



# The Impact of Vigorous Exercise on Behavior Problems and Academic Engagement among Adolescents with Autism Spectrum Disorder

Ashley C. Woodman<sup>1</sup>, Miriam Evans<sup>2</sup>, Rebecca Golden<sup>3</sup>, Yumiko Mori<sup>4</sup>, & John Maina<sup>4</sup>

<sup>1</sup>University of Massachusetts Amherst, Amherst, MA, USA; <sup>2</sup>EdTogether, Inc., Boston, MA, USA;

<sup>3</sup>Boston Children's Hospital, Boston, MA, USA; <sup>4</sup>Boston Higashi School, Randolph, MA, USA



## Background

- Children with autism spectrum disorder (ASD) generally experience less active lifestyles than their typically developing peers (Wachob & Lorenzi, 2015).
- Over the life course, this may put them at increased risk for a variety of physical and mental health issues (Srinivasan, Pescatello, & Bhat, 2014).
- More immediately, insufficient exercise may further exacerbate existing behavior problems. Children with ASD display heightened levels of emotional and behavioral problems, even compared to children with other intellectual or developmental disabilities (Brereton, Tonge, & Einfeld, 2006).
- The Role of Exercise**
- Existing research on typically developing youth suggests that those who are more physically active tend to have healthier, more consistent sleep patterns (Brand et al., 2015) and improved social-emotional outcomes (Gregory & Sadeh, 2012).
- Few studies have examined the importance of physical activity on the health and well-being of youth with ASD.
- The research to date has focused on case studies or small samples of young children with ASD. Most of these studies have been further limited by a reliance on subjective measures of physical exertion and a narrow window of observation.
- Although limited, the existing research on the impact of physical activity on well-being among youth with ASD suggests that it is vigorous intensity exercise (such as jogging) that yields the greatest benefit.

### The Present Study

- The present study addresses the existing gaps in the literature by examining the impact of physical activity on behavior problems and academic engagement among adolescents with ASD.
- Unlike previous studies on this topic, this study uses objective measures of exercise intensity (triaxial accelerometers on the waistband).
- This is the first study to examine these hypotheses among adolescents with moderate to severe ASD.

## Research Aims

- What effect does vigorous activity have on behavior problems and academic engagement among adolescents with ASD?
- We expected that greater vigorous intensity activity would be associated with:
  - Reduced problematic behavior
  - Increased academic engagement

## Participants

- 21 junior high students from age 14 to age 18 ( $M = 15.67$  years,  $SD = 0.73$ ) from a private school for students with ASD, the Boston Higashi School. Most participants ( $N = 19$ ) were male.
- An ASD diagnosis is required for admission to this school. Students in this school jog daily and are periodically exposed to music while jogging.

## Measures

### Baseline

- Demographics:** Gender, age, and body mass index (BMI) were collected from the school's health office.
- Maladaptive behaviors:** Scales of Independent Behavior-Revised (SIB-R; Bruininks et al., 1996). Child Behavior Checklist (CBC-L/6-18; Achenbach & Rescorla, 2001). Parent and teacher report.
- Adaptive behavior:** Waisman Activities of Daily Living Scale (W-ADL; Maenner et al., 2013). Parent and teacher report.
- Autism symptom severity:** Autism Diagnostic Observation Schedule, Second Edition (ADOS-2; Lord et al., 2012).
- Intervention (measures collected on two "target days" each week for each student)**
- Maladaptive behavior:** Scales of Independent Behavior-Revised (SIB-R; Bruininks et al., 1996). Student Daily Behavior Log (BHS created). Teacher report.
- Academic engagement:** Behavioral Observation of Students in Schools (BOSS; Shapiro, 2013), measuring percentage of class time on task.
- Exercise intensity:** Omron HJA-750C triaxial accelerometer, measuring number of minutes of vigorous intensity exercise (6+ Metabolic Equivalent of Tasks).

## Procedures

- Consent forms were mailed to parents of all junior high students. Students were shown a social story to obtain their assent. Teachers and parents were consented and asked to complete questionnaires about participating students.
- Data were collected across four weeks. During these four weeks, students wore triaxial accelerometers on their waistbands throughout the school day.
- For two of these weeks, students spent their morning exercise period (approximately 20 minutes) jogging. For the other two weeks, they spent this time walking.
- Immediately following the exercise period, classroom activity was recorded for 20 minutes.

	Week 1	Week 2	Week 3	Week 4
Cohort 1 (Classrooms A&B)	Walk	Walk	Jog	Jog
Cohort 2 (Classrooms C&D)	Jog	Jog	Walk	Walk

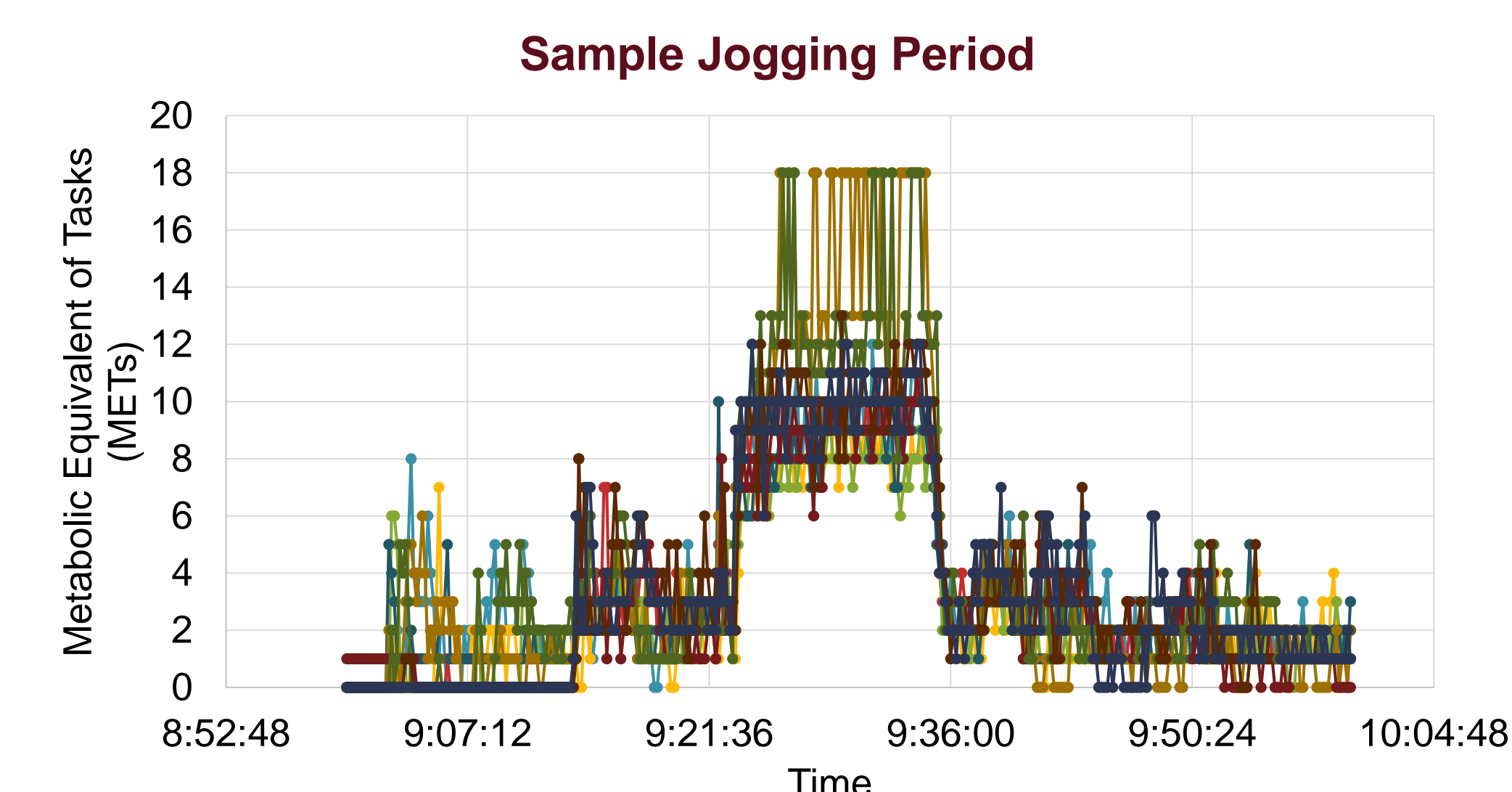
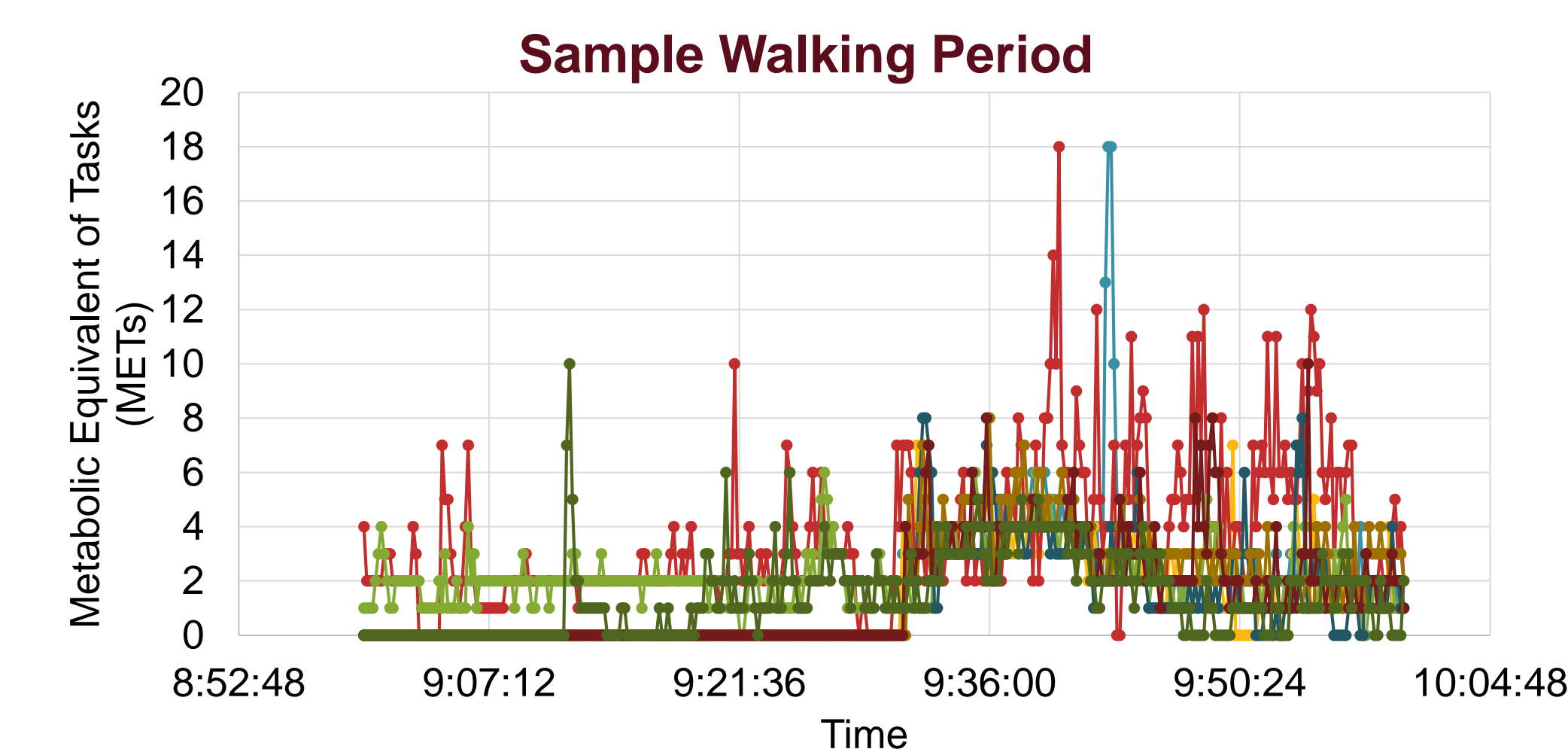
## Results

### Analytic Plan

- Hierarchical Linear Modeling (HLM) was used to examine the impact of vigorous intensity exercise on outcomes. Observations over time (Level 1) were nested within students (Level 2).
- Parallel analyses were conducted for each outcome variable: maladaptive behavior (SIB-R), maladaptive behavior (Student Daily Behavior Log); academic engagement (BOSS).
- Analyses controlled for baseline autism symptoms (ADOS-2), maladaptive behavior (CBC-L), and week.

### Preliminary Analyses

- The number of minutes of vigorous activity was significantly higher for students in the jogging condition than in the walking condition.
- On average, students had less than one minute of vigorous exercise in the walking condition ( $M = 0.94$ ,  $SD = 1.27$ ) and nearly 12 minutes of vigorous exercise in the jogging condition ( $M = 11.61$ ,  $SD = 5.22$ ).
- The number of minutes of vigorous activity in either exercise condition did not differ by cohort.



## Main Analyses

	Maladaptive Behaviors (SIB-R) <sup>c</sup>		Maladaptive Behaviors (Student Daily Behavior Log)		Academic Engagement (BOSS) <sup>d</sup>	
	b	S.E.	b	S.E.	b	S.E.
Fixed Effects						
Intercept	108.26	1.21***	2.01	0.49***	52.09	4.22***
Baseline autism symptoms <sup>a</sup>	-0.18	0.51	0.23	0.21	-3.01	2.03
Baseline externalizing behavior <sup>b</sup>	0.39	0.10***	0.15	0.04***	-0.54	0.37
Week	-0.66	0.55	-0.25	0.24	2.71	1.87
Minutes of vigorous activity <sup>c</sup>	-0.15	0.05**	-0.04	0.02*	0.29	0.13*
Random Effects	Var. Comp.	S.D.	Var. Comp.	S.D.	Var. Comp.	S.D.
Intercept	2.89	8.33*	0.81	0.90	117.17	10.82**
Minutes of vigorous activity	0.01	0.10	<0.01	0.02	0.02	0.15
Level-1 (R)	21.05	4.59	4.63	2.15	185.02	13.60

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

<sup>a</sup>Autism Diagnostic Observation Schedule (ADOS-2), <sup>b</sup>Child Behavior Checklist (CBCL/6-18), <sup>c</sup>Scales of Independent Behavior-Revised (SIB-R), <sup>d</sup>Behavioral Observation of Students in Schools (BOSS)

- Greater vigorous activity predicted significantly **fewer maladaptive behaviors**, according to both measures (SIB-R, Student Daily Behavior Log). Vigorous activity was predictive of each SIB-R subscale (Internalized, Externalized, and Asocial Behaviors) as well as the General Maladaptive Index score.
- Greater vigorous activity predicted significantly **higher academic engagement**. In other words, on days when students engaged in more vigorous activity, they spent a greater percentage of their time on task during the classroom observation.

## Discussion

- Although this sample lacked gender and racial/ethnic diversity, it is one of the first studies to examine the impact of vigorous activity on behavior problems and academic engagement in adolescents with moderate to severe ASD.
- This study showed that exercise intensity is highly variable within students jogging together, which underscores the importance of individualized, objective measurement of physical activity.
- The findings suggest that increasing physical activity in school settings may lead to a reduction in problematic behavior observed throughout the school day as well as an increase in students' ability to stay focused on academic tasks.
- Jogging is a low-cost, low-risk, accessible form of physical activity that may yield great benefits for youth with ASD.