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## Introduction

- Amyotrophic lateral sclerosis (ALS)** is a neurodegenerative disease that progressively damages parts of the nervous system, causes muscle degradation, and significantly affects movement, speech and respiratory functions.
- Quantification of gait**, an essential component for understanding ALS progression as well as intervention outcomes, is usually performed by subjective clinical evaluations or burdensome laboratory-based experiments.
- Wearable digital health technologies (DHTs)** can reduce the patient burden of lab visits and provide objective and sensitive continuous data to quantify real-world behavior.

## Methods

**Setting:** Free-living ambulation  
**Device:** GT9X (ActiGraph, L.L.C., Pensacola, FL)  
**Procedure:**

- GT9X activity monitors were placed on non-dominant wrists of **104 pwALS and 54 age-matched controls**.
- The accelerometer data were continuously recorded for 7 to 8 days at 30 Hz.

Table 1. Participant demographics

Group	n	age (years)	height (cm)	weight (kg)
control	54	55.62 (11.7)	170.57 (8.17)	79.45 (20.96)
ALS	104	60.14 (8.53)	173.9 (8.3)	79.11 (17.75)

## Data processing and outcome measures

Accelerometer data were processed using a custom-built algorithm to extract **step count, gait speed, and cadence**.

Fig. 2. Data processing pipelines for deriving PA and gait measures.

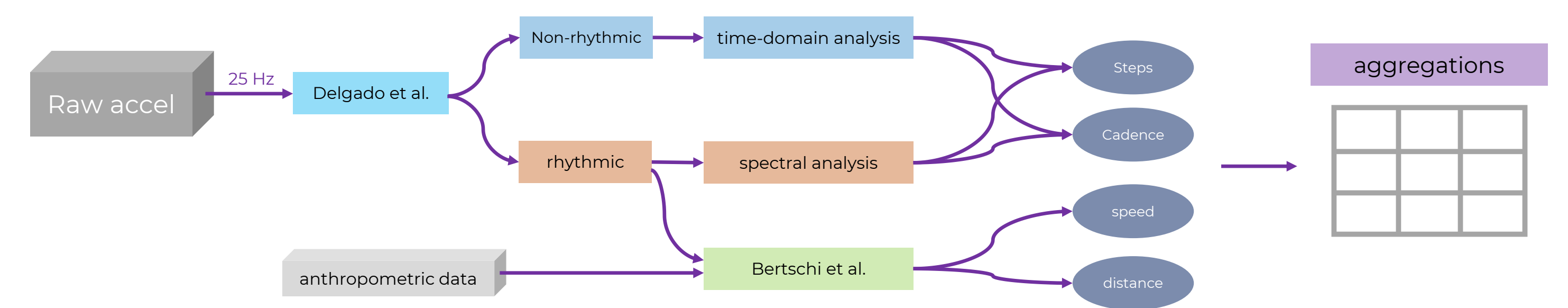


Fig. 1. The Voice of the Patient, ALS drug dev survey, the ALS association, Oct, 2019.  
A. Patients' response, B. Caregivers' response

## Objective

To demonstrate the feasibility of unobtrusive wrist-based accelerometry to free-living gait metrics in persons with ALS (pwALS).

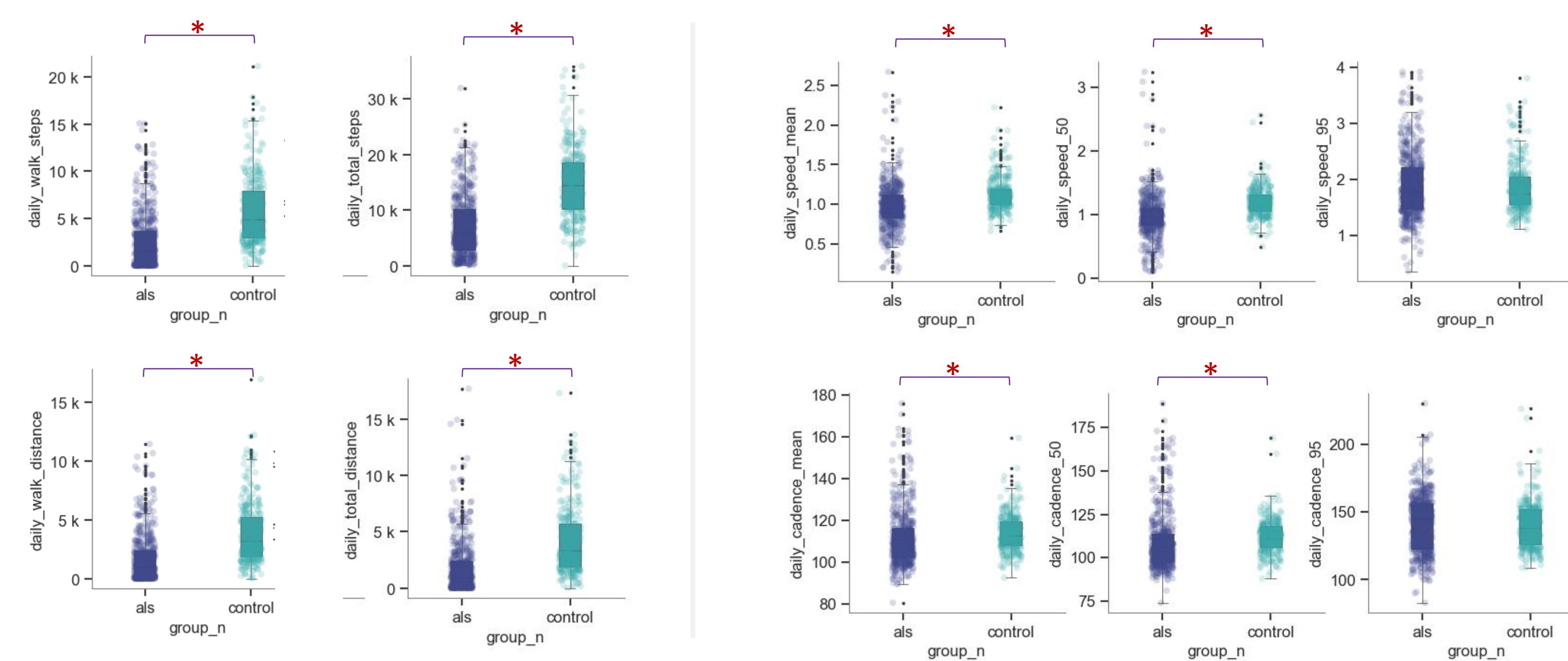
- Q1: Can wrist-based digital gait measures distinguish between ALS and the controls?  
Q2: Can digital gait measures track the ALS progression?  
Q3: How well the digital gait measures correlate with the clinical measure, ALS-FRS?

## Results

### Q1: Can wrist-based digital gait measures distinguish between ALS and the controls?

Session 0, Days 2-6, Controls = 58, ALS = 104

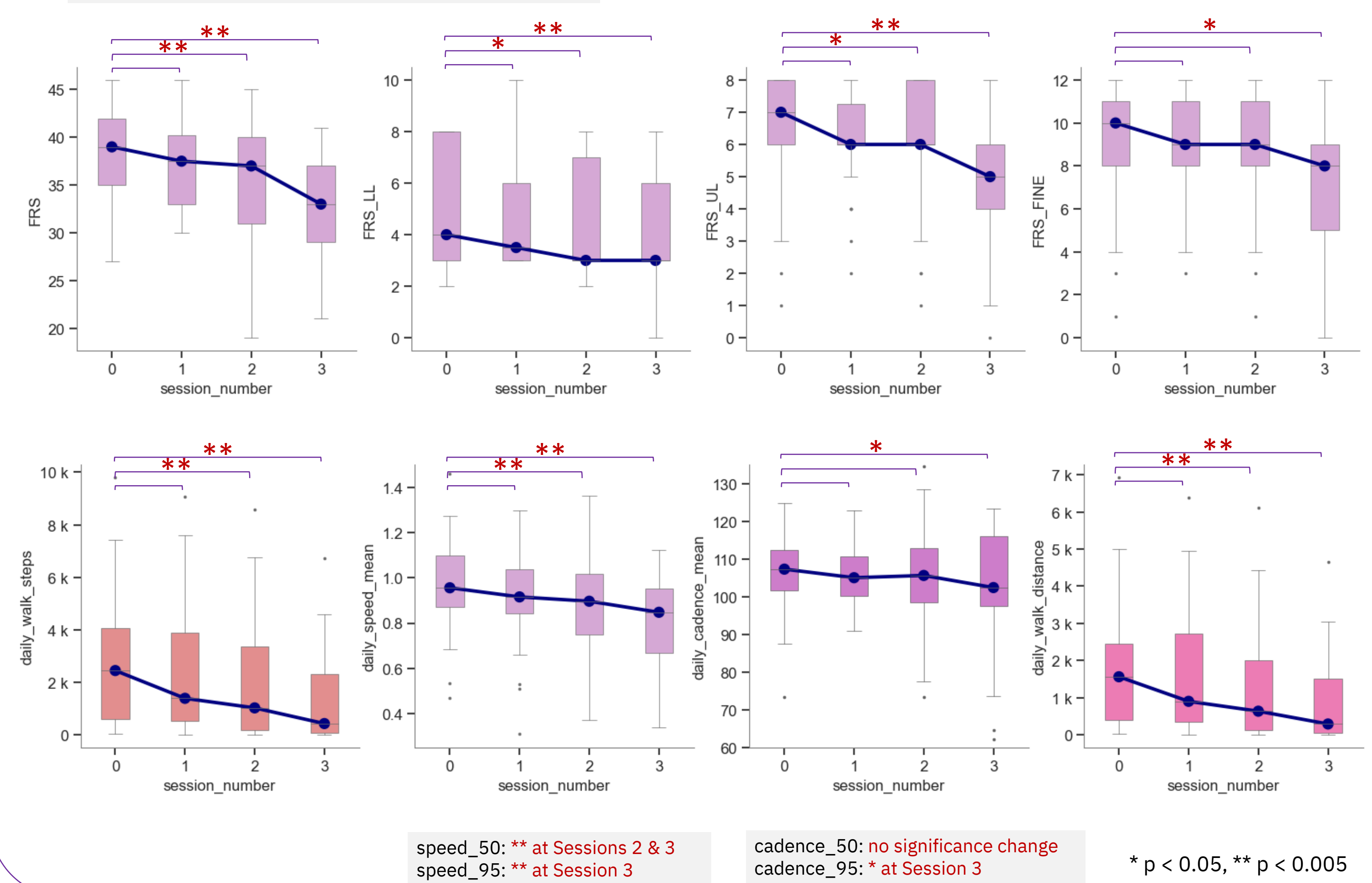
Fig. 3. Group comparisons of digital gait measures



### Q2: Can digital gait measures track the ALS progression?

Session 0-3, Days 2-6, N = 34 ALS, Each session separated by 3-4 months

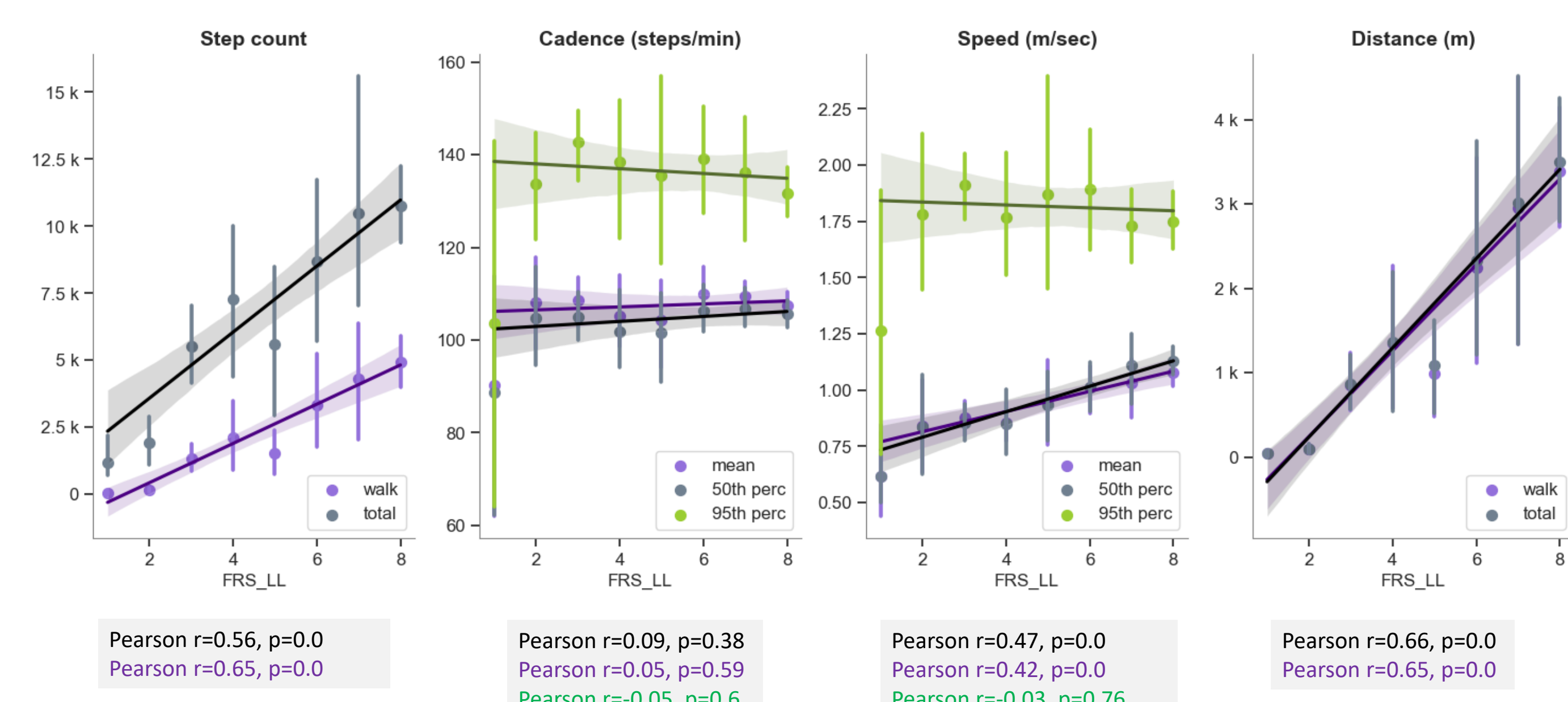
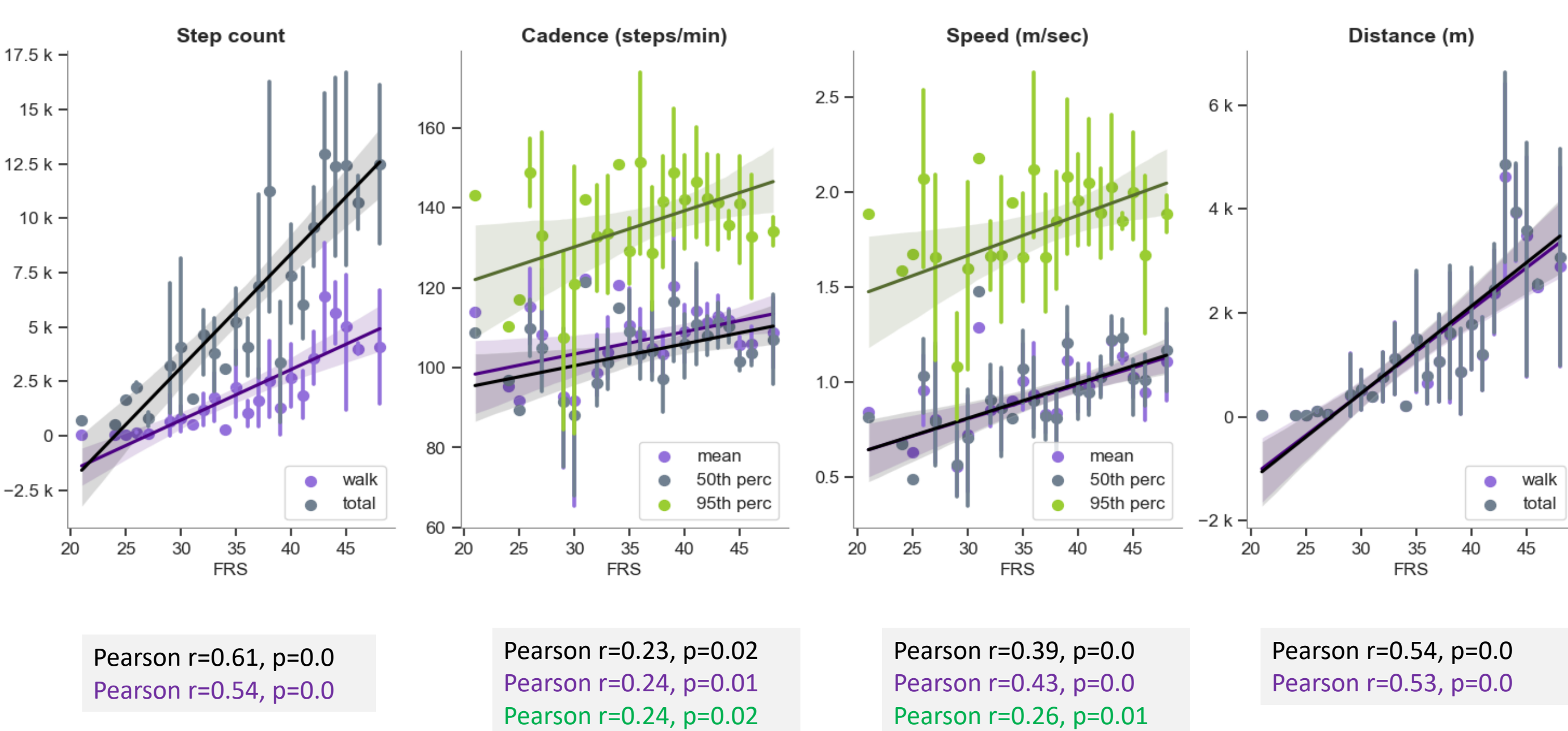
Fig. 4. Longitudinal analysis of ALS-FRS and digital gait measures in ALS



### Q3: How to the digital gait measures correlate with the clinical measure?

Session 0, Days 2-6, Controls = 58, ALS = 104

Fig. 5. Correlation analyses between ALS-FRS and digital gait measures



## Gait bouts

Removing the 'noise' in the data?

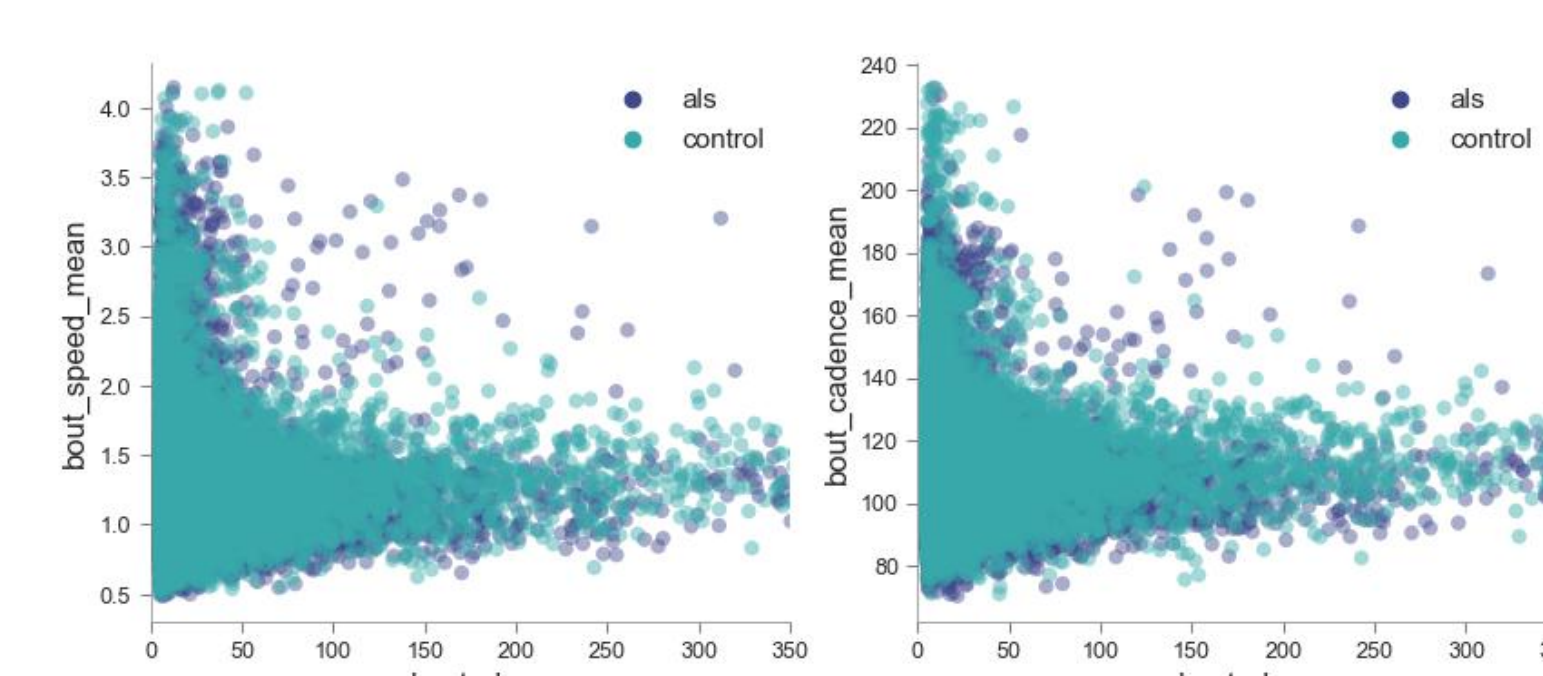
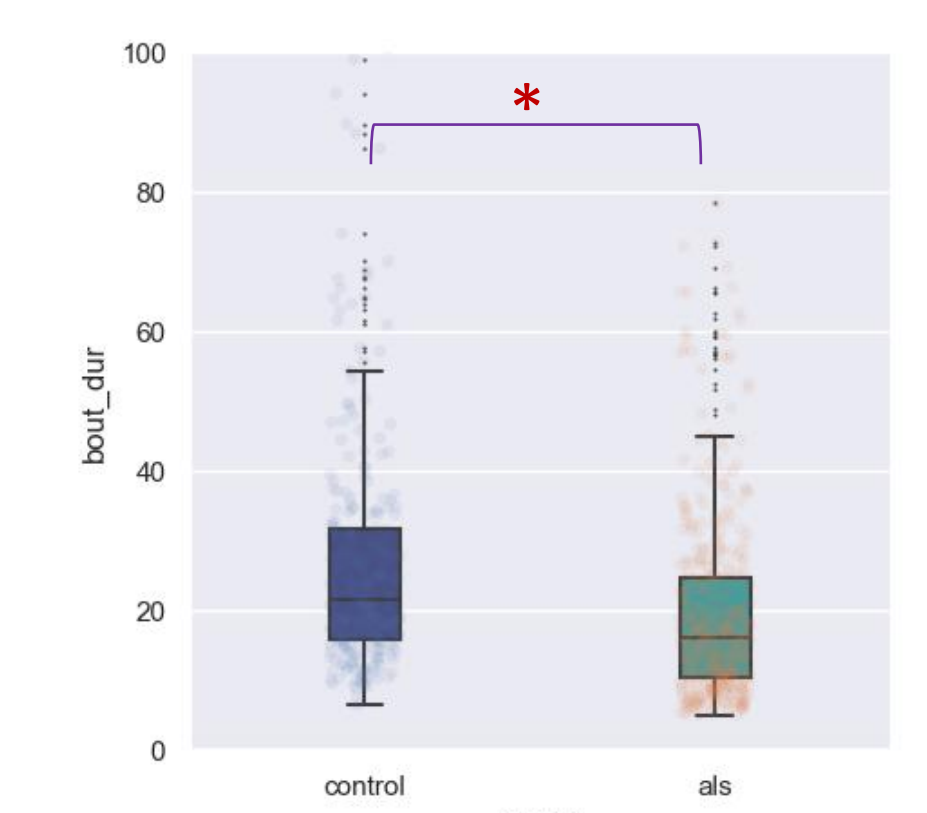


Fig. 6. Representation of free-living gait bouts in ALS and controls



## Conclusions & future work

- Wrist-accelerometry can provide rich data to extract objective and sensitive measures** of real-world gait for pwALS
  - ✓ Showed significant differences between the control and pwALS
  - ✓ Can track ALS progression
  - ✓ Significantly correlated with the clinical measure - ALS-FRS
- Bout-definition can influence the variability and effect size for gait metrics (speed, cadence) in the free-living condition. To be investigated.**



## References

- The Voice of the Patient, ALS drug dev survey, the ALS association, Oct, 2019.
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- R. Delgado-Gonzalo et al., "Physical activity profiling: Activity-specific step counting and energy expenditure models using 3D wrist acceleration," 2015 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Milan, Italy, 2015, pp. 8091-8094, doi:10.1109/EMBC.2015.7320271.
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