wear compliance, particularly when sleep monitoring is important or for younger age groups and when the 24h activity cycle is a primary endpoint.

Technical Challenges and Considerations

Comparing ActiGraph CentrePoint Insight Watch, GT9X Link, and wGT3X-BT Accelerometers to NHANES 2011-2014 GT3X+ Devices Using an Orbital Shaker

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Background: With many researchers seeking to compare their accelerometry data to the NHANES dataset, it is important to establish equivalence between current ActiGraph device generations and the GT3X+. Doing so may help to characterize potential inter-generational differences in data stemming from hardware or firmware changes over time. Methods: ActiGraph devices (15 of each) wGT3X-BT, GT9X CentrePoint Insight Watch (CPIW), and original GT3X+ devices used in the 2011-2014 NHANES data collection were tested on a modified VWR benchtop orbital shaker between 0-250 RPM [~0-3500 milli-g (mg)] in increments of 25 RPM. All devices were tested at 80 Hz except CPIW (64 Hz). Raw vector magnitude (VM) was evaluated as the primary outcome. Equivalence was evaluated two ways: 1) using a ±50 mg threshold and 2) using a ±5% equivalence zone based on the mean GT3X+ VM at each frequency suggested by ActiGraph. Devices are considered statistically equivalent if the 90% confidence intervals fall completely within the equivalence zone. Results: Using either the ±50 mg (Figure 1A) or ±5% prespecified equivalence zone (Figure 20), all devices were statistically equivalent throughout the range of accelerations except the GT9X and wGT3X-BT devices at the highest accelerations. However, the VMs of the newer devices were consistently below the GT3X+, except the CPIW at the highest accelerations (225 and 250 RPM or 3000 and 3600 mg). Conclusion: All ActiGraph generations were found to be statistically equivalent across a range of simulated accelerations to those observed in human studies. However, it is unknown if the consistent small disparities in raw accelerations between device generations detected by mechanical oscillator will lead to practical differences in week-long remote monitoring assessments of physical behavior.

Comparison of a Head-Worn Accelerometer to a Hip-Worn ActiGraph GT9X for Classifying Activity Type and Estimating Energy Expenditure

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Introduction: The purpose of this study was to compare the head-mounted automated ingestion monitor (AIM) to a hip-worn ActiGraph GT9X (GT9X) for classifying activity type and estimating energy expenditure (EE). Methods: Adult participants (N=9, 8 males; mean±SD; 25.1±3.5 y, 179.3±7.4 cm, 81.7±18.1 kg) completed eight structured activities ranging from sedentary (e.g., seated computer work) to vigorous intensity (e.g., treadmill running at 6 MPH, 0% grade). Participants wore an AIM affixed to the right arm of a generic pair of eyeglasses, a GT9X on the right hip, and a Cosmed K5 was used as the criterion measure of EE. Both the AIM and GT9X collected accelerometer (128 Hz and 90 Hz, respectively) and gyroscope (128 Hz and 100 Hz, respectively) data. GT9X gyroscope data were down-sampled to 90 Hz and merged with the GT9X accelerometer data. Vector magnitude was calculated for the AIM and GT9X prior to being collapsed to 1-s means of each sensor signal and computing basic time domain features including: mean, standard deviation (SD), coefficient of variation (CV), variance, mean amplitude deviation (MAD), min, and max in rolling 10-s windows. Two series of random forest models were developed and cross-validated using a leave-one-participant-out-cross-validation procedure to A) classify activity type (7 participants) and B) estimate EE (6 participants) using 1) only accelerometer data, 2) only gyroscope data, and 3) accelerometer + gyroscope data combined. Model performance was reported as mean F1 (harmonic mean of precision and recall) for activity classification and root mean square error (RMSE) for the EE estimation. Results: For all three approaches, the GT9X achieved higher F1 scores by an average of 8.6%, while the AIM achieved a lower RMSE by an average of 0.43 METs. Conclusion: These results show proof-of-concept that a head-mounted device can be used to characterize physical activity parameters typically collected at other attachment sites such as the hip. (Figure 21)

Impact of Using a 60, 80, 90, or 100 Hz Versus 30 Hz ActiGraph Sampling Rate on Free-Living Physical Activity Assessment in Youth

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Using an ActiGraph sampling rate of more than 30 Hz has been shown to result in overestimation of activity counts in both children and adults but research on free-living individuals has not included the full range of sampling frequencies used by researchers. Objective: The present study compared count- and raw-acceleration-based metrics from free-living children and adolescents across a range of ActiGraph sampling frequencies. Methods: Children and adolescents (n=457; 10-15 y) wore an ActiGraph accelerometer over the right hip for at least one 8-h day. Vector Magnitude counts, Mean Amplitude Deviation, Monitor-Independent Movement Summary (MIMS) units, and activity intensity classified using six different methods (four cut-point based approaches, a two-regression model, and an artificial neural network) were compared between 30 Hz and 60, 80, 90, and 100 Hz sampling frequencies using mean absolute differences, correlations, and equivalence testing. Results: All outcomes were considered statistically equivalent, and correlation coefficients were ≥0.984. Absolute differences were largest for the 30 vs. 80 and 30 vs. 100 Hz count comparisons. For comparisons of 30 with 60, 80, 90, or 100 Hz, mean (and maximum) absolute differences in minutes of moderate-to-vigorous physical activity per day ranged from 0.04 to 0.13 (0.23 to 0.96), 0.13 to 1.00 (1.01 to 4.30), 0.09 to 0.18 (0.68 to 1.44), and 0.13 to 2.00 (0.99 to 9.90). At the epoch-level (per 5-sec), mean absolute percent differences between 30 and 60, 80, 90, or 100 Hz were highest for counts (2.9, 7.5, 4.0, 9.7%) and lowest

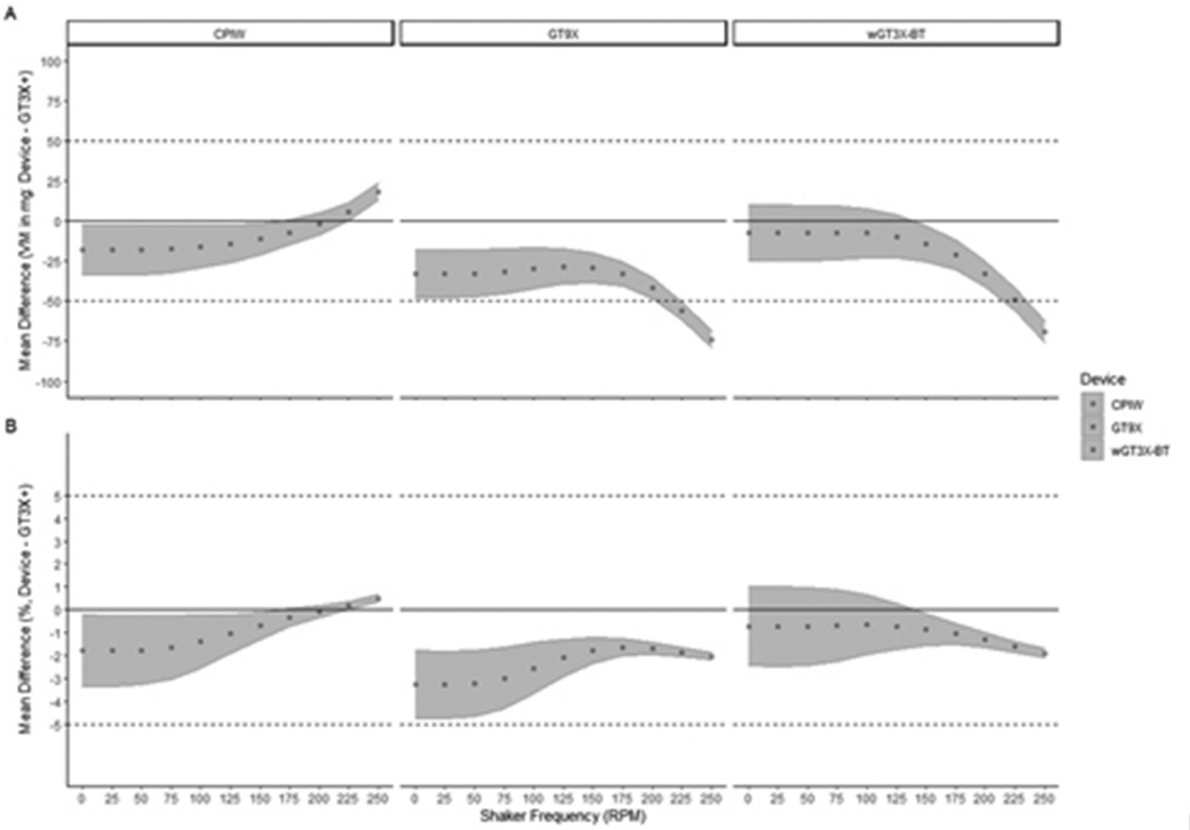

Figure 1. Mean differences in vector magnitude (in milli-g's) are shown for the CentrePoint Insight Watch (CPIW), GT9X, and wGT3X-BT compared to the GT3X+ by shaker frequency. A) 50 milli-g equivalence zones and B) 5% equivalence zones are shown are shown in the dashed lines and the shaded regions are the 90% confidence intervals for the mean differences for each device.

Figure 20