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Free-living arm swing range of motion as a digital progression marker of Parkinson's disease

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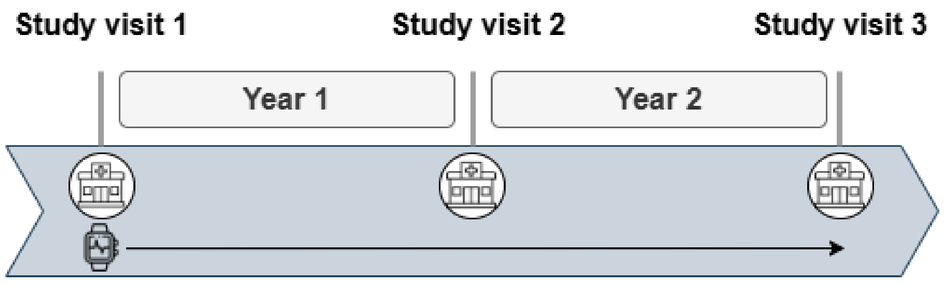
Introduction

- Reduced arm swing during gait is an early and progressive motor sign of Parkinson's Disease (PD), making it a promising marker for disease progression and treatment response.
- Wrist sensors can be used to reliably measure the arm swing range of motion in daily life[1].
- This study evaluates the sensitivity to disease progression of such measures in a large, longitudinal free-living PD cohort.

Study design



- 320 early-stage ambulatory PD participants wore a wrist sensor on their preferred side continuously (median 21 hours/day) for at least 2 years in free-living conditions in the Personalized Parkinson Project[3].
- Participants either used dopaminergic medication (*medicated*) or not (*unmedicated*) during the study; those who initiated treatment were excluded.

Table 1: Number of participants per stratification

	Medicated	Unmedicated
Most affected side	184	18
Least affected side	113	5

- The weekly (1) median and (2) 95th percentile range of motion (RoM) were derived from accelerometer and gyroscope data using the Parkinson's disease Digital Markers (*ParaDigMa*) toolbox[2].

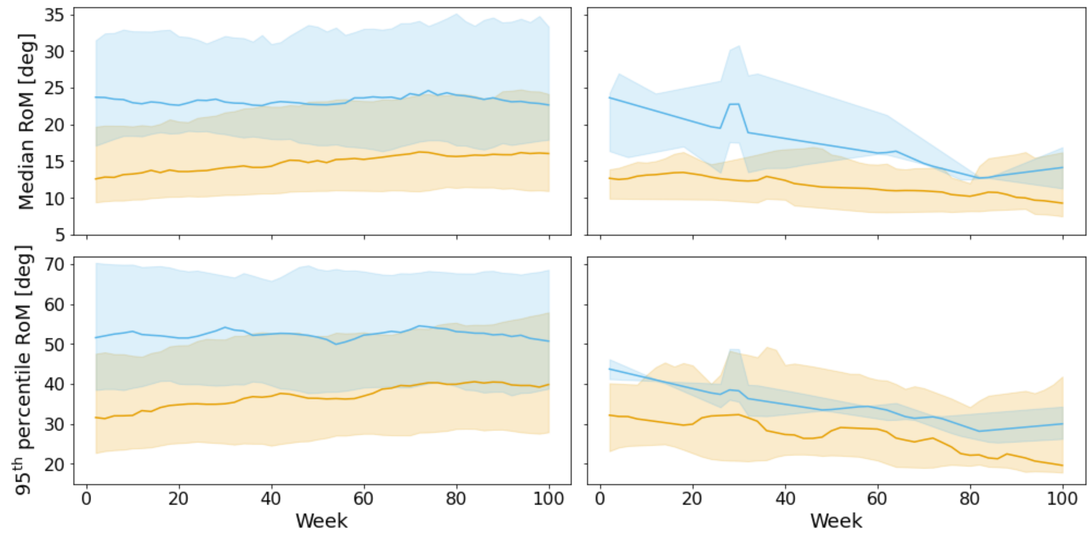
Methodology

- Bootstrapped two year standardized response mean (SRM) with 95% CI to assess sensitivity to progression.
- Comparison with the sum of MDS-UPDRS Part III unilateral non-tremor items (subscore).
- Ordinary least squares (OLS) regression to examine the impact of clinical covariates on observed changes.

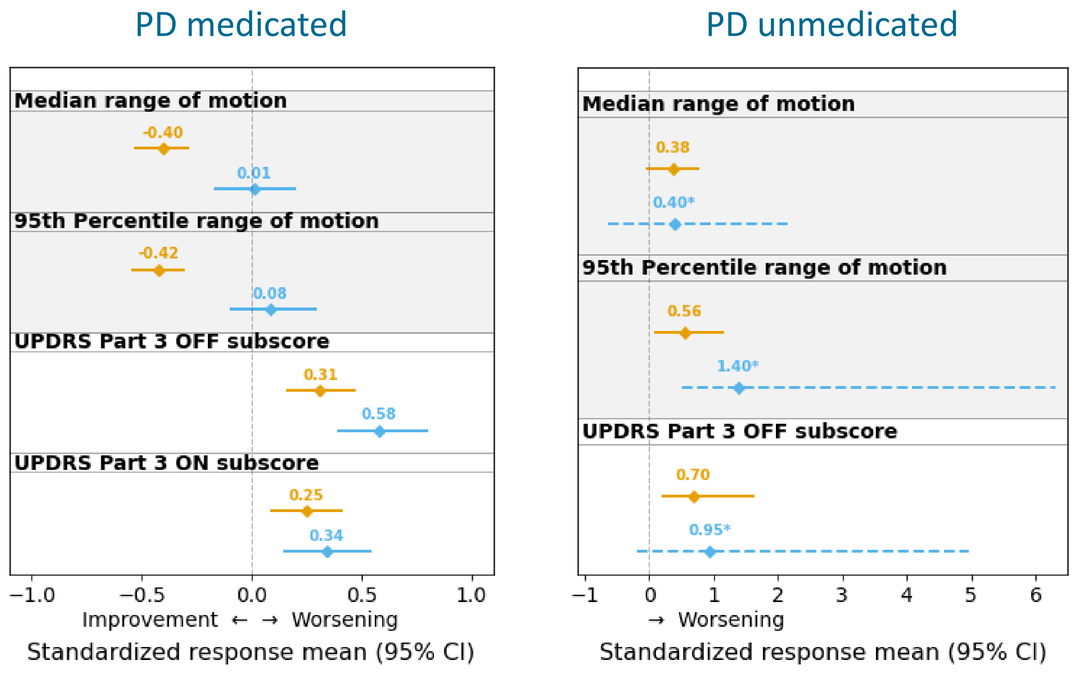
Results

Most affected side — Least affected side

1. Digital measures over time (median, IQR)

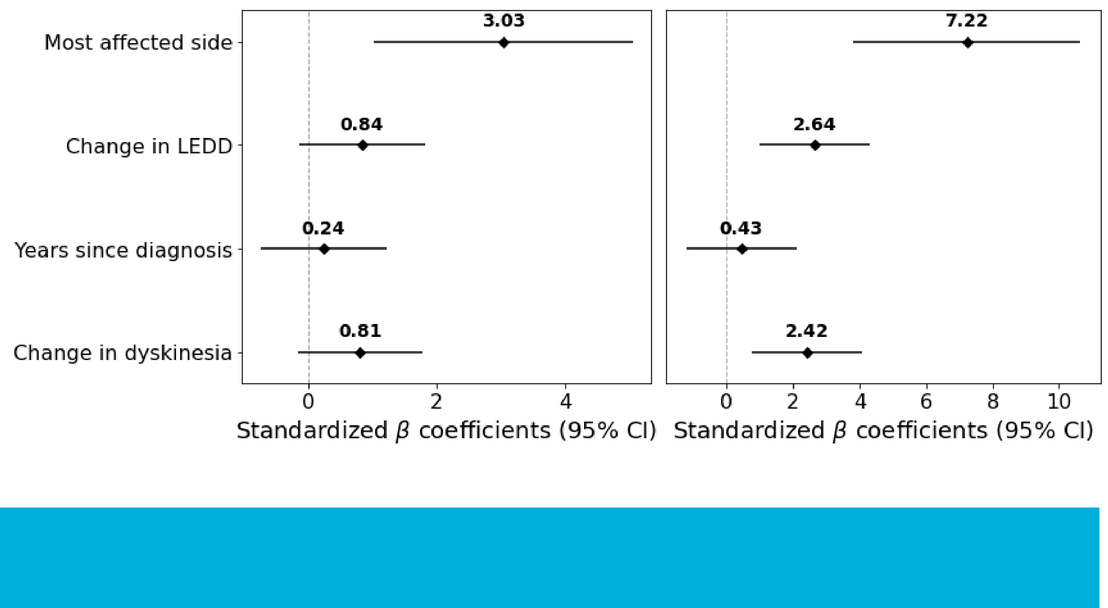


2. Sensitivity to two-year progression



* Results of unmedicated participants wearing the watch on the least affected side (N = 5) are shown with dashed lines due to unreliable (bootstrapping) results when having a small number of participants.

3. Effect of clinical covariates on change



Conclusions

- Digital measures capture progression of arm swing impairment, but this signal is masked by dopaminergic treatment.
- In unmedicated patients, digital arm swing metrics demonstrate sensitivity to progression comparable to the MDS-UPDRS Part III unilateral non-tremor score of the most affected side.

References

1. Post et al. Quantifying arm swing in Parkinson's disease: a method accounting for arm activities during free-living gait. J NeuroEngineering Rehabil 22, 37 (2025).
2. Post et al. ParaDigMa: A toolbox for deriving Parkinson's disease Digital Markers from real-life wrist sensor data (v1.0.0). Zenodo.
3. 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.

Acknowledgements

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