Identifying unique subgroups of individuals after stroke using heart rate and steps to characterize physical activity

Lily Koffman[1], Ciprian Crainiceanu[1], Ryan T. Roemmich[2], Margaret A. French[2]

[1]Department of Biostatistics, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD; [2]Department of Physical Medicine and Rehabilitation, Johns Hopkins University School of Medicine, Baltimore, MD

Introduction

- Low physical activity (PA) is associated with poor health outcomes in individuals recovering from stroke
- Real time PA monitoring with wearables like Fitbit may allow for identification of patients at risk
- Change in heart rate (HR) in response to PA can provide additional health information
- HR/PA relationship may illuminate unique subgroups
- Quantifying this relationship is challenging and has not been explored in individuals with stroke

Purpose and Hypothesis

- We **hypothesize** that metrics of PA, including a combined steps/HR metric, identify subgroups of individuals that may be associated with clinical metrics
- The **purpose** of this work was to **1)** propose a combined metric to reflect the PA/HR relationship, **2)** identify subgroups with distinct PA patterns, and **3)** examine the association between these subgroups and clinical outcomes

Methods

- 70 individuals (38 male, 39 white, 61 $\pm$ 13 y.o.) with stroke wore a Fitbit Inspire 2 for 1 year. A 2-week window from this period was used in the analysis
- Individuals were included if they wore the device >75% of minutes from 7am-10pm for ≥10 days

Combined metric of heart rate and steps in sample subject
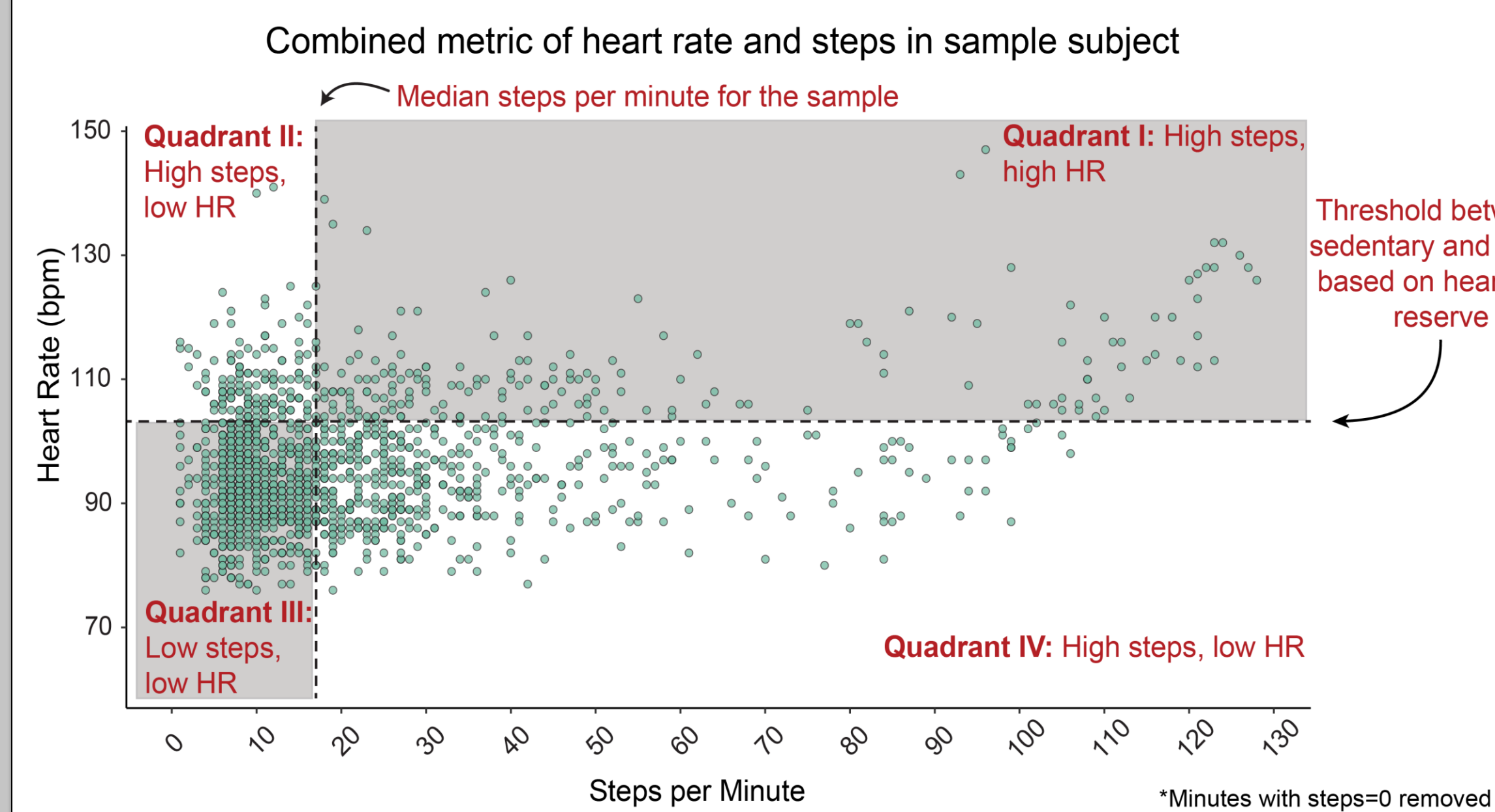
- **Combined metric of PA and heart rate:** each minute of activity categorized by HR and step thresholds

- Metrics included in a k-means **clustering algorithm**: steps/day, percent sedentary time, resting HR, time in quadrant I, II, and IV, and mean steps during high steps/high HR minutes
- **Understanding subgroups:** clustering variables, clinical metrics (AMPAC, gait speed), and demographics compared

Results

1. Percent time spent in each "quadrant" as defined by combined HR/step metric varies between individuals

- Some individuals (sample subject 1) spend a large proportion of minutes in QI (high steps/high HR), while others spend more time in QIII (sample subject 2) or QII (sample subject 3)
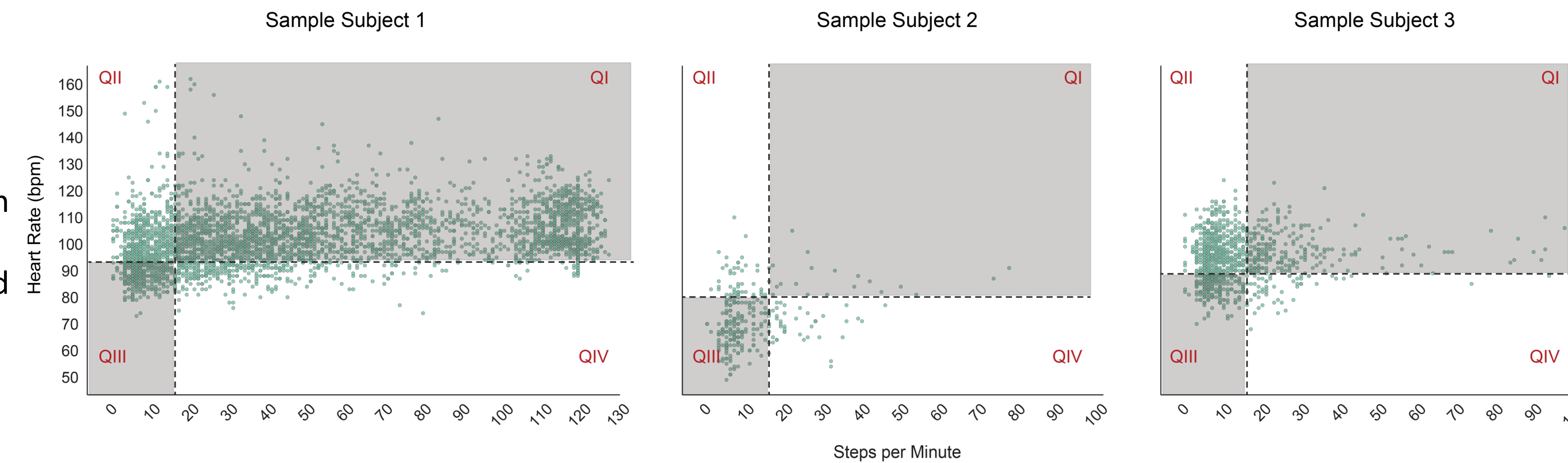

2. K-means clustering identified 3 subgroups: Active (n=8), Sedentary (n=29), and Deconditioned (n=33)

- All clustering variables except resting HR different between groups (p<0.01)
- Active had higher time with high steps/high HR, more steps per day, less sedentary time (p<0.01) than deconditioned and sedentary
- Deconditioned and sedentary differed most on time with low steps/high HR and time with high steps/high HR (p<0.01)
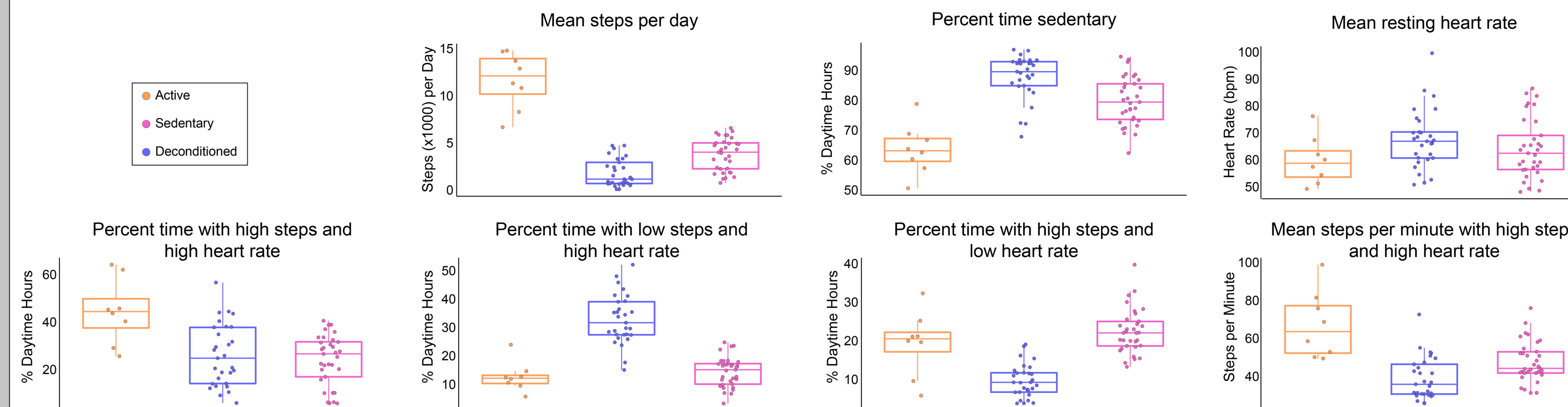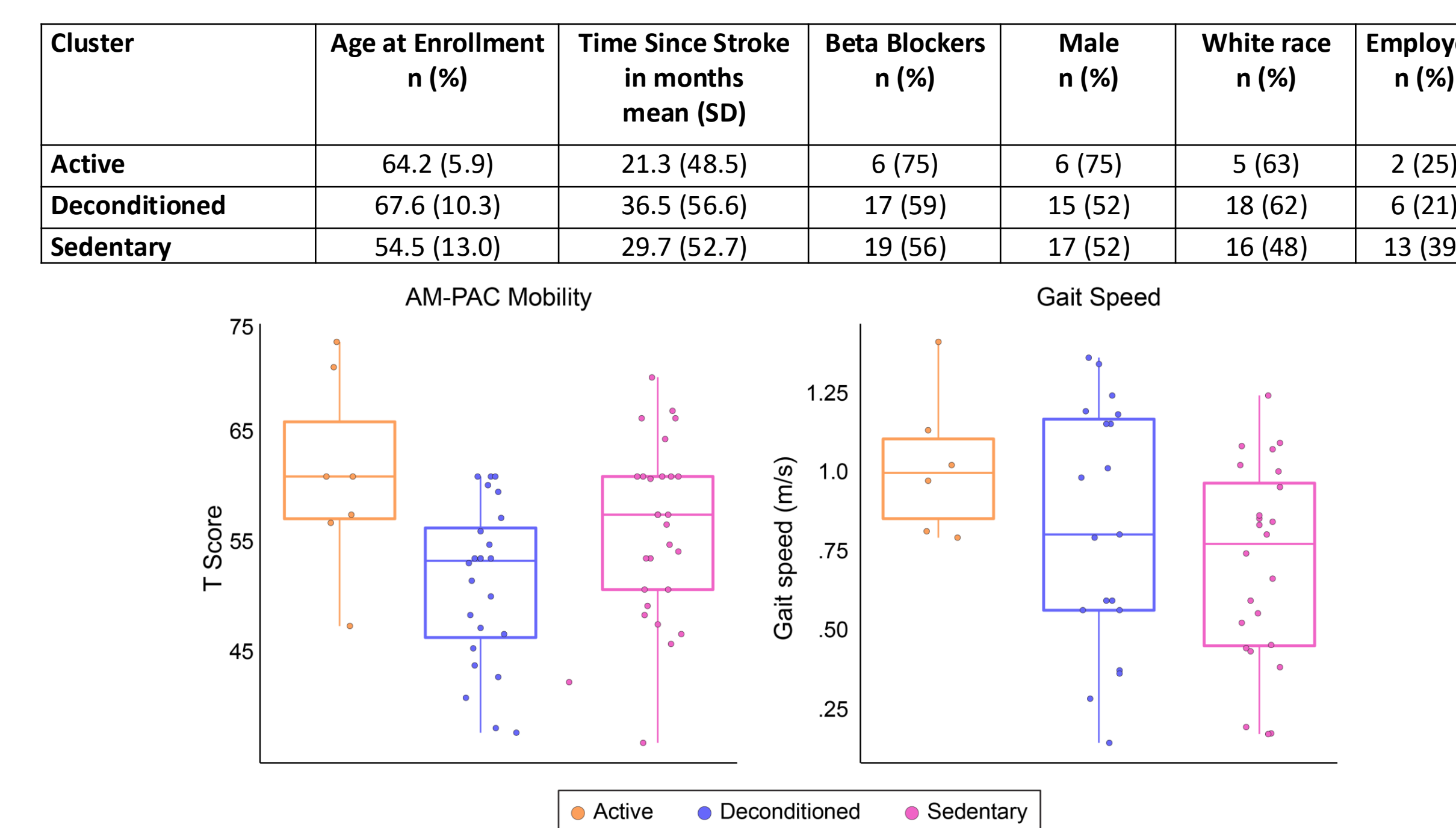

3. Subgroups are evident by examining the combined heart rate and step metrics

- Sedentary and deconditioned are similar when examining sedentary time vs. steps per day, but are distinct when considering the HR/steps metric
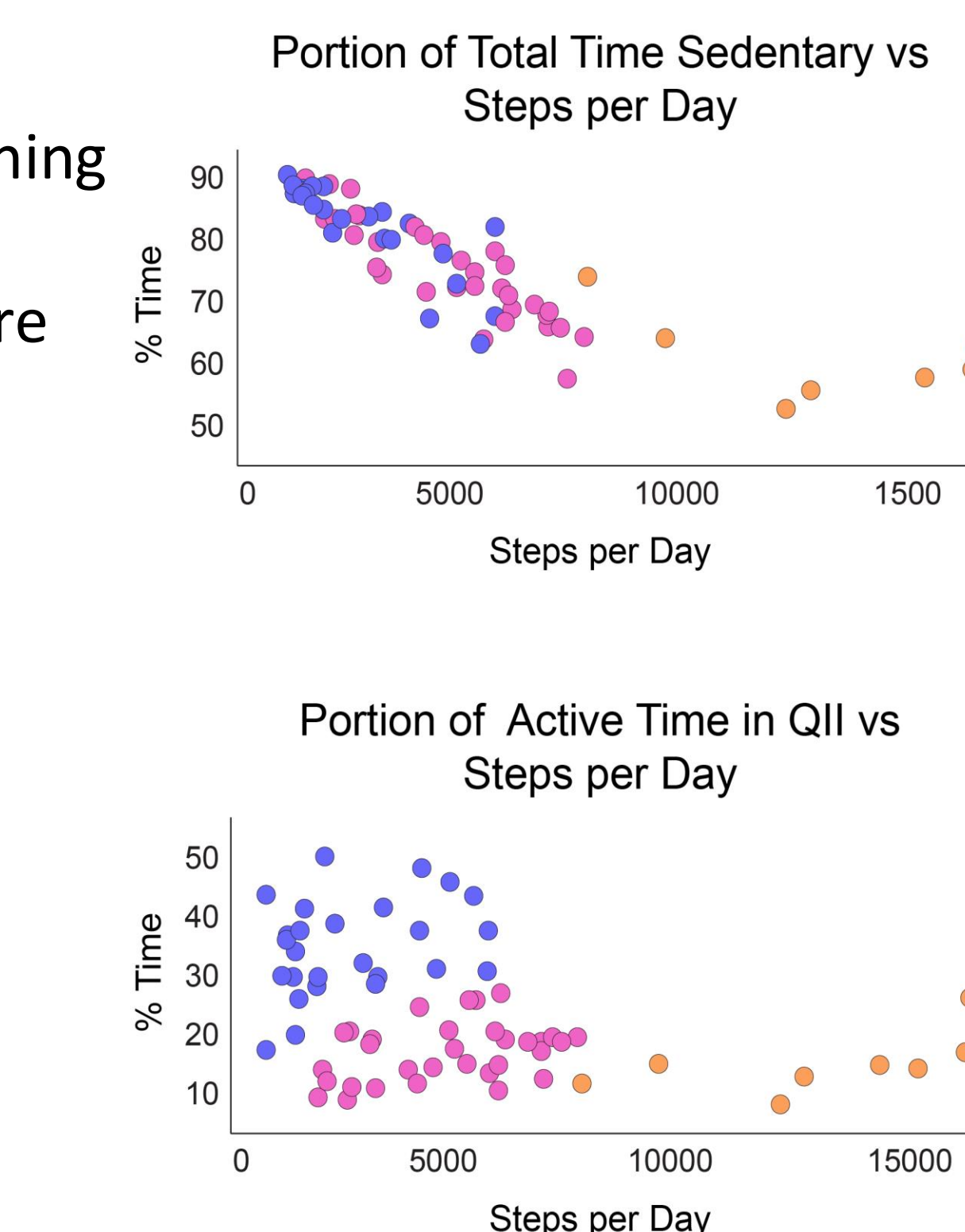
4. Clusters differ on select clinical metrics of mobility, specifically AM-PAC Mobility (p<0.01)

- Pairwise comparisons for AMPAC show differences between active and deconditioned (p=0.04) and sedentary and deconditioned (p<0.01)

Cluster	Age at Enrollment n (%)	Time Since Stroke in months mean (SD)	Beta Blockers n (%)	Male n (%)	White race n (%)	Employed n (%)
Active	64.2 (5.9)	21.3 (48.5)	6 (75)	6 (75)	5 (63)	2 (25)
Deconditioned	67.6 (10.3)	36.5 (56.6)	17 (59)	15 (52)	18 (62)	6 (21)
Sedentary	54.5 (13.0)	29.7 (52.7)	19 (56)	17 (52)	16 (48)	13 (39)

Discussion

- Combined HR/steps metrics based on proportion of time in HR/step categories differs between individuals
- K-means clusters formed with combined HR/steps metric identifies three distinct PA subgroups
- Subgroups differ on AMPAC Mobility T Score
- Distinct PA patterns suggest different interventions for sedentary vs. deconditioned individuals

Future Directions

- Cluster stability over longer periods of time
  - Exploratory analysis split 2-week sample into two 1-week periods and recalculated clusters for each period

		Week 2		
		Active	Decond.	Sed
Week 1	Active	6	1	1
	Decond.	0	23	5
	Sed.	1	3	30

- Whether change in cluster predictive of adverse events (i.e., hospital admissions, emergency room visits)

Acknowledgements

References

1. Schrack, J. A., Leroux, A., Fleg, J. L., Zipunnikov, V., Simonsick, E. M., Studenski, S. A., Crainiceanu, C., & Ferrucci, L. (2018). Using Heart Rate and Accelerometry to Define Quantity and Intensity of Physical Activity in Older Adults. The journals of gerontology. Series A, Biological sciences and medical sciences, 73(5), 668–675. https://doi.org/10.1093/gerona/gly029
2. Billinger, S. A., Arena, R., Bernhardt, J., Eng, J. J., Franklin, B. A., Johnson, C. M., MacKay-Lyons, M., Macko, R. F., Mead, G. E., Roth, E. J., Shaughnessy, M., Tang, A., American Heart Association Stroke Council, Council on Cardiovascular and Stroke Nursing, Council on Lifestyle and Cardiometabolic Health, Council on Epidemiology and Prevention, & Council on Clinical Cardiology (2014). Physical activity and exercise recommendations for stroke survivors: a statement for healthcare professionals from the American Heart Association/American Stroke Association. Stroke, 45(8), 2532–2553. https://doi.org/10.1161/STR.0000000000000022
3. Thilarajah, S., Mentiplay, B. F., Bower, K. J., Tan, D., Pua, Y. H., Williams, G., Koh, G., & Clark, R. A. (2018). Factors Associated With Post-Stroke Physical Activity: A Systematic Review and Meta-Analysis. Archives of physical medicine and rehabilitation, 99(9), 1876–1889. https://doi.org/10.1016/j.apmr.2017.09.117
4. Butler EN, Evenson KR. Prevalence of Physical Activity and Sedentary Behavior Among Stroke Survivors in the United States. Top Stroke Rehabil. 2014;21(3):246-255. doi:10.1310/tsr2103-246
5. Wondergem R, Veenhof C, Wouters EMJ, de Bie RA, Visser-Meily JMA, Pisters MF. Movement Behavior Patterns in People With First-Ever Stroke. Stroke. 2019;50(12):3553-3560. doi:10.1161/STROKEAHA.119.027013