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Estimating Walking Intensity in Adults with Down Syndrome using Portable Accelerometers

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Background

- Less than 10% of adults with intellectual disabilities (ID) achieve the recommended 150 minutes per week of moderate-to-vigorous physical activity (MVPA).
- Studies report that adults with Down syndrome (DS) are less physically active than those with other ID.
- Accurate measurement of physical activity (PA) is critical for population-based surveillance and to examine health benefits.
- No validated measures for assessing PA in adults with DS.

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Background

- Portable accelerometers are widely used to assess free-living PA.
- Data from triaxial accelerometers are expressed in activity counts for a specified time period to represent PA intensity.
- Calibration studies are conducted to develop cut-points associated with energy expenditure in metabolic equivalents (METs).
- These cut-points are population specific. Adults with DS have biomechanical and physiological differences when compared to typically developed (TD) adults.

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Objectives

Aim #1: Develop and compare activity intensity cut-points, i.e., light (1.1-2.9 METs), moderate (3-6 METs), and vigorous (> 6 METs), for walking using vertical axis counts, vector magnitude counts, and gravitational units for accelerometers worn at the non-dominant hip and both wrists.

Aim #2: Compare the DS-specific cut-points for moderate-to-vigorous walking intensity with those previously established for TD adults.

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Assessments

- Anthropometrics: Height, weight, body mass index, and body composition using dual-energy x-ray absorptiometry.
- Resting energy expenditure (REE) is measured to calculate PA intensity by dividing each participant's volume of oxygen consumption (ml/kg/min) during walking by their REE to obtain METs.
  - Adults with DS have a lower resting energy expenditure compared to TD adults.
  - A REE value of 3.5 ml/kg/min is used to define 1 MET in typically developed adults.

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Assessments

Treadmill Walking Protocol:

- ActiGraph accelerometers worn on the non-dominant hip and wrists during the simultaneous measurement of heart rate and activity energy expenditure.
- Seven-minute stages starting at 1.5 mph and increasing in 0.5 mph increments until vigorous intensity (> 6 METs) is reached in the final 4 minutes.
- A 5-minute rest period to minimize fatigue, enhance motivation, and provide a clear distinction between phases of movement.
- Timestamped video to sync the treadmill and accelerometer measurements.

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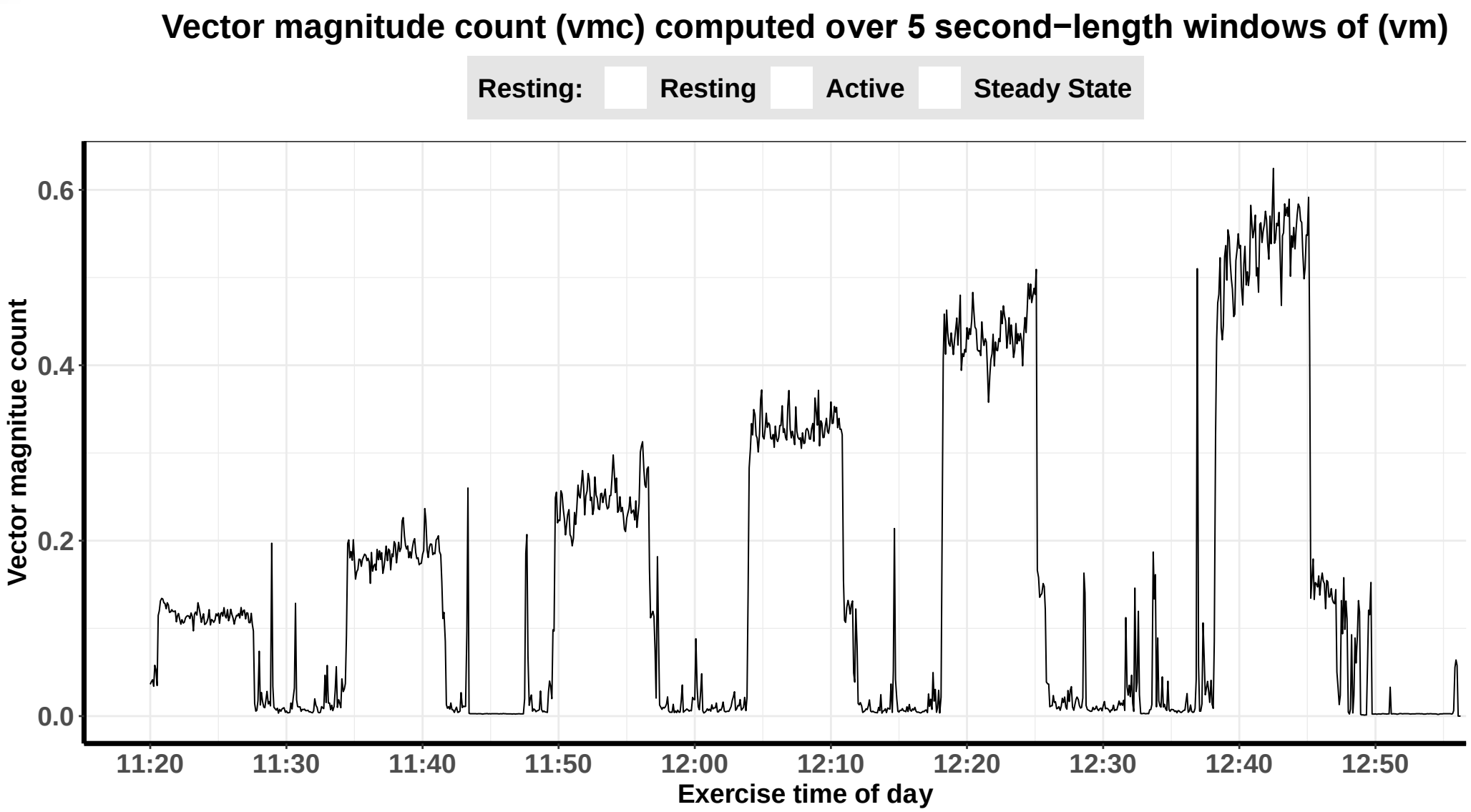

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Analysis

- Raw acceleration data are sampled at 100 Hertz before applying ActiGraph's open-source activity count algorithm to aggregating the data 5-second epochs.
- Optimal MVPA cut-points over 5-second epochs were determined as the value that provided sensitivity and specificity closest to the area under the curve (AUC) and that minimized the absolute difference between sensitivity and specificity.
- Confusion matrices were used to assess the accuracy (correct predictions / total predictions), sensitivity (correct positive predictions / total positive predictions), specificity (correct negative predictions / total negative predictions), and AUC.

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Results

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Table 1. Demographics, anthropometrics and resting energy expenditure (REE)

	Overall (n=21)	Female (n=15)	Male (n=6)
Age	23.6 ± 5.0	22.0 ± 4.4	27.5 ± 4.8
Race: White	19 (90%)	14 (93%)	5 (83%)
Weight (kg)	70.1 ± 15.8	68.4 ± 14.9	74.3 ± 18.5
Height (cm)	149.1 ± 6.4	147.4 ± 6.3	153.3 ± 4.6
BMI (kg/m^2)	31.5 ± 6.8	31.5 ± 6.8	31.6 ± 7.4
Body Fat %	40.0 ± 11.3	42.5 ± 11.0	33.6 ± 10.3
REE (ml/kg/min)	2.3 ± 0.4	2.3 ± 0.4	2.3 ± 0.4
Resting HR (bpm)	60.3 ± 9.5	60.4 ± 10.9	60.2 ± 6.4

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Table 2. Steady state VO_2 and METs during the treadmill walking protocol

Stage	N	VO_2 (ml/kg/min)	METs
1.5 mph	21	9.0 ± 0.8	4.0 ± 0.6
2.0 mph	21	9.7 ± 1.4	4.3 ± 0.7
2.5 mph	21	12.3 ± 1.7	5.5 ± 1.2
3.0 mph	14	14.7 ± 1.2	6.2 ± 1.0
3.5 mph	8	18.9 ± 1.2	7.2 ± 0.7
4.0 mph	2	24.6 ± 1.6	8.4 ± 0.3

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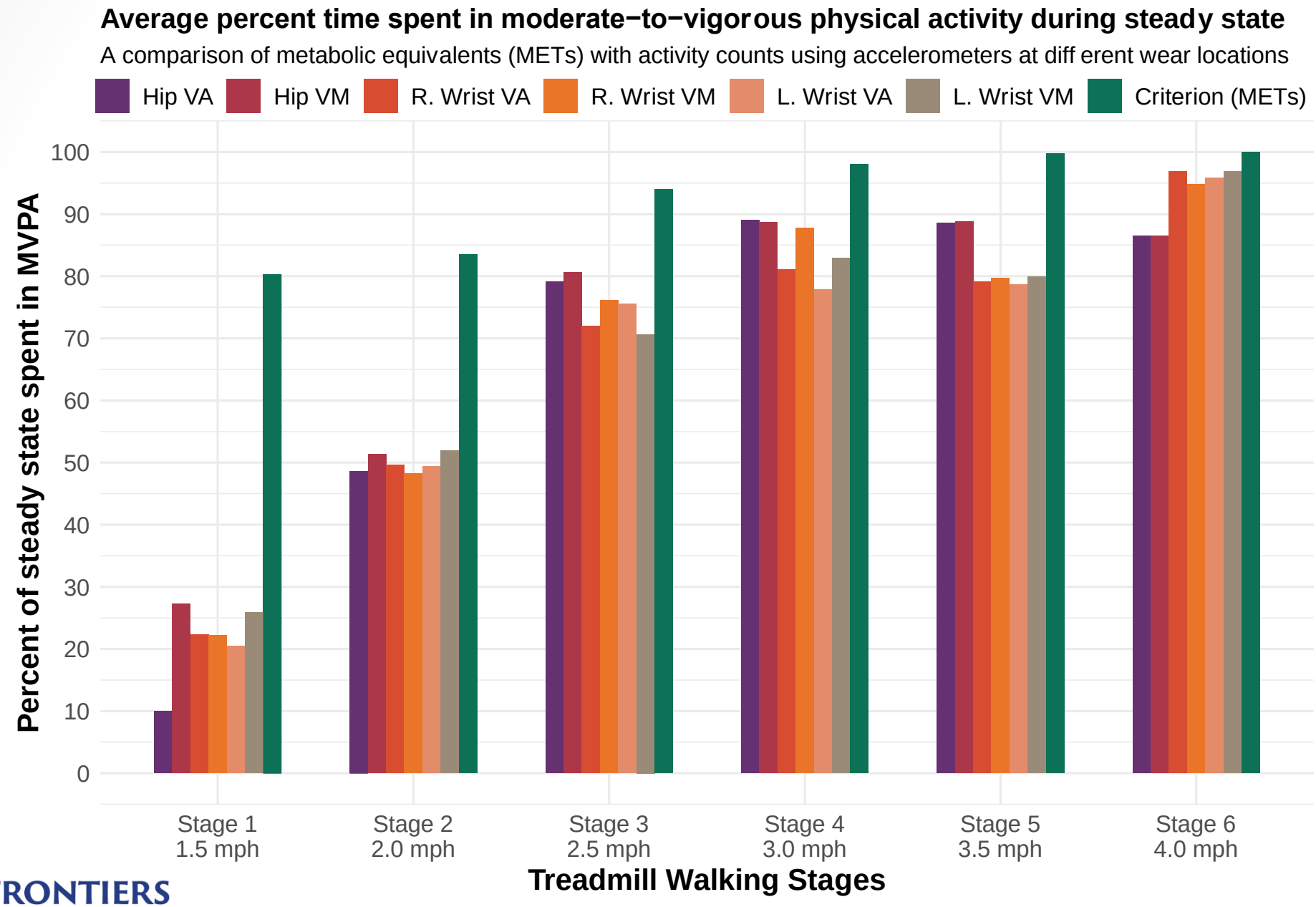
Table 3. ActiGraph cut-points measured in activity counts over 5-second epochs

	Cut-point	Accuracy	Sensitivity	Specificity	AUC
Left Hip					
Vertical Axis	113	0.601	0.604	0.601	0.602
Vector Magnitude	237	0.664	0.659	0.665	0.662
Right Wrist					
Vertical Axis	214	0.595	0.592	0.595	0.594
Vector Magnitude	399	0.617	0.616	0.617	0.617
Left Wrist					
Vertical Axis	194	0.629	0.626	0.630	0.628
Vector Magnitude	349	0.653	0.652	0.653	0.652



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Down Syndrome Cut-point Comparison

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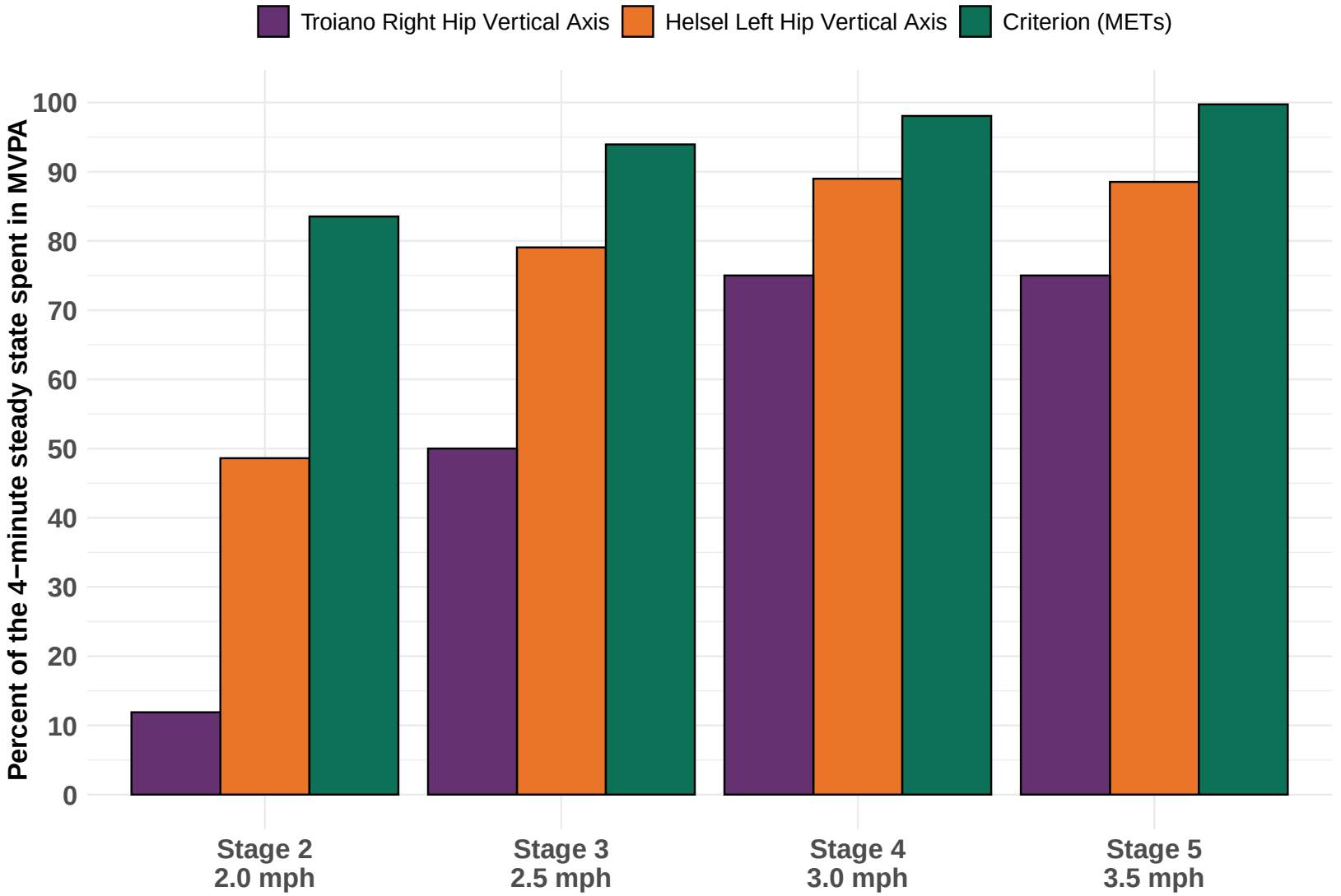

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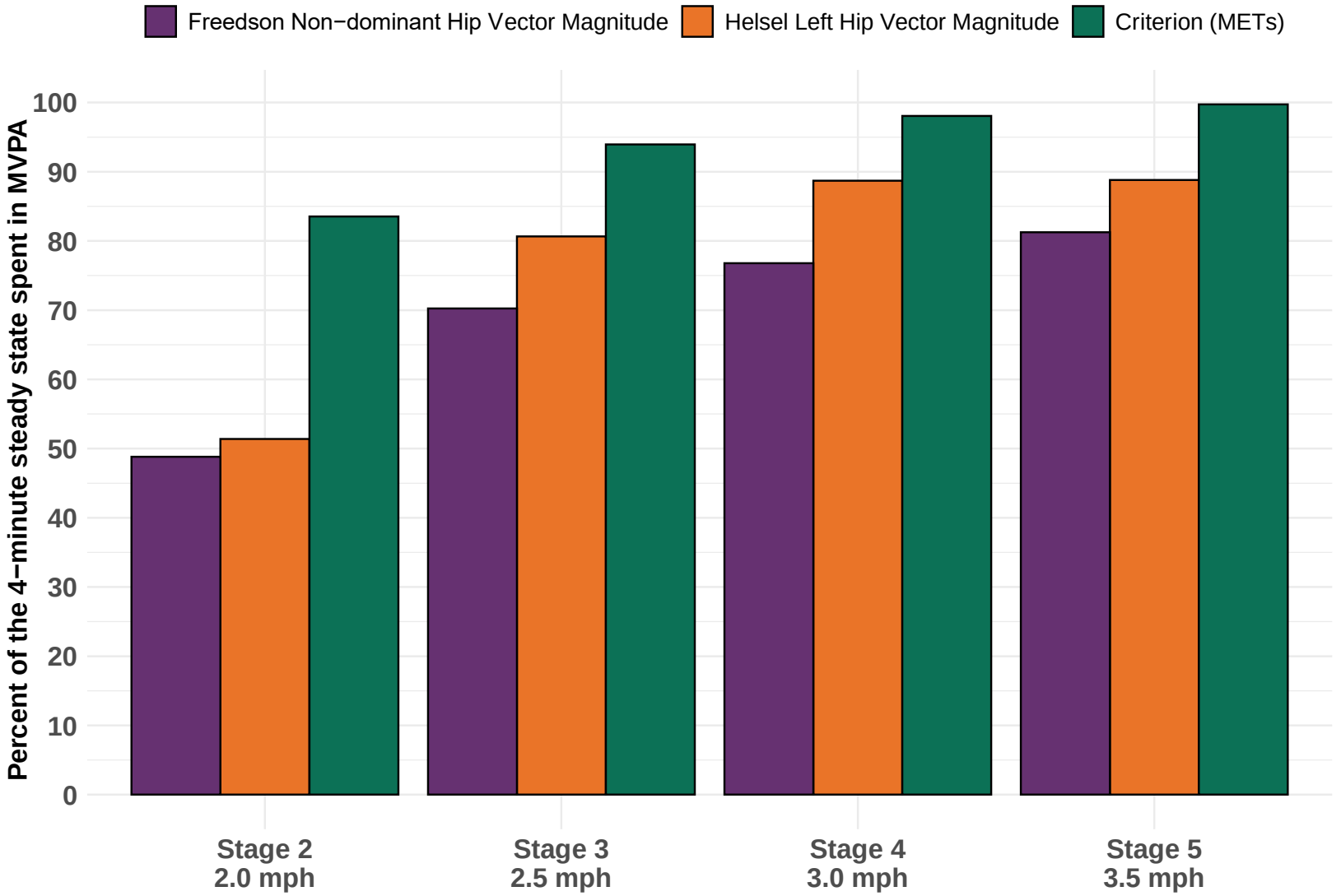

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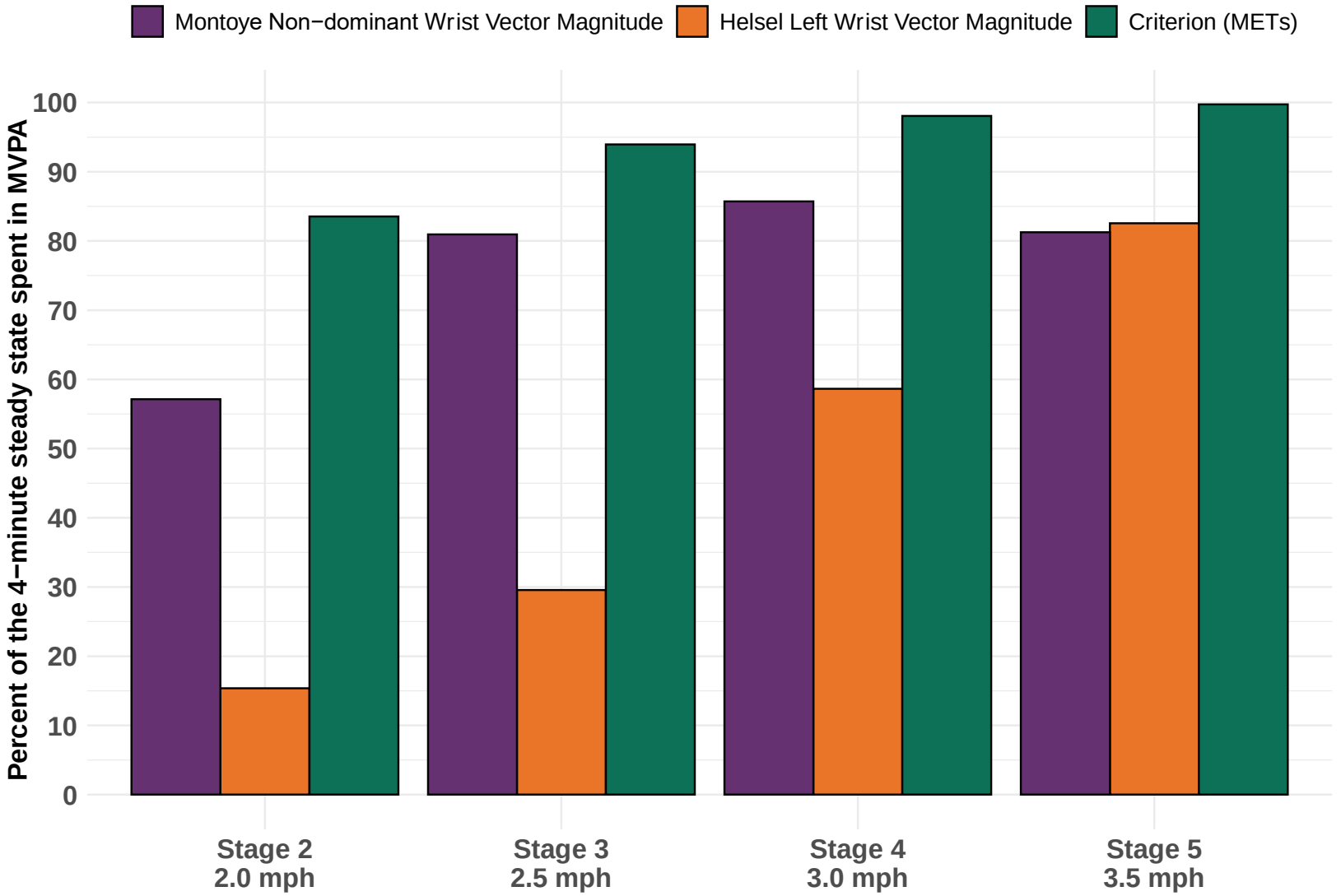

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Limitations

- Adults with Down syndrome were at moderate intensity exercise during the first stage (1.5 mph).
- Comparison of accelerometer cut-points are difficult due to inconsistent sample frequencies, epochs, and wear locations.
- Down syndrome cut-points can only be applied to treadmill walking and may not be transferable to free-living physical activity.

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Conclusions & Future Directions

The left hip-worn ActiGraph vector magnitude cut-point (233 counts/5-sec) provided the highest accuracy for classifying MVPA during TM walking.

Future directions

- Confirmation of our results in a larger sample of adults with Down syndrome during both treadmill and overground walking is warranted.
- Develop and validate free-living accelerometer activity intensity cut-points (pending K01 application).
- Use the newly developed cut-points to explore the impact of physical activity on the risk of Alzheimer's disease in Down syndrome.

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