Validity and reliability of wrist sensor-based measures of the arm swing during free-living gait in Parkinson's disease

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Introduction

- Reduced arm swing is an early and progressive motor sign in Parkinson's Disease (PD), making it a potential digital biomarker.
- Reliable estimations of arm swing can therefore serve as endpoints in clinical trials, facilitating the evaluation of disease progression and therapeutic effects.
- Building on this potential, our study longitudinally validates a previously developed modular pipeline for detecting gait and measuring arm swing in free-living conditions.

Objective

- To evaluate the (1) construct validity, (2) reliability, and (3) sensitivity to disease progression of the median and 95th percentile arm swing range of motion in a larger, longitudinally observed free-living PD cohort.

Study design

- **Population**: 256 ambulatory early-stage PD participants, Hoehn & Yahr stages 1-3 (9% in stage 1, 81% in stage 2, and 10% in stage 3).
- **Data**: continuous smartwatch recordings (median 21 hours/day) from participants' preferred wrist over two consecutive weeks at the start of the study, and one week approximately two years later[1].

Methods

For participants wearing the watch on the most affected side (MAS) or the least affected side (LAS), we assess:

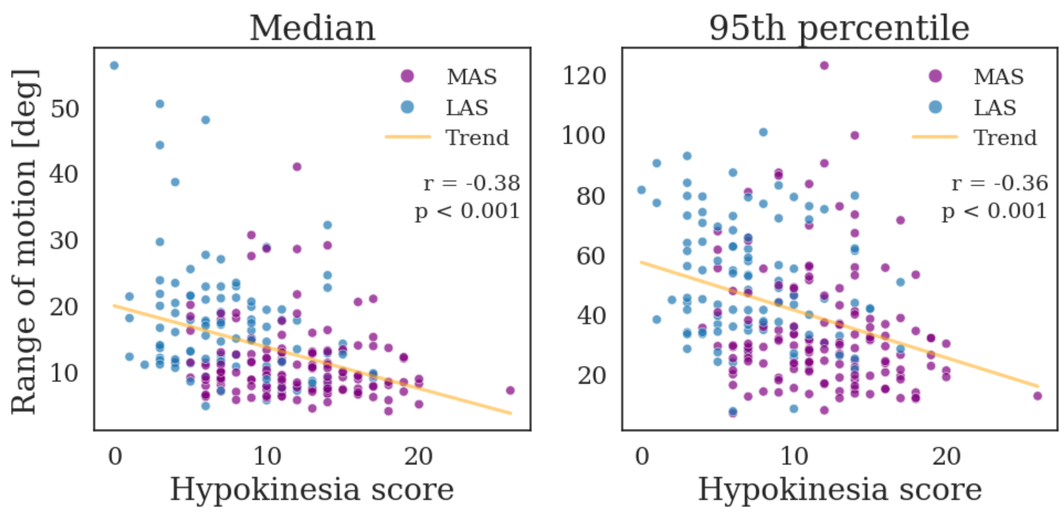
1. Construct validity: correlation with the sum of unilateral non-tremor items of the MDS-UPDRS part III (hypokinesia score).

2. Test-retest reliability: intra-class correlation between two consecutive weeks.

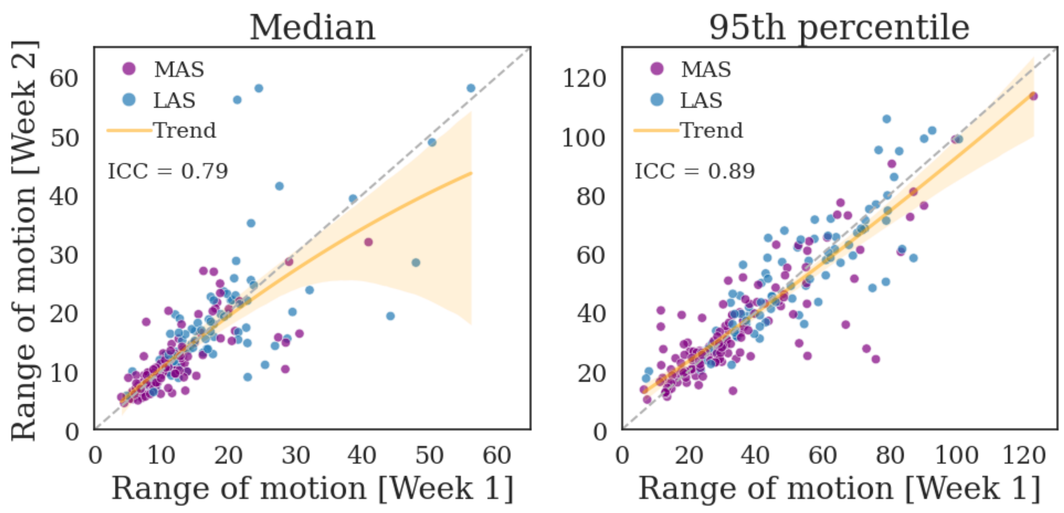
3. Sensitivity to disease progression: absolute progression and standardized response mean (SRM) over two years.

Results

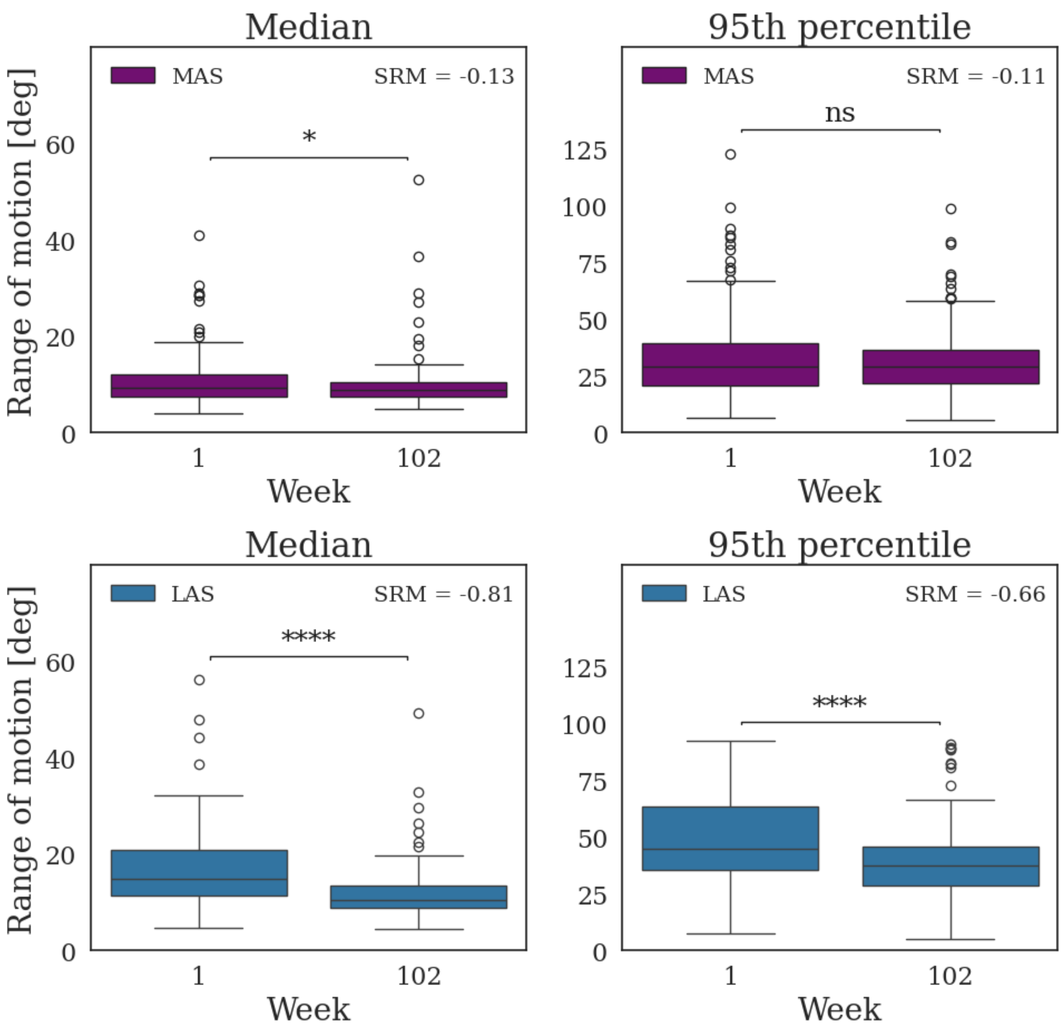
1. Construct validity



2. Test-retest reliability



3. Sensitivity to disease progression



Conclusions

- Both arm swing measures **correlate with clinical observations**, **demonstrate high reliability**, and **are sensitive to disease progression**.
- Participants wearing the watch on their **least affected side** exhibited a **greater range of motion** at baseline and a **more pronounced reduction** over a two-year period.

References

1. Bloem et al. The Personalized Parkinson Project: examining disease progression through broad biomarkers in early Parkinson's disease. BMC Neurol. 2019 Jul 17;19(1):160.

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