Fitbit Accelerometer: Validation and Comparison to Self-Report Measures

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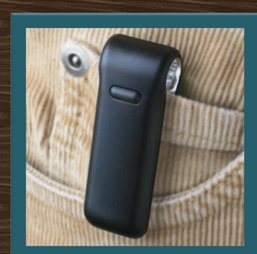
BACKGROUND

- The legitimacy of self-reports is a highly debated issue in the research community. Technological devices, such as accelerometers, have proven to be useful tools for validating self-report measures.
- Limited research is available for the use of accelerometers to validate self-reported sleep measures.
- Montgomery-Downs, Insana, & Bond (2012) investigated the accuracy of the Fitbit accelerometer compared to a Polysomnography sleep-measurement device.



OBJECTIVES

- This study attempts to validate the findings of subjective self-report measures by the use of a Fitbit Accelerometer.
- The main variables, sleep and physical-activity, were captured by both the Fitbit accelerometer and self-report measures.
- We evaluate both between-person (BP) and within-person (WP) relationships between participants' self-report responses with similar indices obtained from Fitbit accelerometer data.

METHOD

- University students participated in a 7-day study consisting of daily self-report surveys.
- Participants were instructed to wear a Fitbit accelerometer to measure their physical activity and sleep patterns.
- The Fitbit is a MEMS accelerometer that measures participant's motion patterns on 3-axis (magnitude, proper and coordinate acceleration). The Fitbit was utilized in this study to monitor participants steps, floors climbed, and distance travelled. These measures were used to compute time spent in light, moderate, and high intensity physical activity.
- The Fitbit measured participant's sleep through it's built-in motion and vibration sensor, which provided multiple measures of sleep: number of hours of sleep, number of times awakened, minutes to fall asleep, and sleep efficiency.

RESULTS

Table 1. **Within-person and between-person comparisons of Fitbit recorded and self-reported physical activity.**

Self-Reported Physical Activity

Fitbit Measured Physical Activity	Light		Moderate		High		Mod + High		Total	
	WP	BP	WP	BP	WP	BP	WP	BP	WP	BP
Low Intensity	0.205	-0.661								
Moderate Intensity			0.247	0.287						
High Intensity					0.541**	0.384†				
Mod + High Intensity							0.363*	0.307†		
Total Activity									0.436**	-0.195

Table 2. **Within-person and between-person comparisons of Fitbit recorded and self-reported sleep.**

Self-Reported Sleep

Fitbit Measured Sleep	Hours of Sleep		Times Awakened		Minutes to Sleep		Sleep Quality	
	WP	BP	WP	BP	WP	BP	WP	BP
Hours of Sleep	0.702**	0.817**						
Times Awakened			-0.003	0.024				
Minutes to Sleep					0.140	0.363		
Sleep Efficiency							0.047*	0.019

Note. †p < .10; *p < .05; **p < .001

Figure 1: Physical Activity Means across 6 Days

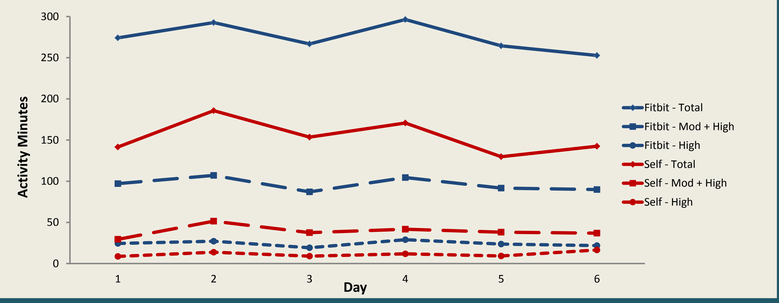
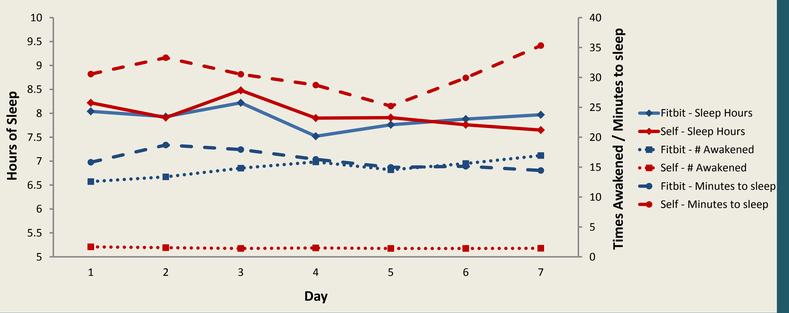


Figure 2: Sleep Means across 7 Days



DISCUSSION

Physical Activity (PA) Measures

- No significant WP or BP correlations were found across low and moderate PA or for BP correlations for high PA intensity, indicating low validity coefficients across objective and self-report indices. Participants frequently self-reported lower levels of activity.
- A modest relationship was found for daily WP variation in high PA intensity. For every one minute of Fitbit recorded high intensity activity, participants reported 0.54 minutes. No BP relationship was found.
- Participants reported 0.44 minutes of total activity for every one Fitbit minute recorded. No statistically significant relationships between person-mean scores of PA were found.
- A limitation of the physical activity comparison was the discrepancy of boundaries between low, moderate, and high intensities. Some participants may have been confused as to which activity fell into a level of intensity on their self-report questionnaire.
- In summary, criterion-related validity was found to be poor for self-report physical activity relative to the Fitbit accelerometer.

Sleep Measures

- The comparison of hours of sleep between the Fitbit recordings and participant self-reports found that for every one minute recorded by Fitbit, participants reported 0.70 minutes for daily variation, and 0.82 minutes on average.
- No relationship was found for the reported number of times awakened, quality of sleep, and the number of minutes it took participants to fall asleep.
- Research by Montgomery-Downs et al., (2012) identified a limitation of the Fitbit for recording sleep. Fitbit overestimated sleep efficiency and total sleep time, which was also found in this study. The Fitbit accelerometer computed awakenings by movements in between lapses in movement.
- However, we found that self-reported number of sleep hours were very similar to the number of hours recorded on the Fitbit.

REFERENCE

Montgomery-Downs, H.E., Insana, S.P., & Bond, J.A. (2012). Movement toward a novel activity monitoring device. *Sleep and Breathing, 16*(3), 913-917.