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Letter to the Editor

Fitbit®: An accurate and reliable device for wireless physical activity tracking

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Although physicians recognize the importance of physical activity in the prevention and maintenance of chronic diseases [1], few incorporate physical activity counseling into routine clinic visits [2]. One major barrier has been the paucity of means to objectively assess patient's long-term physical activity patterns [3]. We investigated if the Fitbit®, one of the most common wireless physical activity trackers in the consumer market, met reasonable validity and reliability standards such that they could be used by primary care physicians to monitor their patient's physical activity objectively between clinic visits.

Twenty-three healthy adult participants (10 males; age range: 20–54 years; body mass index range: 19.6–29.9 kg/m^2) completed a four-stage treadmill exercise protocol consisting of walking at slow (1.9 mph), moderate (3.0 mph), and brisk (4.0 mph) paces; and jogging (5.2 mph). Each stage was 6 min in duration. Participants were fitted with three hip-based Fitbit One® (two on the right, one on the left hip) and two wrist-based Fitbit Flex® (one on the right and left wrists) devices. Minute-by-minute estimated-energy expenditure and step counts from Fitbit® devices were extracted from the manufacturer's website using Fitabase (Small Steps Labs). Energy expenditure was assessed by gas exchange indirect calorimetry (Ultima CPX, MedGraphics) and aggregated to minute-by-minute epochs. Steps were assessed by manual counting of a video recording in minute epochs. Estimated-step counts and energy expenditure from Fitbit® devices were compared to criterion measures of observed step counts and energy expenditure from indirect calorimetry, respectively. All minutes from each stage were analyzed. This study adhered to the guidelines set forth by the Declaration of Helsinki and was approved by the institutional review board at the participating institution. All participants provided informed consent.

Estimated step counts from the hip- and wrist-based Fitbit® devices strongly correlated with observed step counts (Fig. 1, panels A, B). Across phases, the within-participant correlation of Fitbit-estimated step counts to observed step counts was 0.97–0.99 for all hip devices and 0.77–0.85 for wrist devices. The mean difference of Fitbit-estimated step counts from observed step counts ranged from −3.1 to −0.3 steps and −26.3 steps to −2.9 steps for the hip- and wrist-based devices, respectively (Table 1, top panel). The greatest differences were seen in the wrist-based Fitbit® during slow, moderate, and brisk walking as step counts were underestimated during these stages by 16.3%, 10.6%, and 11.3%, respectively (right wrist).

Hip- and wrist-based Fitbit® estimates of energy expenditure strongly correlated with measured energy expenditure (Fig. 1, panels C, D). Across phases, the within-participant correlation of Fitbit-estimated energy expenditure to measured energy expenditure was 0.86–0.87 for all hip devices and 0.88 for both wrist devices. The mean difference of Fitbit-estimated energy expenditure from measured energy expenditure ranged from −0.8 to 0.4 kcals and −0.2 to 2.6 kcals for the hip- and wrist-based Fitbit® devices, respectively (Table 1, bottom panel). The largest discrepancies were seen in the wrist-based Fitbit® during moderate and brisk walking as energy expenditure was overestimated during these stages by 52.4% and 33.3%, respectively (right wrist).

Inter-device correlations between Fitbit-estimated step counts and energy expenditure of the right hip devices were 0.99 (steps) and 0.96 (energy expenditure), between the right and left hip devices were 0.99 (steps) and 0.97 (energy expenditure), and between the right and left wrist devices were 0.90 (steps) and 0.95 (energy expenditure).

Our study shows that the Fitbit One® and Fitbit Flex® reasonably and reliably estimate step counts and energy expenditure during walking and running (two of the most common activities among

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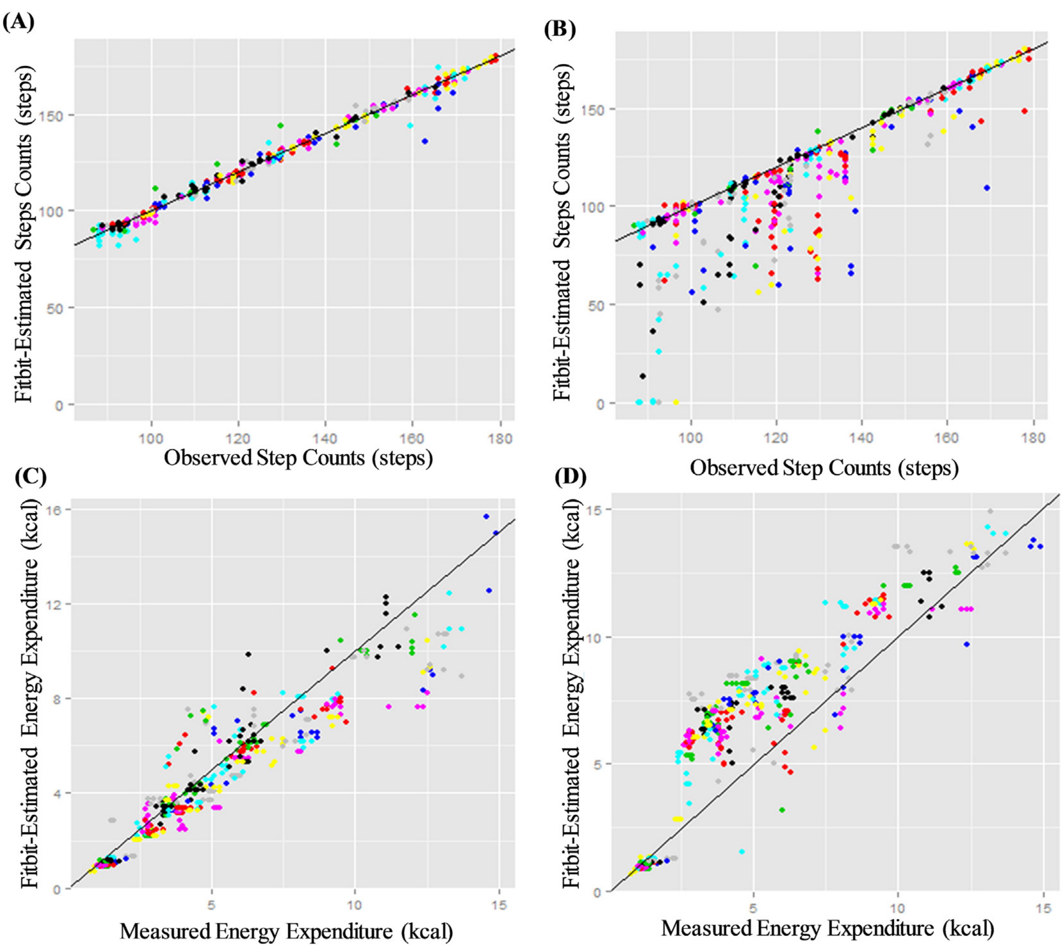

Fig. 1. Relationship of criterion measures of step counts and energy expenditure counts with Fitbit-estimated step counts and energy expenditure. Top panels: relationship of observed step counts with hip-based (A) and wrist-based (B) Fitbit-estimated step counts. Bottom panels: relationship of indirect calorimetry measured energy expenditure with hip-based (C) and wrist-based (D) Fitbit-estimated energy expenditure.

primary care patients); with the hip-based Fitbit One® outperforming the wrist-based Fitbit Flex®. With the capability to wirelessly interface with mobile devices and the growing number of platforms/apps that provide patients a means to share health information with their physician, the Fitbit® may be an accurate, reliable, and efficient tool for physicians to track the adoption/maintenance of physical activity programs and support their patient's attempt at an active lifestyle.

Table 1
Mean difference of Fitbit-estimated step counts and energy expenditure relative to observed step counts (top panel) and energy expenditure measured by indirect calorimetry (bottom panel).

Exercise phase	Observed step counts (steps)[a]	Mean difference of Fitbit-estimated step counts				
		Right hip (front-most)	Right hip (back-most)	Left hip	Right wrist	Left wrist
Overall[b]	123.9 ± 24.4	−0.8 ± 2.8	−2.0 ± 8.3	−1.5 ± 7.6	−11.5 ± 19.7	−19.2 ± 23.2
Slow walk	96.1 ± 6.5	−1.2 ± 2.3	−2.5 ± 7.0	−2.1 ± 7.1	−15.7 ± 28.0	−20.0 ± 26.3
Moderate walk	114.5 ± 6.6	−0.6 ± 1.9	−1.3 ± 8.1	−1.3 ± 8.0	−12.1 ± 15.4	−22.6 ± 21.7
Brisk walk	129.3 ± 7.7	−0.3 ± 2.0	−1.1 ± 9.2	−1.2 ± 9.1	−14.7 ± 18.2	−26.3 ± 25.2
Jogging	159.4 ± 10.4	−0.9 ± 4.2	−3.1 ± 8.9	−1.4 ± 6.1	−2.9 ± 8.4	−7.3 ± 11.7
	Measured energy expenditure (kcal)[c]	Mean difference of Fitbit-estimated energy expenditure				
		Right hip (front-most)	Right hip (back-most)	Left hip	Right wrist	Left wrist
Overall[b]	5.0 ± 3.0	−0.3 ± 1.6	−0.3 ± 1.6	−0.3 ± 1.6	0.9 ± 1.8	1.2 ± 1.9
Slow walk	3.2 ± 0.7	−0.8 ± 1.1	−0.7 ± 1.3	−0.8 ± 1.2	−0.3 ± 1.2	−0.2 ± 1.5
Moderate walk	4.2 ± 0.9	−0.2 ± 0.5	−0.2 ± 0.5	−0.2 ± 0.5	2.2 ± 1.4	2.5 ± 1.6
Brisk walk	6.0 ± 1.6	0.3 ± 1.5	0.4 ± 1.5	0.3 ± 1.4	2.0 ± 1.3	2.6 ± 1.1
Jogging	9.2 ± 3.0	0.3 ± 2.0	0.2 ± 2.0	0.1 ± 2.1	0.7 ± 1.6	1.4 ± 1.5

Data presented as mean ± standard deviation.
[a] Manually counted by two observers from a video recording and averaged.
[b] Data pooled from all four exercise phases.
[c] Measured by gas exchange indirect calorimetry.

Conflicts of interest

None.

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