

## Article

Nicholson VP, Spathis JG, Hogarth LW, et al. (2018). Establishing the reliability of a novel battery of range of motion tests to enable evidence-based classification in Para Swimming. *Phys Ther Sport*, 32, 34-41. <https://doi.org/10.1016/j.ptsp.2018.04.021>.

## Adaptive Sports/Recreation Topic Categories

- Classification.
- Impaired range of motion or movement.
- Para swimming.

## Research Question

- For a novel range of movement (ROM) battery of tests specific to swimming, what are the:
  - Intra-examiner and inter-examiner reliability of each novel ROM measure in non-disabled participants?
  - Preliminary normative values in non-disabled participants and a group of trained Para swimmers?
  - Differences in the novel ROM battery outcomes between non-disabled participants and Para swimmers?

## Methodology

- Participants: 42 non-disabled participants and 24 elite Para swimmers
  - Non-disabled participants were from two Australian universities and were physically active, injury-free, and engaged in at least 90 minutes of moderate physical activity per week.
  - Para swimmers were from England, Spain, Italy, and Czech Republic and nationally or internationally classified (classes S1-S8), undertaking planned training regimes, and competing at national or international level. Para swimmers' conditions that led to impaired ROM included spinal cord injury (SCI), polio, cerebral palsy (CP) or acquired brain injury (ABI).
    - Categorized into 2 subgroups:
      - Hypertonia secondary to CP or ABI (n=11).
      - Impaired muscle power secondary to SCI or polio (n=13).
- ROM testing:
  - Active ROM assessed via battery of 10 tests designed to measure the below joint motions relevant to S-class swimming events (freestyle, backstroke, and butterfly strokes). Supplementary Table 1 provides detailed descriptions of all tests.
    - Bilateral shoulder flexion (streamline).
    - Bilateral shoulder abduction (streamline).
    - Elbow flexion and extension.
    - Lower limb streamline (hip, knee, and ankle extension).
    - Hip and knee flexion.
    - Shoulder internal and external rotation.
    - Prone shoulder extension (in elbow flexion and extension).
    - Prone shoulder horizontal abduction.
    - Prone shoulder flexion.
    - Trunk functional reach (forward, backward, sideways).
  - Conducted with an Acumar Digital Inclinometer. Universal goniometer also used to compare reliability and ease of administration for elbow flexion and

- extension. Supported fixed tape measure used for trunk functional reach measures.
- Anatomical landmarks were used for consistency of inclinometer placement.
- Test-retest intra- and inter-examiner reliability of ROM:
  - Measures from 42 non-disabled participants served as preliminary normative values.
  - Intra-examiner reliability: 15 non-disabled participants.
    - Each participant completed two 1-hour testing sessions, during which the same examiner evaluated them on both occasions following a standardized order for joints tested, with at least 1 day between testing sessions. Average results from two trials of each test used for analysis.
  - Inter-examiner reliability testing: 16 non-disabled participants.
    - Each participant completed a single 2-hour testing session during which 2 examiners tested each participant individually following a standardized order of joints tested. Each participant was tested independently by 2 examiners for all ROM tests within a single session. Average results from two trials of each test used for analysis.
- ROM testing performed on Para swimmers during one occasion.
- Primary outcome measures: Intra- and inter-examiner reliability of a battery of novel active range of motion tests; ROM of joints (degrees).
- Secondary outcome measures: Demographics, training history (number and types of sessions per week), and injury history gathered from baseline questionnaire; anthropometric measures (standing height, body mass, body mass index).

## Results

- Intra-examiner reliability:
  - Each test session separated by average of 4.1 days. Majority of tests (31/34) produced good to excellent (>0.75) intra-class coefficient (ICC) absolute agreement values except for 3 ROM tests that had moderate reliability.
  - No significant differences between sessions for any measures except for 3 out of the 34 joint ROM tests (2 performed with goniometer, 1 with inclinometer).
- Inter-examiner reliability:
  - 35 of the 42 tests had good to excellent (>0.75) ICC absolute agreement values. 6 measures had moderate reliability and 1 measure had poor reliability.
  - Significant differences between examiners for 9 out of 42 joint ROM tests (5 performed with goniometer, 4 with inclinometer).
- Preliminary normative values:
  - Listed in Table 4 of original article.
  - Significant differences between non-disabled participants and Para swimmers for majority of ROM tests.
  - Significant differences between Para swimmers with hypertonia vs. impaired muscle power for certain measures at the trunk, hip, and knee.

## Discussion/Conclusion

- Majority of active ROM assessments were reliable in non-disabled participants.
- Para swimmers had significantly less ROM than non-disabled participants.
- Majority of tests that did not achieve good to excellent reliability in the test battery were measured using a goniometer, with some of the tests achieving increased reliability when using an inclinometer.

### **Article Strengths**

- Provides support for a more precise and comprehensive evidence-based model of assessing active ROM during Para swimming classification that is theoretically more functionally relevant than the current system of evaluating passive ROM.
  - This new model is still inexpensive and possibly more easily administered.
- Good to excellent levels of reliability in active ROM measures in non-disabled participants sets the foundation for further studies on reliability of these measures in Para swimmers.
- Study demonstrated that test can be feasibly performed even by those in the most severely impacted classification class (S1).

### **Article Weaknesses**

- Small sample size.
- Did not assess inter- and intra-examiner reliability of testing in the Para swimming population.
- Study did not mention that non-disabled participants had to be swimmers. This is a limitation as swimmers even without disabilities could possibly have different ROM characteristics than non-swimmers.
- Para swimmers with impaired ROM were all of neurologic diagnoses and did not include non-neurologic diagnoses that could lead to impaired ROM, such as arthrogryposis or achondroplasia. Thus, difficult to generalize this study to all Para swimmers with impaired ROM as those with non-neurologic diagnoses may have different functional manifestations of their impaired ROM.
- Study did not address situations in which Para swimmers with neurologic diagnoses could have variable active ROM depending on environmental factors such as climate/temperature, stress, etc (e.g. hypertonia could be increased in colder temperatures leading to decreased ROM) and how this would be factored into this novel test for classification.
  - There was also no discussion on Para swimmers' current treatments (e.g. anti-spasmodic medications for hypertonia) and if these factors were considered when evaluating participants.
- Inclinometer measurements of knee flexion and elbow ROM were only included for inter-examiner reliability testing.
- Para swimmers did not complete all ROM tests (i.e. supported prone position assessments of shoulder ROM) due to data collection occurring during training camps that had time constraints and limited personnel.
- Study focused on ROM relevant to S-class (classification for freestyle, backstroke, and breaststroke) only and further studies needed for SB-class (classification for breaststroke).
- Study did not compare novel active ROM results to current passive ROM system or evaluate Para swimmers sports performance and times. Further research needed to evaluate how this novel active ROM test would change the classification results for those with impaired ROM.
- Study did not provide a good explanation as to why there were significant side-to-side differences in reliability of ROM measurements. This needs to be further investigated to improve this new potential classification model for evaluating Para swimmers with impaired ROM.

### **Take Home Messages**

- The novel ROM tests assessed for this study provides great potential for a more precise and comprehensive evidence-based model of assessing active ROM during Para swimming classification that is theoretically more functional-based than the current system of evaluating passive ROM.
  - This new model is still inexpensive and possibly more easily administered.
- Most tests have good to excellent inter- and intra-examiner reliability, especially when using an inclinometer, but further research is needed to improve the reliability for all tests and also to evaluate the reliability of testing in Para swimmers, inclusive of Para swimmers with impaired ROM from non-neurologic diagnoses.
- This study establishes preliminary normative ROM values for both non-disabled participants and Para swimmers, but further research is needed in comparing non-disabled swimmers to Para swimmers and also in how this test relates to swimming function and performance, impacts Para swimming classification, and compares to the current classification system for impaired ROM.