

ORIGINAL ARTICLE

Validity of Physical Activity Measures in Individuals After Total Knee Arthroplasty



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Abstract

Objective: To determine the concurrent criterion-related validity of 2 activity monitors in comparison with the criterion method of indirect calorimetry in older adults after total knee arthroplasty (TKA).

Design: Validation study.

Setting: Subjects completed 9 increasingly demanding daily activities in a research laboratory; each activity was performed for 7 minutes, for a total of 80 minutes, while the activity monitors and criterion method were used concurrently.

Participants: Subjects (N=21, 67% women) had a mean age \pm SD of 68 \pm 7 years and a body mass index of 29 \pm 4.

Interventions: Not applicable.

Main Outcome Measures: Energy expenditure (in kcal/min) measured by accelerometer-based and multisensor-based monitors and by a criterion method. Validity was assessed by the paired *t* test, intraclass correlation coefficient (ICC), and Bland-Altman plots comparing the measurements from the activity monitors with those of the criterion method.

Results: Measurements from the accelerometer-based monitor were significantly lower than those of the criterion method across all walking and nonwalking activities. The underestimations ranged from 40% to 100%. The accelerometer-based monitor demonstrated small to moderate agreement compared with the criterion method (ICCs from 0 to .38). Measurements from the multisensor-based monitor were significantly lower than those of the criterion method during several nonwalking activities; yet, the differences were minor (2%–19%). Measurements from the multisensor-based monitor during walking activities were not different compared with the criterion method. The multisensor-based monitor demonstrated moderate to excellent agreement with the criterion method (ICCs from .48 to .81).

Conclusions: The multisensor-based monitor showed better criterion-related validity than the accelerometer-based monitor and should be considered as a tool to measure physical activity in individuals after TKA.

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Physical activity (PA) is an important construct to be assessed in older adults because it relates to future mobility disability, chronic disease, and mortality.¹ Older adults who underwent total knee arthroplasty (TKA) generally have an inactive lifestyle because of persistent knee pain and functional limitations caused by several decades of living with knee osteoarthritis.²⁻⁴ Thus, investigating the validity of measures to assess PA in individuals after TKA is warranted.

Commonly used activity monitors are accelerometer-based and multisensor-based.⁵⁻¹³ A beneficial aspect of these devices is that they capture PA at several intensities, ranging from sedentary to moderate. The ability of these devices to assess PA at sedentary and light intensities is important since older adults who undergo TKA perform most of their daily activities at light intensities.²⁻⁴ Therefore, research is needed in this population to validate and compare the performance of these devices during PA across a variety of intensities.

Numerous studies⁵⁻¹² have assessed the validity of these activity monitors in separate investigations, reporting mixed results. However, validity of the devices cannot be compared because they have not been assessed concurrently in the same study, and studies

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	Lie-down	Sit-and-read	Computer-work	Stand-and-talk	Stand-and-load shelves	Mopping
VO2000 in kcal/min	1.13±0.35	1.18±0.33	1.40±0.33	1.74±0.46	1.92±0.38	2.47±0.51
ACT in kcal/min	0.00	0.001±0.002	0.001±0.002	0.011±0.022	0.05±0.16	0.18±0.33
Raw Diff. (% diff.)	-1.13 (100%)	-1.18 (100%)	-1.40 (100%)	-1.73 (99%)	1.87 (97%)	2.31 (93%)
ICC	§	0.00	0.00	0.01	-0.01	0.01
P-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
SWA in kcal/min	1.11±0.18	1.03±0.16	1.24±0.19	1.54±0.53	1.66±0.56	2.95±1.10
Raw Diff. (% diff.)	-0.02 (2%)	-0.15 (13%)	-0.16 (11%)	-0.20 (12%)	-0.26 (13%)	0.48 (19%)
ICC	0.81	0.60	0.69	0.81	0.72	0.64
P-value	0.713	0.014	0.006	0.028	0.008	0.015

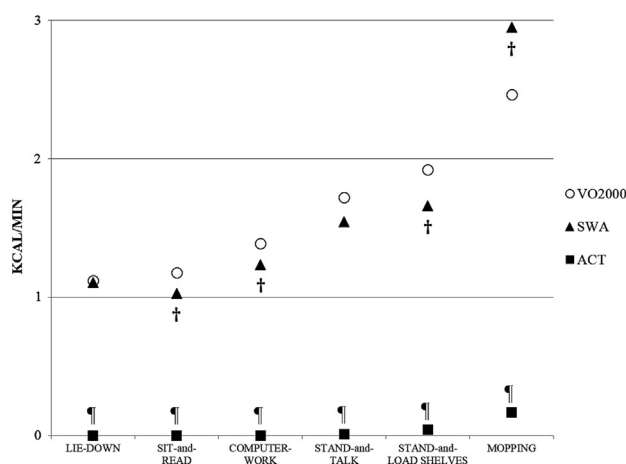


Fig 1 Measures of EE in kilocalories per minute estimated by the ACT and the SWA, in comparison with the VO2000 (criterion method) during nonwalking activities. Numbers represent mean \pm SD, unless otherwise indicated. Abbreviation: Diff., difference between VO2000 and portable monitor. §Not able to calculate because of lack of variance (all ACT values were 0). †Significant difference between measurements from VO2000 and ACT ($P < .025$). ‡Significant difference between measurements from VO2000 and SWA ($P < .025$).

have used diverse populations and methods to estimate PA. In older adults, we are aware of only 1 study¹³ that investigated the concurrent validity of the 2 activity monitors against indirect calorimetry. This study reported a moderate association between measures of energy expenditure (EE) from the accelerometer-based monitor and indirect calorimetry and noted a strong association between the multisensor-based monitor and indirect calorimetry during a protocol that included various activities. To our knowledge, no studies have concurrently compared the performance of these activity monitors against a criterion method during individual activities of several intensity levels in older adults with TKA.

Investigating the concurrent validity of activity monitors to measure individual daily activities performed by individuals after TKA is relevant because their functional limitations and gait deviations may contribute to their inactive lifestyle and may affect

accelerometry data.^{14,15} Comparing the performance of an accelerometer-based to a multisensor-based monitor will also provide evidence for informed decisions by clinicians and researchers when choosing a monitor to measure PA in people with similar characteristics.

The purpose of this study was to determine the concurrent criterion-related validity of 2 activity monitors against indirect calorimetry in measuring EE during sedentary to moderate-intensity activities in older adults after TKA. We hypothesized similar validity of both activity monitors.

Methods

This validation study was conducted at the Pittsburgh Claude D. Pepper Older Americans Independence Center, University of Pittsburgh, Pittsburgh, PA, from August 2009 to March 2011. All subjects recruited signed the informed consent approved by the university's institutional review board. Invitation letters were sent to individuals who underwent TKA. Eligibility screening was done over the phone (by K.S.B.) and in person (by G.J.A.). Inclusion criteria were (1) age ≥ 50 years and (2) prior unilateral TKA because of end-stage knee osteoarthritis. Exclusion criteria were (1) ≥ 2 falls within the previous year; (2) inability to walk for 31m without an assistive device; (3) history of cardiovascular disease or uncontrolled high blood pressure; (4) severe visual impairment; (5) lower extremity amputation; and (6) neurologic disorder.

List of abbreviations:

ACT	Actigraph
EE	energy expenditure
ICC	intraclass correlation coefficient
PA	physical activity
SWA	SenseWear Armband
TKA	total knee arthroplasty
WOMAC	Western Ontario and McMaster Universities Osteoarthritis Index

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