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Validity of wearable physical activity monitors during activities of daily living

Skyler Brooke
University of Nebraska at Omaha, Sbrooke@unomaha.edu

Hyun-Sung An
University of Nebraska at Omaha, han@unomaha.edu

Danae M. Dinkel
University of Nebraska at Omaha, dmdinkel@unomaha.edu

John M. Noble
University of Nebraska at Omaha, johnnoble@unomaha.edu

Jung-Min Lee
University of Nebraska at Omaha, jungminlee@unomaha.edu

UNIVERSITY OF NEBRASKA AT OMAHA

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Skyler M. Brooke, Hyun-Sung An, Danae M. Dinkel, John M. Noble, Jung-Min Lee, School of Health, Physical Education and Recreation, University of Nebraska - Omaha

ABSTRACT

PURPOSE: To evaluate the validity of wearable activity monitors in SPT and EE under free-living environment. **METHODS:** Thirty-nine (24.9±5.4 years) healthy males (n=26) and females (n=11) participated in this study. Total SPT and EE were measured by eight monitors; Nike+Fuel Band SE (NFB), Garmin VivoFit (VF), Misfit Shine (MF), Fitbit Flex (FF), Jawbone UP (JU), Basis B1 (BB1), Polar Loop (PL), and Sense Wear Armband Mini (SWA). The monitors were worn for at least 23 hours to be included in final data analysis and no PA restriction was applied. The SWA and a sleep log were used as a criterion measure for SPT and EE, respectively. **RESULTS:** Total 24 hours of EE (Kcal) (means±SD) were 3234.51±977, 2352.2 ±423, 2291.4±567, 2679.8±752, 1955.4±251, 2950.9±864, 2724.9 ±627, 2822.1±525 for SWA, VF, JU, PL, BB1, FB, NFB, and MF, respectively. Mean absolute percent errors (MAPE) were calculated (means±SD) 23.4%±8.0, 24.2%±8.8, 14.0% ±9.7, 28.9% ±22.0, 17.5%±12.1, 16.9%±12.8, and 17.7%±15.0 for the VF, JU, PL, BB1, FB, NFB, and MF, respectively. SPT in minutes (mean±SD) were 481±83.32, 370.1±86.9, 432.9±93.2, 467.7 ±51.2, 440.6±85.7, 424.6±103.3, 480.3±128.6, 436.6±35.3, and 436.2±78.2 for the log, SWA, SWA laying down, VF, JU, PL, BB1, FB, and NFB, respectively. MAPE were calculated for SPT (mean±SD) 22.77% ±13.6, 12.96±11.510.58% ±25.1, 11.6%±9.3, 18.2%±16.4, 14.6%±7.7, 8.7%±9.3, and 13.5%±9.9 for the SWA, SWA laying down, VF, JU, PL, BB1, FB, and MF, respectively. ANOVA and post-hoc analyses with LSD indicated no significant differences were found with the FB, NFB, and MF in EE estimates. Additional post-hoc analyses with LSD for SPT revealed no significant difference (P>.05) in all monitors except SWA. **CONCLUSION:** The present study indicates that the FF, MS, and NFB are the most accurate wearable activity monitors when estimating EE and all monitors provide reasonable estimates of sleep period time, except SWA.

INTRODUCTION

- The increased popularity of wrist worn wearable technology may provide a valid way to measure physical activity.
- The validity of wearable monitors have not been evaluated in free living conditions.

PURPOSE

- To evaluate the validity of wearable activity monitors in SPT and EE under free-living environment

METHODS

- Thirty-nine (24.9±5.4 years) healthy males (n=26) and females (n=11) participated in this study.

METHODS (Cont.)

- Total SPT and EE were measured by eight monitors; Nike+Fuel Band SE (NFB), Garmin VivoFit (VF), Misfit Shine (MF), Fitbit Flex (FF), Jawbone UP (JU), Basis B1 (BB1), Polar Loop (PL), and Sense Wear Armband Mini (SWA).
- The SWA and a sleep log were used as a criterion measure for SPT and EE, respectively.

Sensewaear Armband Mini | Jawbone UP | Nike Fuel Band SE | Basis B1 | Fitbit Flex | Garmin VivoFit | Misfit Shine | Polar Loop

RESULTS

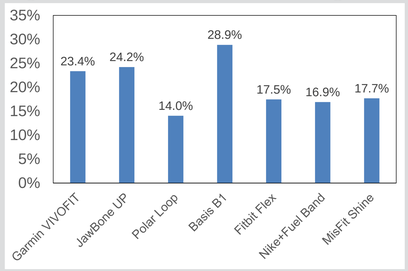
Table 1. Descriptive Statistics (Mean ± SD) for EE and SPT for all monitors

Monitors	Mean ± SD	Range
SWA	3234.5 ± 976.9	1874 - 6532
VIVOFIT	2352.2 ± 472.7	1882 - 3510
JAWBON	2291.4 ± 566.9	1703 - 3724
POLAR	2679.9 ± 752.2	1804 - 3999
BASIS B1	1955.4 ± 250.6	1595 - 2168
FITBIT FLEX	2950.9 ± 864.3	1716 - 5029
NIKE+FUEL	2724.9 ± 627.7	1899 -3724
MISFITEE	2822.1 ± 525.6	2044 - 3986

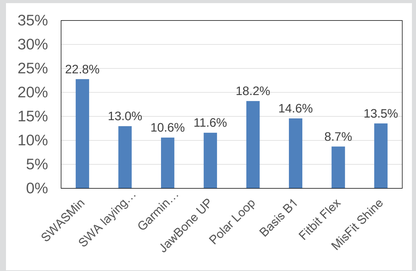
Monitors	Mean ± SD	Range
SLEEP LOG	481.0 ± 83.3	266 - 673
SWA	370.0 ± 86.9	222 - 550
SWA laying down	432.9 ± 93.2	241 - 611
VIVOFIT	467.8 ± 51.2	335 -521
JAWBON	440.6 ± 85.7	215 -551
POLARS	424.6 ± 103.3	205 - 561
BASIS B1	480.3 ± 128.6	336 - 604
FITBIT FLEX	436.5 ± 35.3	391 - 498
MISFIT SHINE	436.2 ± 78.2	300 - 562

- SPT in minutes (mean±SD) were 481±83.32, 370.1±86.9, 432.9±93.2, 467.7 ±51.2, 440.6±85.7, 424.6±103.3, 480.3±128.6, 436.6±35.3, and 436.2±78.2 for the log, SWA, SWA laying down, VF, JU, PL, BB1, FB, and NFB, respectively

Figure 1. Mean absolute Percentage Error for EE and SPT for all monitors



- The mean absolute percent error for each consumer monitor for EE.



- The mean absolute percent error for each consumer monitor for SPT.

RESULTS (Cont.)

Table 2. Correlation Matrix for EE for all monitors

	SWA	VIVOFIT	JAWBONE	POLAR	BASIS B1	FITBIT FLEX	Nike+Fuel	MISFIT
SWAEE	1	.871**	.879**	.915**	-0.417	.867**	.640*	.593**
VIVOFIT		1	.968**	1.000**	.c	1.000**	-1.000**	.991**
JAWBONE			1	.993**	.c	-1.000**	.c	.986**
POLAR				1	0.551	0.935	0.788	.733*
BASIS B1					1	.c	.c	1.000**
FITBIT FIEX						1	0.656	.941*
Nike+Fuel							1	0.63
MISFIT								1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

- The Pearson correlation of EE between the consumer wearable monitors and the criterion measure SWA. VF, JU, PL, Fb, show strong correlation with the SWA, whereas BB1, NFB, and MF Shows moderate correlation.

Table 3. Correlation Matrix for SPT for all monitors

	LOG	SWA	SWA laying down	VIVOFIT	JAWBON	POLAR	BASIS B1	FITBIT FLEX	MISFIT
LOG	1	.641**	.661**	.837**	.722**	0.32	0.771	0.53	0.488
SWA		1	.893**	0.424	0.42	0.076	0.914	0.473	0.062
SWA laying down			1	0.085	0.453	0.066	0.895	0.184	-0.097
VIVOFIT				1	.897**	1.000**	.b	1.000**	1.000**
JAWBON					1	0.855	.b	-1.000**	0.805
POLAR						1	-0.976	0.823	0.454
BASISB1							1	.b	
FITBIT FLEX								1	.b
MISFIT									1

**. Correlation is significant at the 0.01 level (2-tailed).

b. Cannot be computed because at least one of the variables is constant.

- The Pearson correlation of the consumer wearable monitors and the criterion measure sleep log. SWA, SWA laying down, PL, FB, and MF show moderate correlation, whereas VF, BB1 show strong correlation.

Conclusion

The FF, MS, and NFB are the most accurate wearable activity monitors when estimating EE and all monitors provide reasonable estimates of sleep period time, except SWA.