

# Calibration and Validation of a Wrist Worn Accelerometer for 8 to 12 Year Old Children

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## BACKGROUND

Currently, there is no valid method of distilling physical activity data from the wrist-worn ActiGraph GT3X+ accelerometer in 8-12 year old children. Without cutoff values, the raw data can not be meaningfully interpreted. The purpose of this study was to calibrate and cross-validate a wrist-worn accelerometer in 8-12 year old children in a free-living setting.

## METHODS

### Participants and Setting

- Children between the ages of 8 and 12 attending one of three YMCA summer camps in Columbia, SC.

### Activities Performed

- Activities were performed in pairs (2 children at a time).
- Included intensity ranges from sedentary to vigorous
- Each activity was performed for 10 minutes.
- Activities included: rest, enrichment (coloring/drawing), walking, playground, splashpad, swimming and the PACER.

### Data Analysis

Minutes 5-8.5 of each activity were used for data analysis. Descriptive statistics were calculated for all variables. Direct observation (DO) and percent of heart rate reserve (HRR) were used to determine activity intensity. Sedentary and light intensities were determined by DO. HRR ranging from 50-69.99% was classified as moderate, and HRR over 70% was classified as vigorous activity.

Sedentary/Light Cutpoint  
162 counts/5second:  
AUC: 0.894



Light/Moderate Cutpoint  
530 counts/5seconds  
AUC: 0.808

Moderate/Vigorous Cutpoint  
1462/5seconds  
AUC: 0.668

Table 2. Cutpoints/15sec, Sensitivity, Specificity and Area Under the Curve Based on ROC Curves

Intensity Category	Counts/15s	Sensitivity (%)	Specificity (%)	AUC (95% CI)	Cross-Validation AUC (95% CI)
Sedentary	<485				
Light	486-1589	61.67	91.80	0.894 (0.881-0.907)	0.896 (0.882-0.911)
Moderate	1590-4384	80.94	69.87	0.808 (0.777-0.839)	0.828 (0.800-0.856)
Vigorous	4385+	65.98	66.96	0.668 (0.626-0.709)	0.648 (0.602-0.693)
MVPA	1590+	95.02	80.66	0.877 (0.863-0.891)	0.873(0.857-0.888)

\*AUC: Area Under the Curve, \*CI: Confidence Interval, \*MVPA: Moderate to Vigorous Physical Activity

## METHODS

Receiver Operator Characteristic Analyses (ROC) were used to derive cutoff values for light, moderate and vigorous physical activity. The ROC curves were calculated by dichotomizing intensities and then determining the cutoff value at which both sensitivity and specificity were maximized. A 10-fold calibration and cross validation were performed to ensure the most accurate derivation of cutoff values and area under the curve (AUC) values.

## RESULTS

There were 45 total participants with an average age of 9.3±1.2 years. Participants were 49% male and 40% were overweight or obese. The average height of participants was 143±9.5 centimeters, and the average weight was 40.1±10.6 kilograms. Cutpoints were derived based on 5 second epochs, and were translated into 15 second cutpoints for comparison to other published cutpoints.

## CONCLUSIONS

This field-based calibration study was the first to our knowledge to calibrate a wrist-mounted accelerometer for children ages 8-12. The derived cutpoints can distinguish sedentary, light, moderate, and moderate-to-vigorous activity with confidence. The ROC analysis to derive the vigorous outpoints resulted in poor classification ability. However, for purposes of measuring sedentary, light, and moderate-to-vigorous physical activity, these cutpoints can be used with confidence in settings where wrist placement is advantageous.

Figure 1. Distributions of Counts by Activity Intensity

Table 1. Descriptive Statistics

Activity	n	Percent of Heart Rate Reserve			Accelerometer Counts		
		Mean (SD)	Mean (SD)	Mean (SD)	IQR (Median)	IQR (Median)	IQR (Median)
Enrichment	45	2.2 (5.8)	4.9 (3.7)	7 (6.2)	0 - 45 (0)	0 - 34 (0)	0 - 108 (13)
Walk	45	27.9 (8.4)	27.5 (8.6)	30.5 (5.4)	229 - 478 (332)	227 - 408 (332)	243 - 425 (327)
Playground	7	49.9 (11.7)	--	49.9 (11.7)	172 - 770 (426)	--	172 - 770 (426)
Splashpad	11	31.7 (17.5)	32.2 (17.0)	--	214 - 795 (470)	214 - 795 (470)	--
Swimming	7	39.1 (15.4)	--	39.1 (15.4)	421 - 933 (663)	--	421 - 933 (663)
PACER	45	82.8 (14.9)	83.3 (14.9)	77.5 (14.1)	1302 - 2047 (1627)	1288 - 2036 (1620)	1302 - 2047 (1753)

\*IQR: Interquartile Range, SD: Standard Deviation, PACER: Progressive Aerobic Cardiovascular Endurance Run