Assessing the accuracy of DHT-derived gait measures in amyotrophic lateral sclerosis – an analytical validation study

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Introduction

- **Amyotrophic lateral sclerosis (ALS)** is a neurodegenerative disease that is associated with the death of upper and lower motor neurons, resulting in the progressive worsening of muscle weakness and wasting that significantly affects movement, speech and respiratory function.
- **Quantification of gait**, an essential component for understanding ALS progression as well as intervention outcomes, is usually performed by subjective clinical evaluations or burdensome physical function assessments.
- **Wearable digital health technologies (DHTs)** can reduce the patient burden of in-clinic assessments and provide objective and sensitive continuous data to quantify real-world behavior.

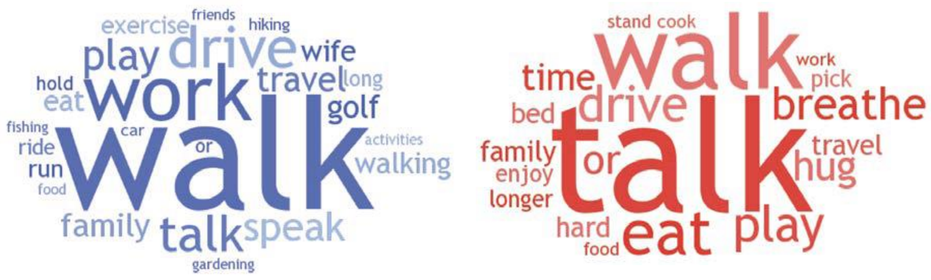


Fig. 1. The Voice of the Patient, ALS drug dev survey, the ALS association, Oct, 2019.
A. Patients' response, **B**. Caregivers' response

Objective

To evaluate the accuracy of DHT-derived measures of gait in people living with ALS.

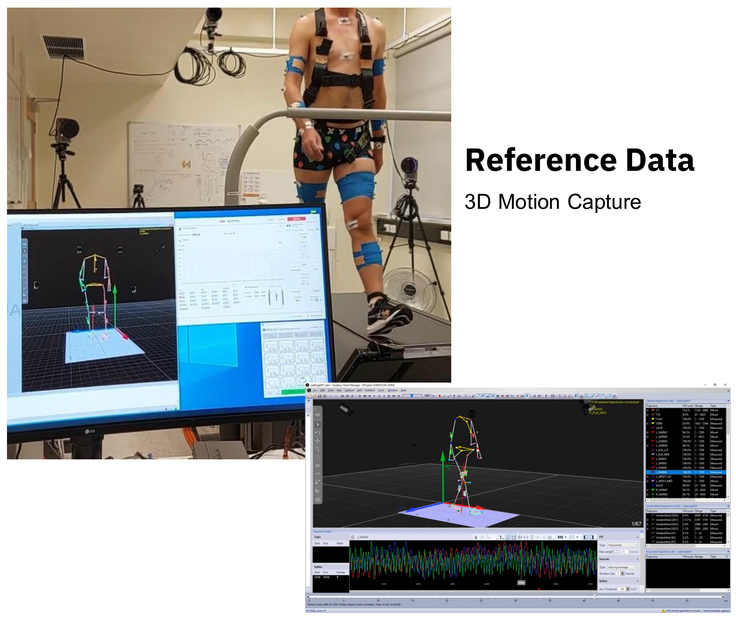
Methods

Setting: Laboratory-based gait analysis
Device: GT9X (ActiGraph, L.L.C. , Pensacola, FL)
Procedure:

- GT9X activity monitors were placed on wrists, lumbar (L4-L5), and ankles
- Accelerometer and gyroscope data were continuously recorded at 100 Hz.
- Segments of 1-min walk on the treadmill were recorded and used for validation

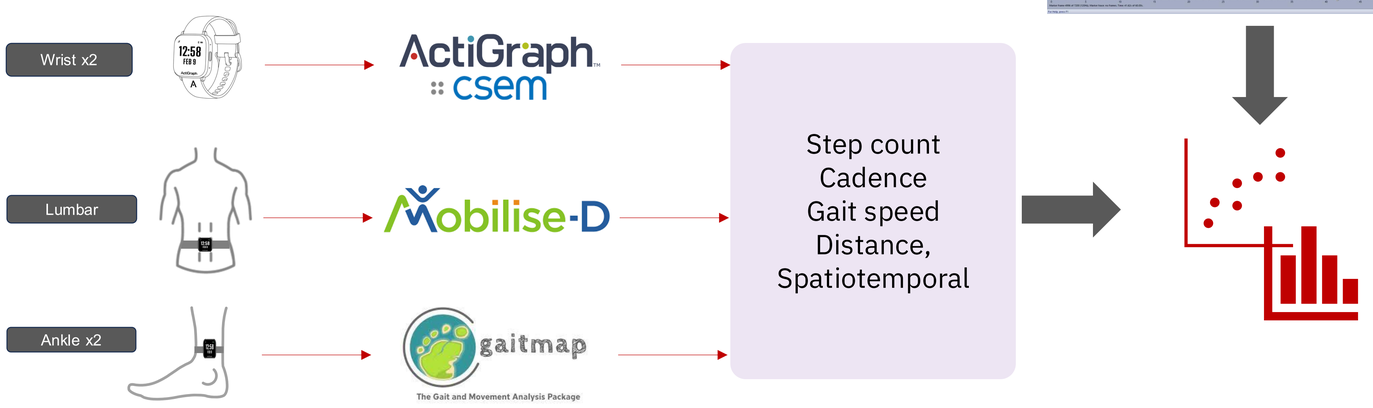
Table 1. Participant demographics

Condition	n	age (years)	height (cm)	weight (kg)	sex
ALS	9	59.67 (15.2)	180.44 (12.8)	88.06 (18.85)	7 m, 2 f
Control	9	52(9.2)	175.67 (4.7)	83.67 (15.4)	5 m, 4 f



Reference Data
3D Motion Capture

Data processing and outcome measures



Results

Fig. 2. Scatter plots and Bland-Altman analysis showing agreement between WRIST-derived digital measures and reference values

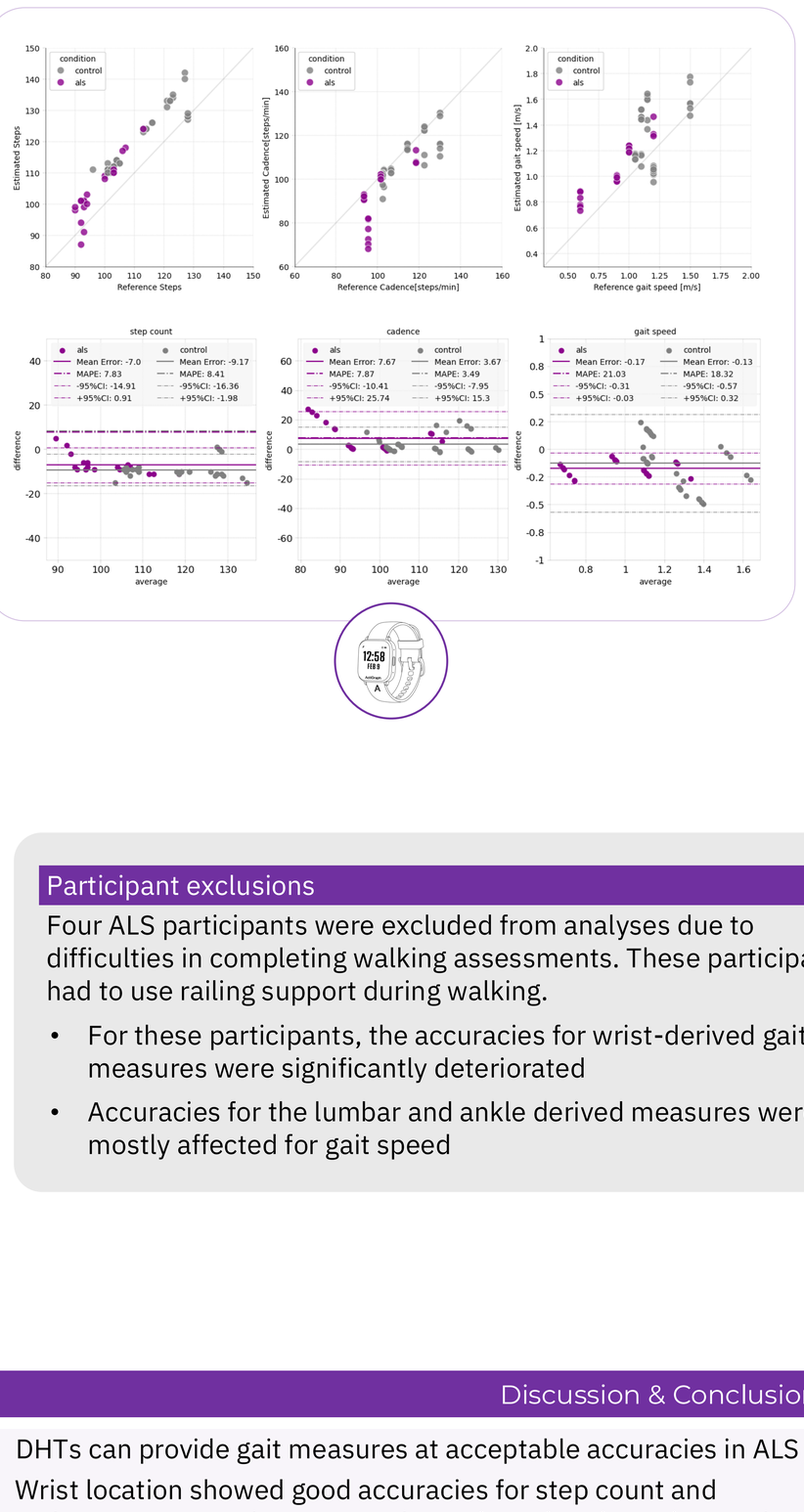


Fig. 3. Scatter plots and Bland-Altman analysis showing agreement between LUMBAR-derived digital measures and reference values

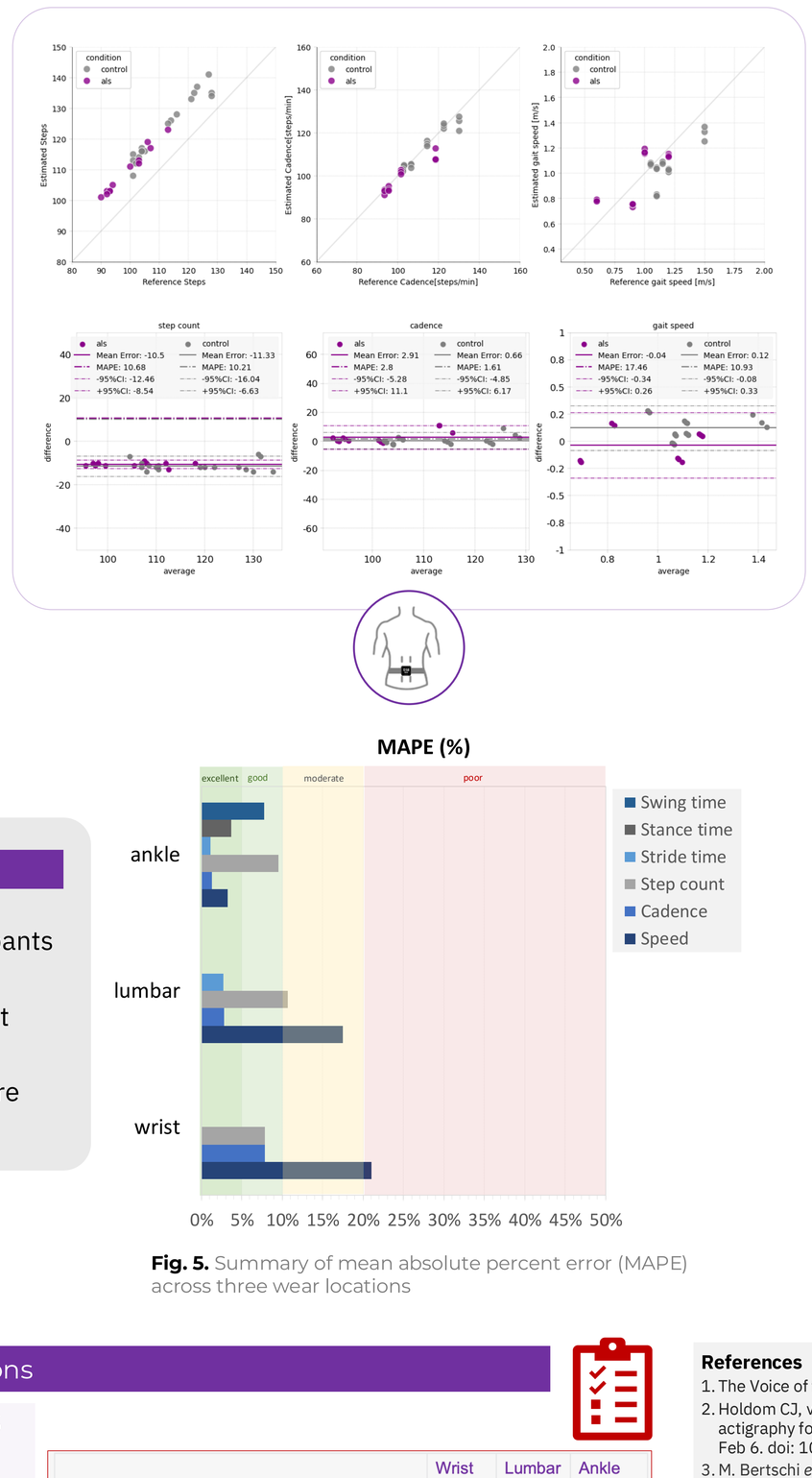
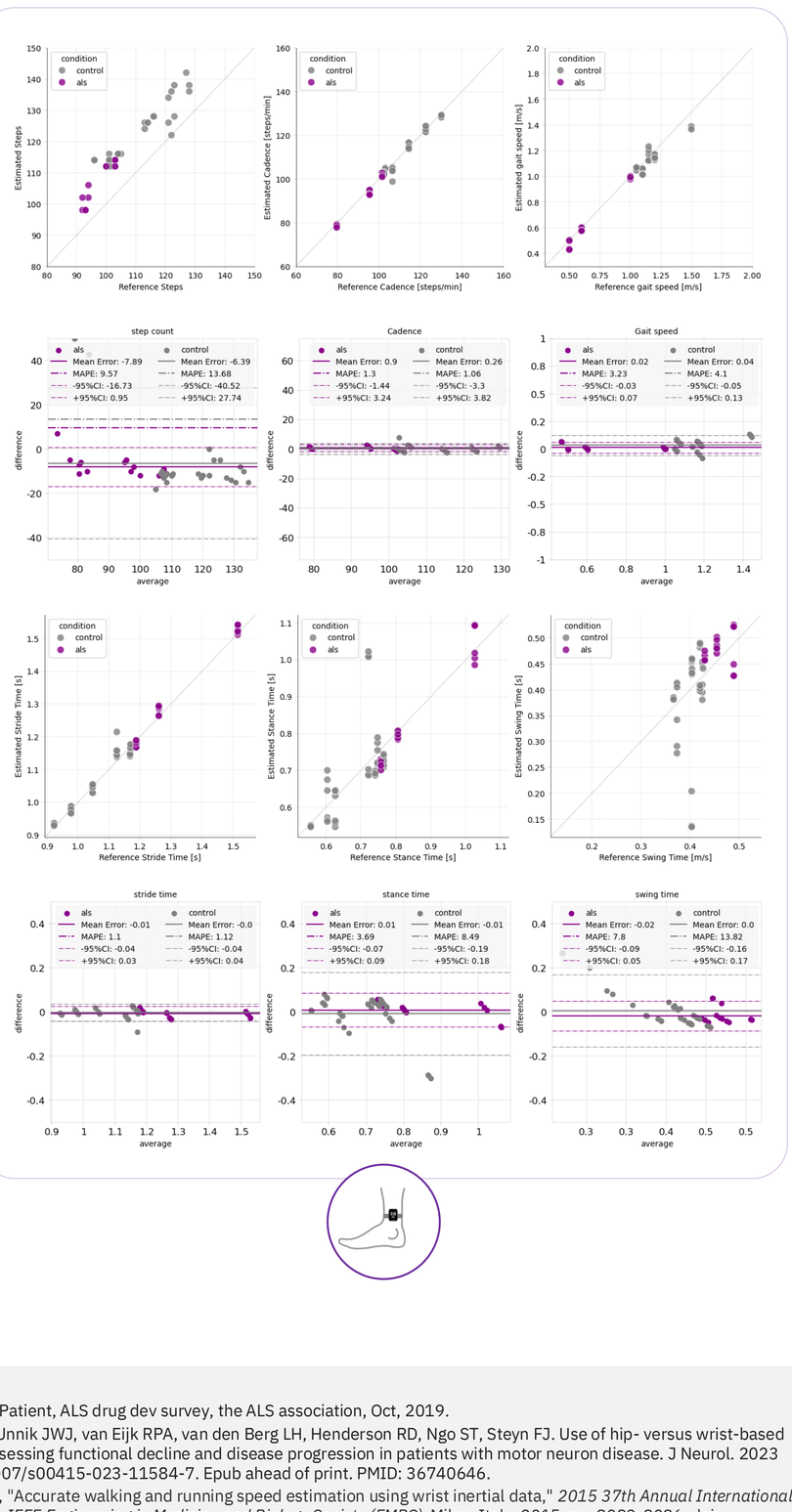


Fig. 4. Scatter plots and Bland-Altman analysis showing the agreement between ANKLE-derived digital measures and reference values



Participant exclusions

Four ALS participants were excluded from analyses due to difficulties in completing walking assessments. These participants had to use railing support during walking.

- For these participants, the accuracies for wrist-derived gait measures were significantly deteriorated
- Accuracies for the lumbar and ankle derived measures were mostly affected for gait speed

Fig. 5. Summary of mean absolute percent error (MAPE) across three wear locations

Discussion & Conclusions

- DHTs can provide gait measures at acceptable accuracies in ALS
- Wrist location showed good accuracies for step count and cadence measures but was moderate in estimating gait speed
- Lumbar location showed good to excellent accuracies across all gait measures, but was moderate for gait speed
- Ankle measures are most accurate for estimating gait measures
- Use of assistive devices should be considered before selecting placement location for gait

	Wrist	Lumbar	Ankle
How much vs How?			
How much: steps, cadence etc.	✓	✓	✓
How: Mechanistic aspects of gait	⊘	✓	✓
Assistive device use	‖	✓	✓
Non-ambulatory (PA)	✓	⊘	⊘
Validations in same/similar indications	?	?	?

References

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