



# Postural Sway Analysis with a Wearable Sensor Differentiates Stages of Parkinson disease

Ruth Y. Akinlosotu, Kelly P Westlake, Lisa M. Shulman, Rainer von Coelln  
*University of Maryland School of Medicine*

## Objective

To compare quantitative measures of postural sway between age matched controls & the stages of Parkinson disease (PD) using the Dynaport triaxial accelerometer.

## Background

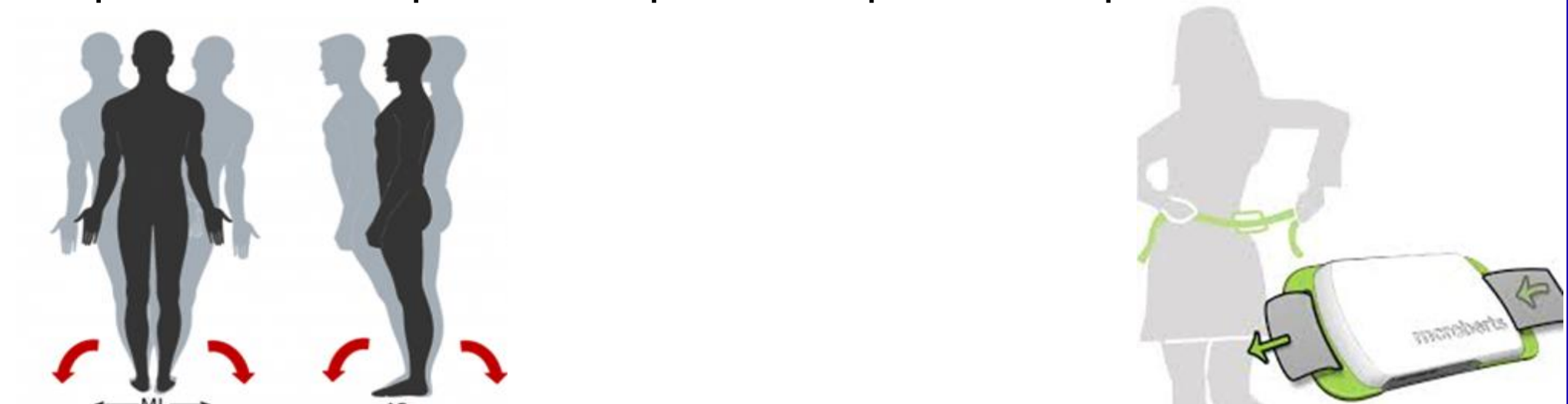
- Postural instability and tremor are major parkinsonian symptoms that worsen with PD progression.
- Clinical measures used to measure these symptoms are often subjective.
- Postural sway has been used as a laboratory measure of postural instability in PD.
- Accelerometers provide clinicians with a wearable device to measure center of mass (CoM) sway during quiet standing in individuals with PD.
- It is unknown whether postural sway data collected using the Dynaport triaxial accelerometer during quiet stance can be used to differentiate between age-matched controls (no PD group) and Hoehn & Yahr (H&Y) stages 1-2, 2.5-3, and 4.

## Modified Hoehn & Yahr (mHY) Scale

- 1.0 Unilateral involvement
- 1.5 Unilateral + axial involvement
- 2.0 Bilateral involvement without impairment of balance
- 2.5 Mild bilateral disease with recovery on pull test
- 3.0 Mild to moderate bilateral disease; some postural instability; physically independent
- 4.0 Severe disability; still able to walk or stand unassisted
- 5.0 Wheelchair bound or bedridden unless aided

## Methods

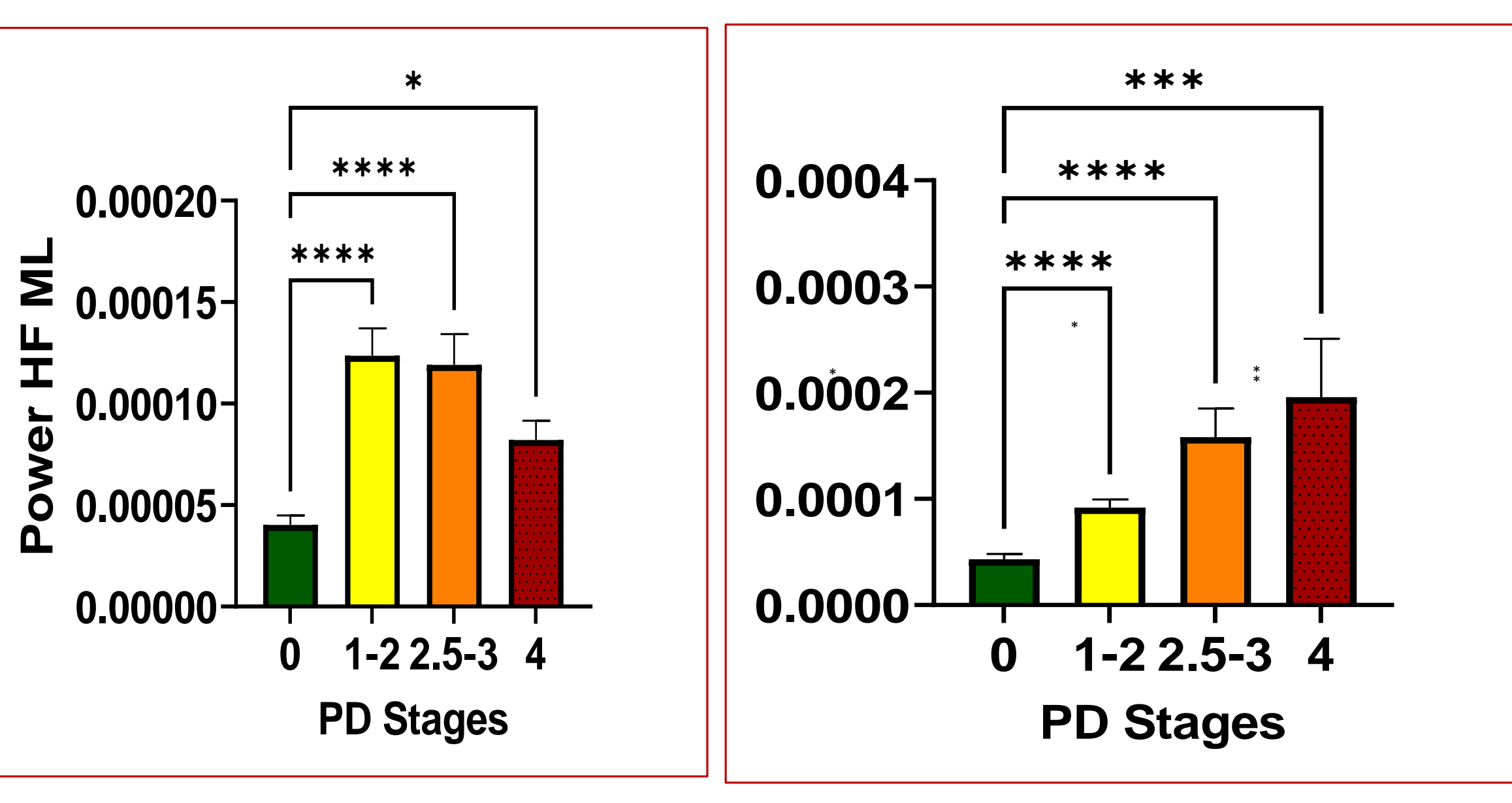
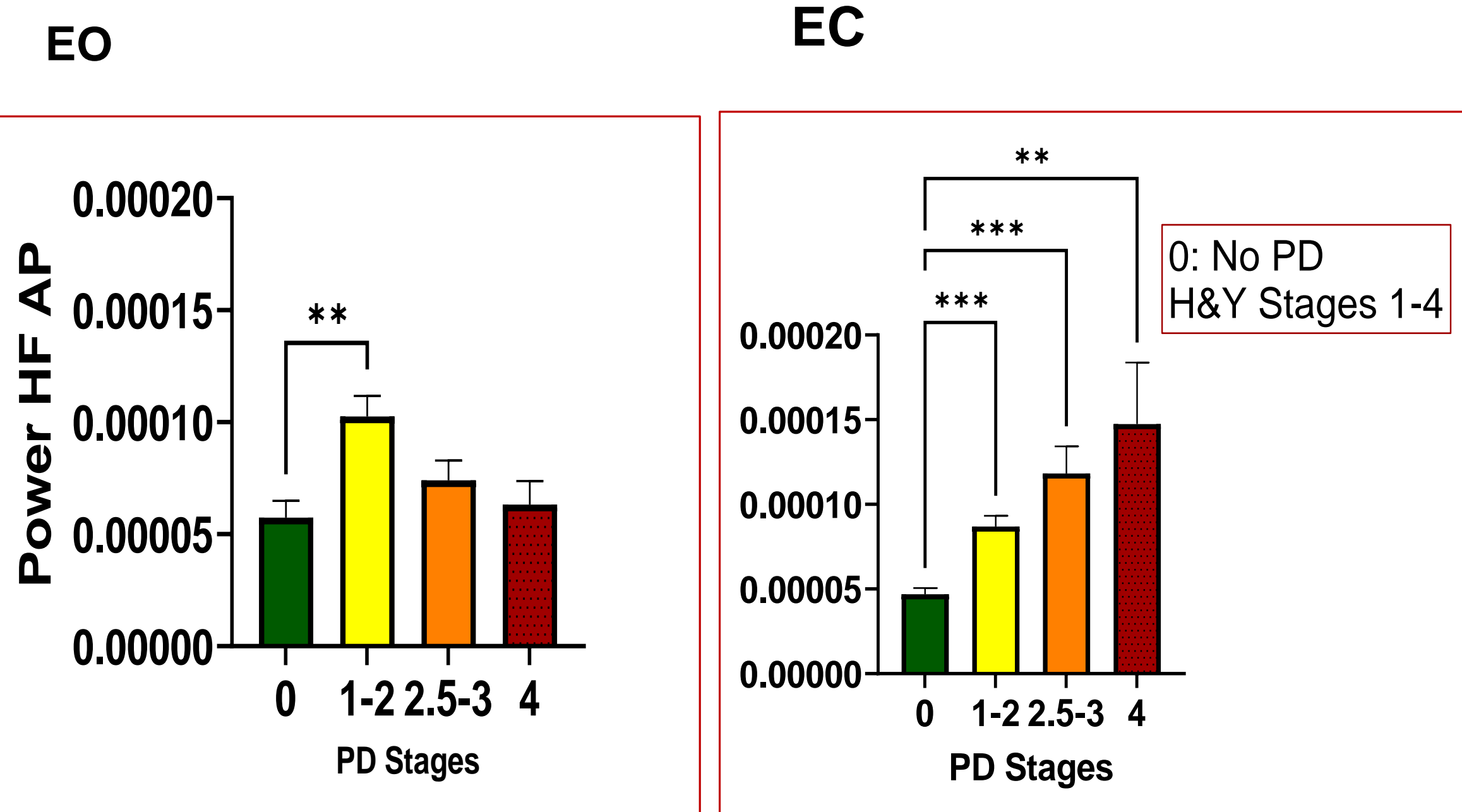
- Persons with PD (mH&Y stages 1-4, medication ON state) and age-matched family members without PD (H&Y 0).
- Participants wore a Dynaport triaxial accelerometer on their lower back & stood on a firm surface for 20s with eyes open (EO) & eyes closed (EC).
- Dynaport data was collected with a sampling rate of 100Hz.
- A customized MATLAB script was used to extract and process the postural sway variables in the anterior-posterior (AP) & medio-lateral (ML) direction<sup>1</sup>.
- A Kruskal Wallis test was used to compare postural sway variables between groups (H&Y stages 0, 1-2, 2.5-3, and 4) and a Dunn's test was used for the pairwise multiple comparison (p adjusted,  $\alpha$  set at 0.05).
- A receiver operative curve analysis (ROC) was done to explore the differences between the PD stages and their area under curve (AUC) was plotted and reported as percentages
- The variables included
  - Tremor measures (High frequency power AP & ML, 4-7 Hz)
  - Postural instability measures (mean center of mass (CoM) velocity AP & ML and jerk AP & ML).
- p value was reported as \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .



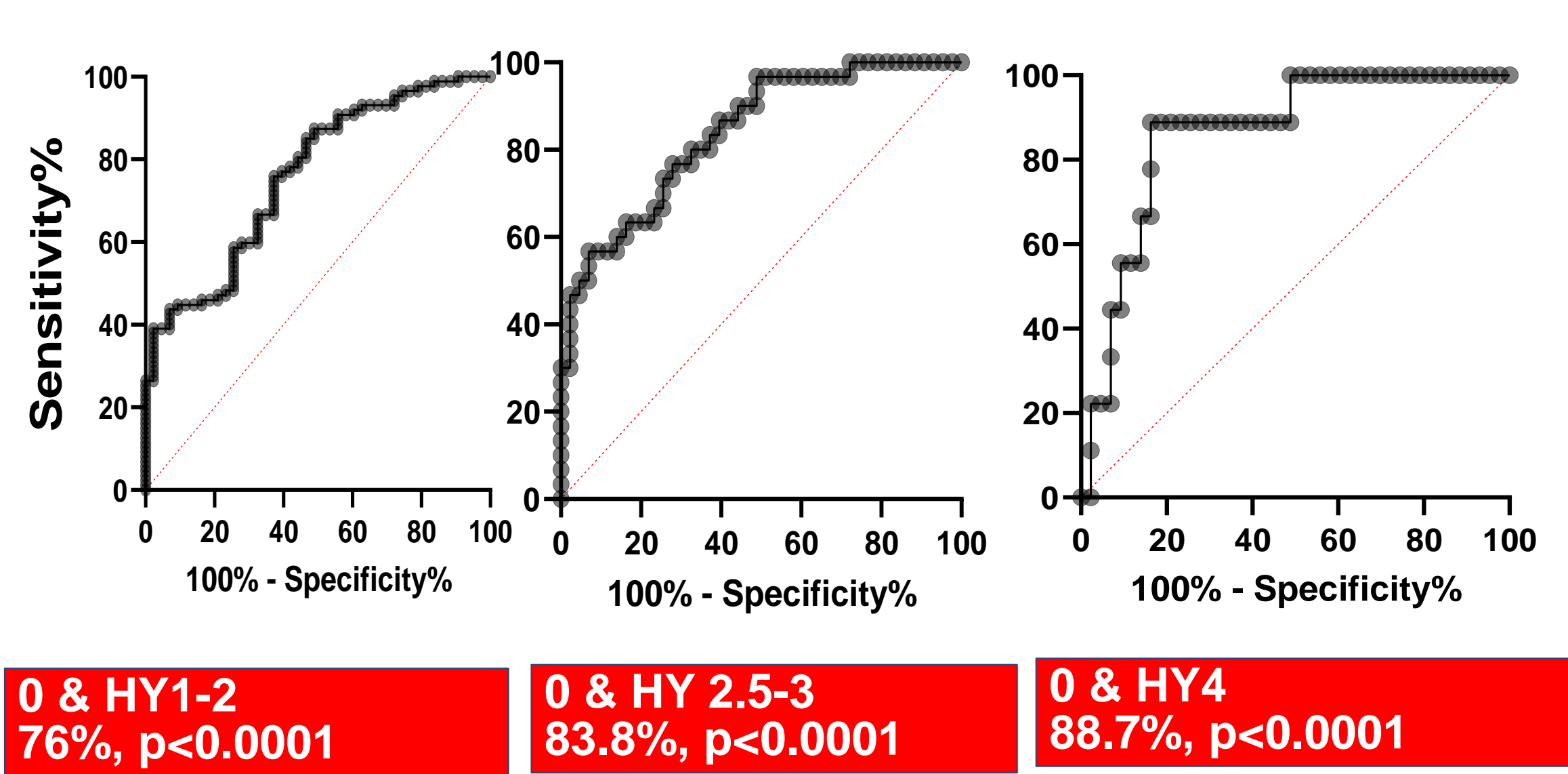
## Demographics

|          | No PD     | HY 1 or 2  | HY 2.5 or 3 | HY 4       |
|----------|-----------|------------|-------------|------------|
| N        | 50        | 101        | 34          | 10         |
| Male (%) | 38        | 59.8       | 52.9        | 60         |
| Age      | 64 ± 10.0 | 65.7 ± 8.9 | 71.9 ± 7.0  | 74.2 ± 7.6 |
| UPDRS 3  |           | 20.0       | 26.4        | 30.1       |

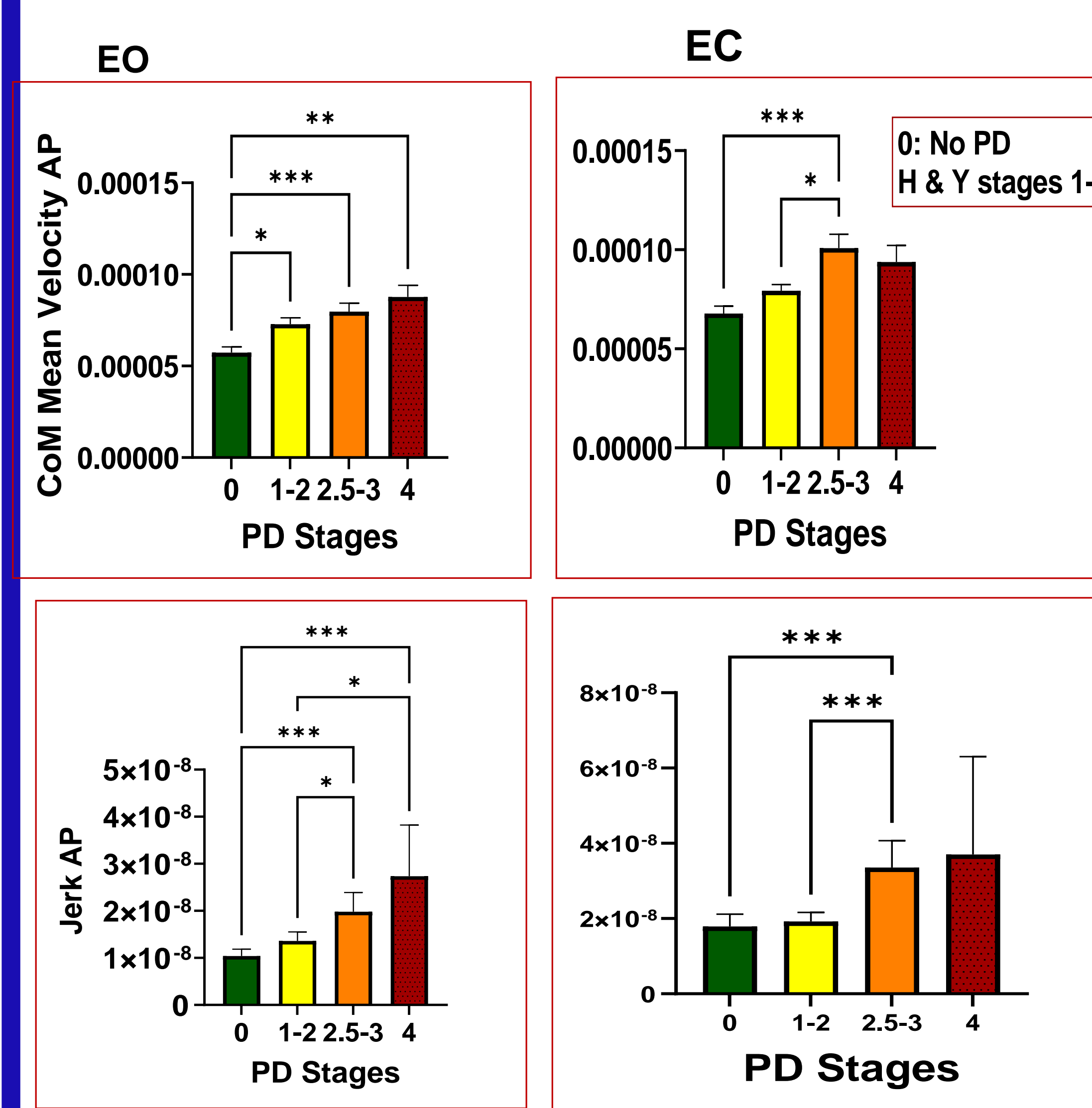
## Results: Tremor Measures AP & ML



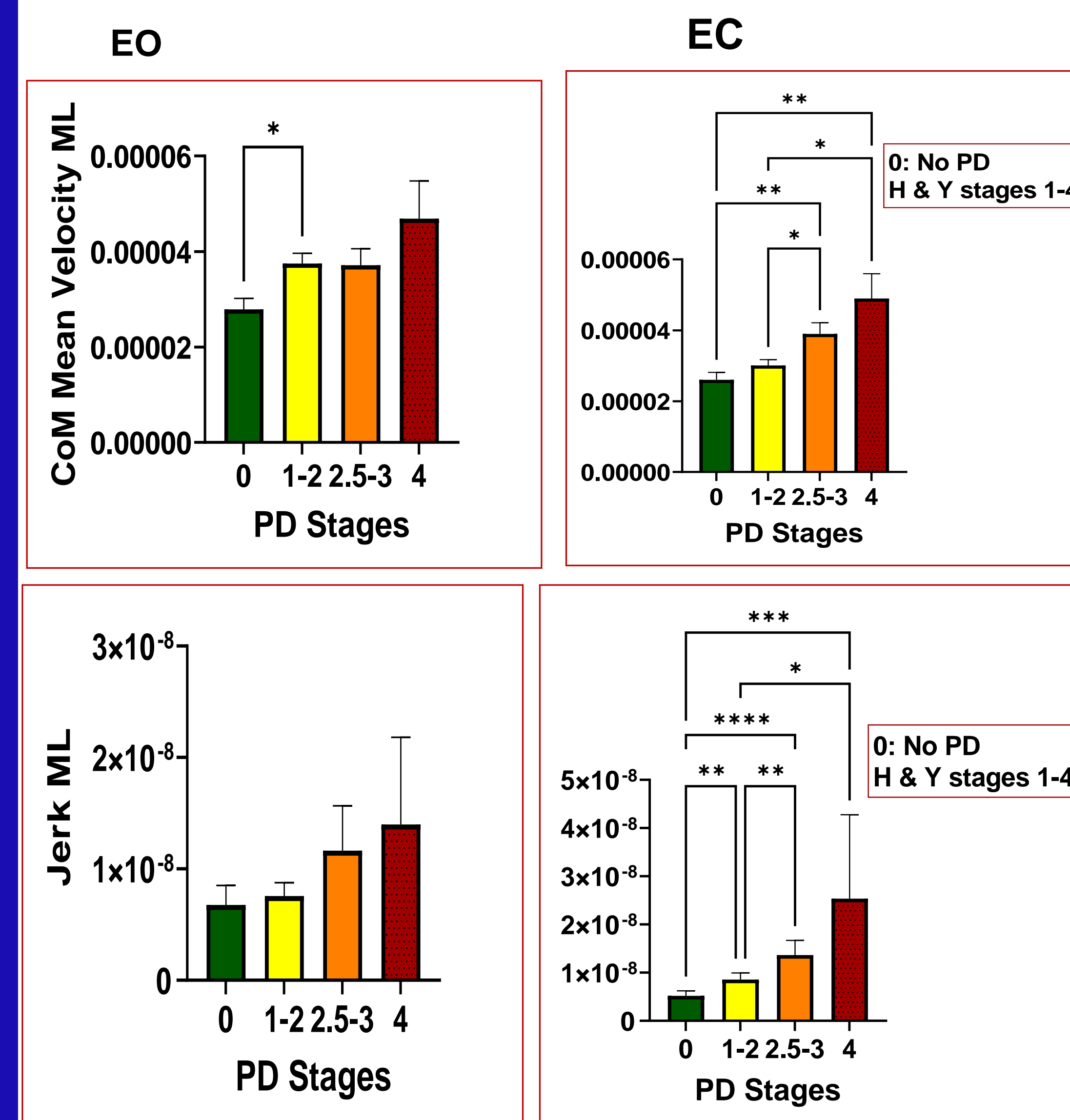
## Area Under Curve: HF Power ML Eyes Open



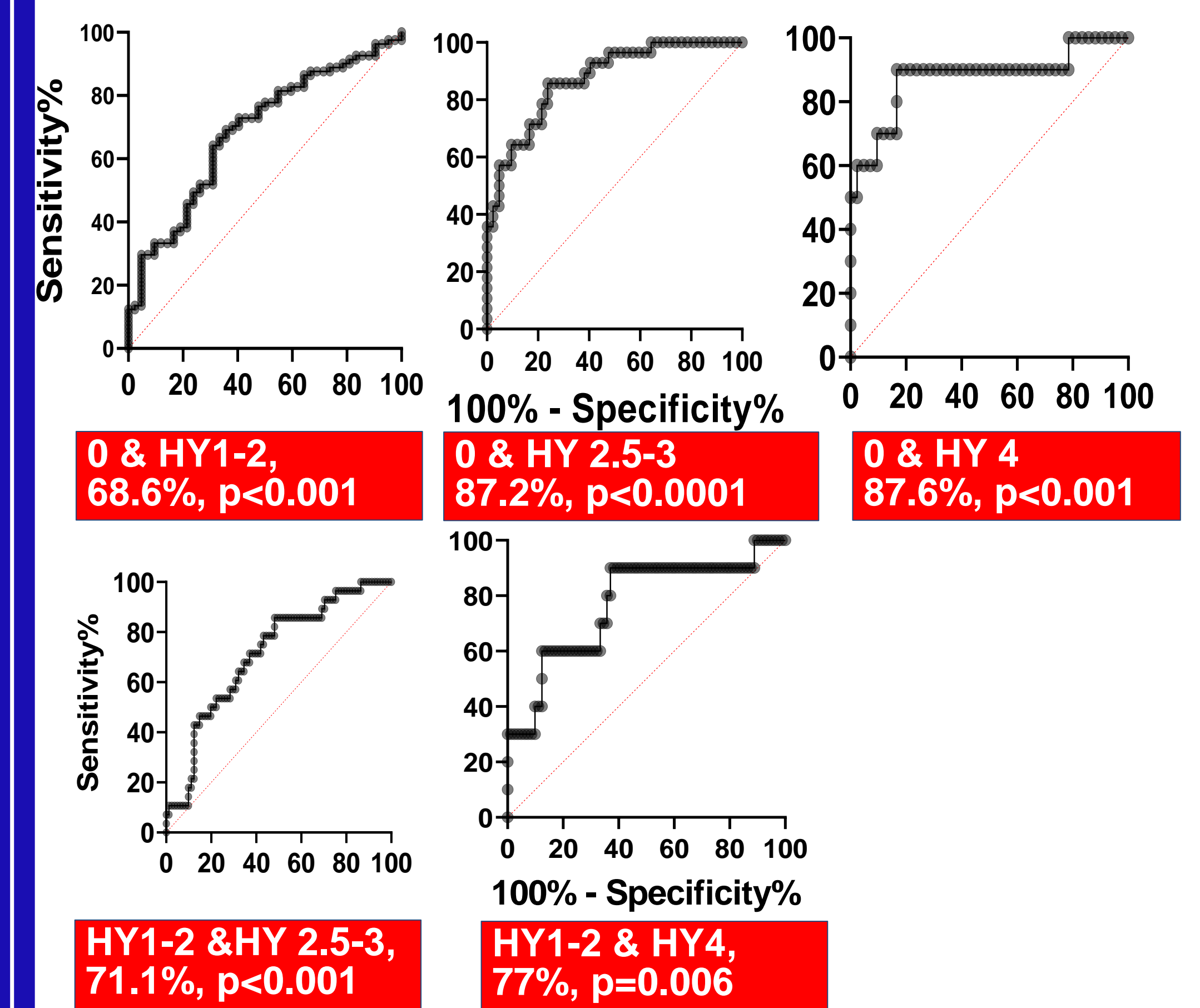
## Results: AP Postural Stability Measures



## Results: ML Postural Stability Measures



## Area Under Curve: Jerk ML Eyes Closed



## Summary & Conclusions

- Groups of PD patients stratified by H&Y stage and age-matched controls show significant differences in postural sway measures from a wearable triaxial accelerometer.
- The ROC analysis differentiates age-matched controls and patients of different PD stages with low (HY1-2 only) and moderate to high accuracies (HF power ML & Jerk ML).
- With eyes closed, jerk ML further differentiates HY1-2 & 2.5-3, as well as 4 with fair & moderate accuracies, respectively.
- ML jerk with eyes closed provides the best differentiation between PD stages of all analyzed postural sway measures.
- Further analysis is warranted to determine the clinical utility of accelerometry-based postural sway measures.

## Acknowledgement

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## References

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