

Psychometric Properties of a Smartphone Application for Measuring Shoulder Active Range of Motion in Individuals with and without Shoulder Pain and Mobility Deficits [Response to the Letter]

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Dear editor

We sincerely thank Goyal K, Goyal M, and Bathla M for their interest in our article and welcome the opportunity to clarify the methodological choices made in our study.

1. ICC Model Selection: In our reliability analysis, we utilized a two-way random-effects model, absolute agreement, single-rater type, commonly denoted as ICC (2,1). This specific model was selected because our study utilized multiple raters (Raters 1, 2, and 3) to evaluate the participants. By applying a two-way random model, we treat these raters as a representative sample of the broader clinical workforce, ensuring that our inter-rater and intra-rater reliability findings are highly generalizable to other clinicians in similar professional settings. Furthermore, the single-rater type was chosen to reflect standard clinical practice, where a patient is typically evaluated by a single physiotherapist.¹

2. Criterion Validity and Agreement: Our assessment of criterion validity was not limited to association. As demonstrated in the manuscript, we utilized Bland–Altman analysis as the primary method to evaluate the level of agreement and identify potential systematic bias between the smartphone application and the universal goniometer. Methodological experts emphasize that simple correlation can be highly misleading in agreement studies, as it measures the strength of a relationship rather than the agreement between two clinical methods.²

3. Intra-rater Reliability Interval: The decision to assess intra-rater reliability within a short time interval was a deliberate design choice to isolate the instrument's stability while minimizing the confounding effects of biological variability and pain fluctuations inherent in symptomatic populations. In clinical measurement research, a short interval is often preferred to ensure the underlying trait being measured remains stable, thereby preventing “true change” from being misidentified as “measurement error”.³

4. Addressing Baseline Confounders: While differences in age and BMI were observed between groups, our study employed a paired-comparison design where each participant served as their own control. In this design, individual characteristics like BMI and age remain constant across both measurement methods, effectively neutralizing their impact on the internal validity of the comparison between the two tools. This within-subject approach is the standard for assessing the degree of agreement between two different instruments.⁴

5. Sampling and Generalizability: Convenience sampling was used as an efficient and practical strategy to establish the primary psychometric properties of this technology in the demographic most frequently seeking rehabilitation for shoulder mobility deficits. While we targeted the 20–50 age range to provide a robust foundation for this active



population, the use of non-probability samples is a valid and widely accepted starting point for psychometric validation before progressing to broader, stratified populations.⁵

Disclosure

The authors report no conflicts of interest in this communication.

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