How Secure Is Your Gait Today? Understanding Gait Security Through Digital Mobility Outcomes

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Gait security influences quality of life in people with Parkinsonian disorders [1], yet its assessment remains challenging. Patient-reported outcome measures provide subjective insight [2], while digital mobility outcomes (DMOs) [3] provide objective information on mobility.

The aim of this study was to model patient self-reported gait security using DMOs.

Home-monitoring data from the Luxembourg subcohort of the MobilityAPP study (IRB 202207/04) were analyzed. Participants reported daily perceived gait security using a 3-level scale, while their mobility was continuously tracked using wearable sensors. A DMOs processing pipeline was developed by integrating stride parameters from established algorithms [4] with free-living aggregation techniques identified from literature [5].

A total of 83 days of home-monitoring from 12 participants (4 with atypical parkinsonism and 8 with Parkinson's disease) were analyzed.

The feature selection process, based on a nested patient-grouped Elastic Net regression, identified 8 relevant predictors for self-reported gait security; representing stride characteristics, mobility patterns, and adherence. Hierarchical Bayesian ordinal mixed-effects models were trained and tested on all the 28 possible combinations made of 6 out of these 8 features. Predictive performance was assessed using leave-one-day-out (LODO) validation. All models met convergence and Pareto criteria.

Fixed-effect analyses of the best equivalent models identified 6 DMOs associated with self-reported gait security. LODO validation of a representative best-performing model correctly predicted 67 of 83 daily observations.

Ultimately, perceived gait security appears to reflect multiple complementary dimensions of mobility. The Bayesian approach enabled the characterization of both population-level and

personalized associations between gait security and DMOs, supporting its potential for individualized intervention targeting.

References

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Biosketch

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Boschi, F.; Sapienza, S.; Ibrahim, A.A.; Sonner, M.; Winkler, J.; Eskofier, B.; Gaßner, H.; Klucken, J. Sensor-Derived Parameters from Standardized Walking Tasks Can Support the Identification of Patients with Parkinson's Disease at Risk of Gait Deterioration. Bioengineering 2026, 13, 130. https://doi.org/10.3390/bioengineering13020130

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