternion data from the IMU is used to estimate shoulder RoM". However, it would be better to show how you calculated the angle from the quaternion data. If you have software that calculates the angle, you need to provide it.

- Reply 20: We acknowledge that more information could be provided on how joint angles were calculated from quaternion data collected by the IMU. However, due to the proprietary nature of the software algorithm by XCLR8 Technologies Private Limited, we are unable to disclose the calculations to the public. No edits therefore have been made to the text to address this comment.
- Changes to text: NA

Comment 21: Please provide the reason for IMU fixed position on the forearm instead of the upper arm. I understand that one of the reasons is for measuring external rotation. However, in that fixed position, there are concerns of forearm rotation and elbow angle which is not always straight in the extended position.

- Reply 21: We have elaborated on the limitations of forearm positioning in which forearm rotation and elbow angles may affect accuracy of measurements. We have explained our main motivating factors for choosing the forearm, to make it an easy location for patients with limited mobility to access and wear the device on their own. We have also explained why we did not use multiple locations for the IMU sensor, as we wanted to limit the number of times patients had to relocate the sensor when they were performing their rehabilitation. We have moved the discussion of forearm positioning from limitations to “validity of IMU” section in reference to current literature. These changes are now reflected from lines 208-214.

- Changes to text: However, fixation on the forearm comes with concerns of misalignment of the IMU sensor and anatomical axes during RoM assessment due to forearm rotation and elbow angle (15). Despite these limitations, we chose to place the sensor on the forearm to accentuate ease of use for the patient. The IMU and Rebee application interface is designed for patients with limited mobility, and it was important to choose a location that was easy for patients to wear independently while limiting the number of times they must relocate the sensor during rehabilitation.

Comment 22: Please provide the reason why the measuring angle range was limited to 90.
In the rehabilitation settings, more than 90 would be required. If the calculation becomes difficult, for example, I recommend mentioning it in the paper.

- Reply 22: We have addressed this comment by including the reasons for choosing 90 degrees as the maximum RoM measured in this paper (lines 140-143). We acknowledge that rehabilitation settings would require RoM testing greater than 90 deg. However, as the intention of this study was to validate the accuracy of this IMU system and obtain preliminary data for the device, we wanted to obtain data that would be comparable among all patient populations regardless of various shoulder pathologies. Therefore, 90 degrees was chosen as a standardized range that most clinical patients were expected to achieve. This includes certain post-operative patients, which may not be able to perform RoM past 90 degrees in the perioperative period due to restrictions. We would like to clarify that the IMU device can measure more than 90 degrees of RoM, but the study protocol we had designed for this manuscript is such that we measured RoM up till 90 degrees.
- Changes in text: The IMUs were validated for four active movements– 90° flexion, extension, external rotation, and 90° abduction (Figure 3). In our study protocol, we chose 90° as a standardised range that most clinical patients would be expected to achieve. For example, certain post-operative patients may not be able to perform RoM past 90° in the perioperative period.

Comment 23: The result that high measurement accuracy was obtained with only one sensor is remarkable. However, the accuracy would be obtained with patient’s trunk vertical under precise guidance by examiner, which may be difficult in a patient-alone situation such as remote rehabilitation. Therefore, there seems to be a bit leap to conclude that this “one IMU method” can be used for remote rehabilitation.

- Reply 23: We agree that the use of one IMU may affect accuracy in clinical implementation. However, we are focused on the ease of use of the system for application in remote rehabilitation. We want to develop an IMU system that is convenient for patients to encourage compliance. Perhaps future comparative studies between a one- and two-IMU system for significant differences may serve to conclude if greater number of IMUs will lead to meaningful clinical differences in RoM measurements. Initially, this discussion was mentioned briefly as a point in the limitations section. However, we have now moved this discussion to the segment on "Validity of IMU" and discussed the one IMU system with reference to current literature. These changes are reflected in lines 234-238.

- Changes in text: While we recognise that using more IMUs to estimate joint angles will lead to greater accuracy, this comes at the expense of ease of use which decreases the usability and compliance of the system for application in remote rehabilitation. Further research can be conducted comparing the use of one versus two IMU sensors for any significant differences in RoM measurements.

Comment 24: Lines 194-202. "There were statistically significant differences in measurements for flexion (p= 0.027) and abduction ($p < 0.001$). Firstly, we attribute these inaccuracies to shifts in sensor position during shoulder RoM testing. ... This suggests the larger magnitudes of joint movement could contribute towards IMU measurement error. These errors may be reduced with better fixation of the IMU to prevent movement during RoM testing." I think it is a bit logically invalid to think that the difference caused by large movement is due to the sensor shifting. Please add a more detailed discussion of this, citing previous reports. In addition, it would be better if the authors present additional validation with different fixation methods if possible. Or are there any other causes? For example, IMU-specific sources of error, such as drift.

- Reply 24: We have removed our initial discussion attributing IMU measurement error to sensor shifting. Upon further discussion among the authors, we attribute these errors which were exacerbated by larger RoM to the rotation of the sensor on two different axes during joint motion. With larger movements, the center line of the sensor shifts more resulting in greater degree of error. This concept is illustrated in an example from lines 194-199.
- Changes in text: here were statistically significant differences in measurements for flexion ($p = 0.027$) and abduction ($p < 0.001$). These inaccuracies may be due to rotation of the IMU sensor on two different axes. For example, if shoulder abduction is taken as the x-axis, and wrist rotation is taken as the y-axis, larger RoM shifts the central line of the sensor higher along the x-axis. Therefore, this source of error is exacerbated by greater magnitudes of joint motion as observed in our study. In contrast, smaller measurement errors were likely observed during external rotation and extension as they were statistically insignificant.

Minor comments

Comment 25: Lines 73-74. "The XCLR8 IMU (XCLR8 Technologies Private Limited, Singapore) consists of a gyroscope, accelerometer, and magnetometer to assess motion." I think it would be better to explain the details of the device in the "Methods" part.
Putting the details into this part of the introduction seems somewhat abrupt.

- Reply 25: This comment is similar to that suggested by reviewer A (see comment 3). We agree that the information is better placed in the Methods section and have moved this sentence.
- Changes in text: NA

Comment 26: Figure 3. In D, "side-view" is not side-view.

- Reply 26: We apologise for the mistake in labelling. We have amended Figure 3 to reflect the correct label.
- Changes in text: NA

Comment 27: Figure 3. In this paper, one IMU sensor was fixed on the forearm. However, the images show there is another sensor (or black strap?) on the upper arm, making the readers think two sensors are being used.

- Reply 27: We apologise for the confusion arising from Figure 3. While we are unable to take new images, we have attempted to censor and block out the additional Velcro strap.
- Changes in text: NA

Comment 28: "Shapiro-Wilk test was performed to check for normality of data." The result for this test is not mentioned in the results.

- Reply 28: We have described the results of the test for normality in the results section (lines 173-175).
- Changes in text: Shapiro-Wilk test revealed that the distribution of data was not significantly different from the normal distribution ($p > 0.05$) and normality of our study population was assumed.

Comment 29: Table2 and Fig4. There are descriptions and graphs of correlations between two methods, but they are not mentioned for that in the methods. Please add an explanation for evaluating correlations in the methods part.

- Reply 29: We have elaborated on the evaluation of correlations in our methods section in lines 169-171.
- Changes in text: The relationship between kinematic data collected by the OMC and IMU systems were analysed by a linear regression, where the slope of the regression line and the coefficient of determination (R^2) were calculated.

Reviewer C

Currently, the COVID-19 pandemic has made it a hindrance to the diagnosis and treatment efforts between clinicians and patients. Therefore, remote rehabilitation has become an important way for patients. This article compares data for joint angles between OMC systems and IMU systems. The IMU can be operated independently by the patient, and its experimental results seem to be within a reasonable range.

Comment 30: This experiment lacks novelty, and similar work has been done in the existing literature, and it is recommended that the contribution described in this paper be more specific.

- Reply 30: We recognize that there are several validation studies for the use of IMU systems in the upper limb. However, the aim of our study was to validate this IMU system by XCLR8 technologies which has not been performed before. Furthermore, there are few studies in current literature who have performed a validation study among healthy individuals in the general population. Majority of studies have evaluated its use in the athletic population (Rawashdeh SA, Rafeldt DA, Uhl TL. Wearable IMU for Shoulder Injury Prevention in Overhead Sports. Sensors (Basel). 2016;16(11):1847. Published 2016 Nov 3. doi:10.3390/s16111847; Pedro B, Cabral S, Veloso AP. Concurrent validity of an inertial measurement system in tennis forehand drive. J Biomech. 2021;121:110410. doi:10.1016/j.jbiomech.2021.110410) or in populations with comorbidities that could affect shoulder motion (Bravi R, Caputo S, Jayousi S, et al. An Inertial Measurement Unit-Based Wireless System for Shoulder Motion Assessment in Patients with Cervical Spinal Cord Injury: A Validation Pilot Study in a Clinical Setting. Sensors (Basel). 2021;21(4):1057. Published 2021 Feb 4. doi:10.3390/s21041057). In addition, the results from our study act to support findings from previous research. As the study of kinematics using inertial measurement units is still an up and coming area, we believe that our study augments the current literature.
- Changes in text: NA

Comment 31: It is recommended to add an experimental flowchart so that the reader has a clearer understanding of the OMC system and IMU experimental steps.

- Reply 31: We have created an experimental flowchart as suggested by the reviewer. This can be found as Figure 5, referenced in lines 154-155.
- Changes in text: A flowchart summarising the experimental workflow described in this section can be found in Figure 5.

Comment 32: The experiment should be based on each age group and gender as the test object, generally speaking, the swing angle of young children is small, so can the error rate of the angle be accurate less than 8 degrees?

- Reply 32: We thank the reviewer for this comment and highlighting that while this error rate is acceptable in the adult population, it might not be the case when used in the paediatric population as the swing angle is smaller which will result in the overall percentage error being larger. While this is worthy to take note for developing or using the same IMU system in this younger population, the main aim of our study was to validate this system based on normal range of motion of an adult. However, we have highlighted to readers to be careful in applying our conclusions from this study in other age groups and genders (lines 278-280).

- Changes to text: NA