***Journal for the Measurement of Physical Behaviour*, 2019, 2, 82-93**
https://doi.org/10.1123/jmpb.2018-0057

Human Kinetics
ORIGINAL RESEARCH

Comparison of Questionnaire and Device Measures of Physical Activity and Sedentary Behavior in a Multi-Ethnic Cohort of Older Women

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Background: Limited data are available regarding the correlation between questionnaire and device-measured physical activity (PA) and sedentary behavior (SB) in older women. **Methods**: We evaluated these correlations in 5,992 women, aged 63 and older, who completed the Women's Health Initiative (WHI) and Community Healthy Activities Model Program for Seniors (CHAMPS) PA questionnaires and the CARDIA SB questionnaire prior to wearing a hip-worn accelerometer for 7 consecutive days. Accelerometer-measured total, light, and moderate-to-vigorous PA (MVPA), and total SB time were defined according to cutpoints established in a calibration study. Spearman coefficients were used to evaluate correlations between questionnaire and device measures. **Results**: Mean time spent in PA and SB was lower for questionnaire than accelerometer measures, with variation in means according to age, race/ethnicity, body mass index, and functional status. Overall, correlations between questionnaires and accelerometer measures were moderate for total PA, MVPA, and SB ($r \approx 0.20$–0.40). Light intensity PA correlated weakly for WHI ($r \approx 0.01$–0.06) and was variable for CHAMPS ($r \approx 0.07$–0.22). **Conclusion**: Questionnaire and accelerometer estimates of total PA, MVPA, and SB have at best moderate correlations in older women and should not be assumed to be measuring the same behaviors or quantity of behavior. Light intensity PA is poorly measured by questionnaire. Because light intensity activities account for the largest proportion of daily activity time in older adults, and likely contribute to its health benefits, further research should investigate how to improve measurement of light intensity PA by questionnaires.

Keywords: accelerometer, measurement, menopause, self-report, validity

Accurate assessment of physical activity (PA) and sedentary behaviors (SB) is critical in studying how these behaviors affect health status, and in assessing the effectiveness of health promotion interventions designed to change these behaviors. Questionnaire assessments of self-reported time spent in PA and SB have been widely used in research (Atkin et al., 2012; Paffenbarger, Blair, Lee, & Hyde, 1993) and in health promotion settings (Dunn et al., 1999; Wilcox et al., 2008). However, there have been concerns about the accuracy of PA and SB questionnaires in free-living populations (Healy et al., 2011; Sallis & Saelens, 2000), particularly so in

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women, in older adults, and in race/ethnic minorities (Masse et al., 1998; van Uffelen, Heesch, Hill, & Brown, 2011).

There is increasing use of device measurements of PA and SB, which offer the potential for reducing exposure misclassification that can result from questionnaire assessments (Lee & Shiroma, 2014; Wijndaele et al., 2015). While devices commonly used in research do improve the accuracy of quantifying time spent in various types of PA, there also are disadvantages. Devices that measure PA and SB, such as accelerometers, still are relatively expensive and may not be feasible for many large studies (Lee & Shiroma, 2014). Devices do not provide qualitative context of the activity (e.g., recreational or housework; mild or heavy relative effort). This has implications for development of PA guidelines and promotion programs (Wareham & Rennie, 1998). Furthermore, questionnaire assessments largely target intentional PA and exercise, whereas devices measure movements of all intensities and purposes throughout the waking hours of the day. Studies have evaluated how questionnaire measures of PA (Banda et al., 2010; Colbert, Matthews, Havighurst, Kim, & Schoeller, 2011; Copeland & Esliger, 2009; Craig et al., 2003; Hagstromer, Oja, & Sjostrom, 2006; Harada, Chiu, King, & Stewart, 2001; Harris et al., 2009; Hekler et al., 2012; Jacobs, Ainsworth, Hartman, & Leon, 1993; Oguma et al., 2017; Orsini et al., 2008; Pettee Gabriel et al., 2009; Sabia et al., 2014; Shiroma et al., 2015) and SB (Craig et al., 2003; Gardiner et al., 2011; Hagstromer et al., 2006; Hekler et al., 2012; Marshall, Miller, Burton, & Brown, 2010; Marshall et al., 2015; Rosenberg et al., 2010; Visser & Koster, 2013; Wijndaele et al., 2014) compare with device measures. However, few studies have included large samples of older women or race/ethnic minorities, two population subgroups in whom questionnaire assessments may be particularly prone to error (Masse et al., 1998).

The present study compared accelerometer and questionnaire measures of PA and SB in a large cohort of older, multi-ethnic women residing in the U.S. community. The study objectives were to determine: (1) the comparability of the amounts of PA and SB measured by questionnaire and accelerometer; (2) how correlated questionnaire and device measures are, overall and according to participant age, race/ethnicity, body mass index, and physical functioning level; and (3) whether associations with prevalence of poor health status is similar for questionnaire and device measures, after adjusting for potential confounding factors.

Methods

Study Design and Participants

The Women's Health Initiative (WHI) Clinical Trials and Observational Study is a major research program of the US National Institutes of Health that enrolled postmenopausal women, 50 to 79 years, from 40 clinical sites throughout the US between 1993 and 1998. Details of the WHI have been extensively described elsewhere (The Women's Health Initiative Study Group, 1998). During 2012–2013, 7,875 women consented to participate in the WHI Long Life Study (LaCroix et al., 2017) that included in-home examinations comprised of anthropometric measurements, a physical functioning test (Short Physical Performance Battery, SPPB), and a blood draw. A subset of 7,058 ambulatory women, aged 63 and older, further consented to the Objectively Measured Physical Activity and Cardiovascular Health Study (OPACH) (LaCroix et al., 2017). As part of OPACH, participants were asked to wear an accelerometer for 7 consecutive days (details provided below), complete the OPACH questionnaire which included the PA and SB instruments evaluated herein, and return both to the WHI Clinical Coordinating Center by mail at the end of the wear week. 6,489 women returned accelerometers with evidence of human wear. Only women who wore the device during out-of-bed time for at least 10 hours/day on at least 4 days (conventional standard for wear time (Tudor-Locke, Camhi, & Troiano, 2012)) were included in the present analyses (n = 6,126).

Among compliant women, there were 5,992 who also completed the self-administered OPACH PA questionnaire (details provided below) and represent the analytic sample for the present cross-sectional study comparing accelerometer and questionnaire measures of PA and SB. The study protocol was approved by the Fred Hutchinson Cancer Research Center IRB and all women provided informed consent either in writing or by telephone.

Accelerometer Measures

Participants were asked to wear a triaxial accelerometer (ActiGraph GT3X+, ActiGraph Corp) on an elastic band over their right hip for 24 hours a day on 7 consecutive days, removing devices only when showering or swimming. Women additionally reported in-bed and out-of-bed times using sleep logs, on days that the accelerometer was worn. These times were used to remove periods of wear while in bed. When sleep logs were missing bed times, they were imputed using person-specific averages when available, or the OPACH population average otherwise (in-bed = 10:45 PM; out-of-bed = 7:22 AM).

Devices were set to record accelerations at 30 Hz and data were output in 15-second epochs with the normal filter enabled. Vector magnitude (VM) counts per 15-seconds were derived by taking the square root of the sum of squares of counts from the vertical, anterior–posterior, and medial-lateral axes. These data were then screened for wear time using the Choi algorithm specifying a 90-minute frame, 2-minute allowance, and a 30-minute stream (Choi, Ward, Schnelle, & Buchowski, 2012).

Using the accelerometer data processed with the normal filter setting, we then calculated for each woman the time per week spent in light intensity PA, moderate-to-vigorous intensity PA (MVPA), as well as sedentary time. Cutpoints for these PA categories were determined from a WHI calibration study conducted among 200 women aged 60–91 years (Evenson et al., 2015). Light intensity PA was defined as 19–518; MVPA, ≥519; and sedentary behavior, ≤18 VM counts per 15 seconds. Light intensity PA refers to activities requiring an energy expenditure of 1.6–2.9 metabolic equivalents (METs) (e.g., wash/dry dishes, folding laundry, mopping), and MVPA requiring ≥3 METs (e.g., level walking at 1.5–2.0 mph).

Questionnaire Measures

We were interested in comparing accelerometer measures with self-reported measures from three widely used questionnaires that have been tested for reliability and validity: the WHI PA questionnaire (Meyer, Evenson, Morimoto, Siscovick, & White, 2009), the Community Healthy Activities Model Program for Seniors (CHAMPS) PA questionnaire (Stewart et al., 2001), and the Coronary Artery Risk Development in Young Adults Study (CARDIA) SB questionnaire (Gibbs et al., 2014; Rosenberg et al., 2010). These questionnaires, formatted for use in OPACH, are available in a previous publication from our study (LaCroix et al., 2017).

For the WHI questionnaire items, women were asked their "usual PA and exercise" including a separate question pertaining to walking outside the home for 10 minutes or more, querying the usual speed, frequency, and duration. Recreational PA, cued to recall separately from responses to the walking question, was assessed by mutually exclusive questions on the frequency and duration of participation in "moderate or strenuous" and "mild" exercise. Women also were asked, in separate questions, about time spent on yardwork, and time spent doing heavy indoor household chores. With regard to SB, women reported the number of hours a day spent sitting. For analyses, we separately calculated the time per week spent walking, light ("mild") PA, and MVPA, with the sum of all three used for time in total recreational PA.

On the CHAMPS questionnaire items, women reported for "a typical week during the past 4 weeks" their weekly frequency and duration of participation in 35 different specified activities. For analyses, we categorized these activities as walking, light intensity PA (requiring <3 METs), or MVPA (requiring ≥3 METs) based on the assumed energy cost of the activities (Ainsworth et al., 2011; Ainsworth et al., 1993). To calculate time in all activities, we summed up the time per week spent walking, and in activities of light- and moderate-to-vigorous intensity.

For the CARDIA SB questionnaire, six questions on television viewing, computer use, travelling in a vehicle, doing paperwork, talking on the phone, or other sedentary recreational activities (e.g., reading a book) were asked, querying the duration (hours/day) of each of these. We summed duration across all of these sedentary behaviors to calculate sitting time. Women were asked about usual weekday and weekend SB separately. In analyses, we examined total, as well as weekday and weekend sitting separately.

Covariates

At baseline of the main WHI study, information on age, race/ethnicity (Non-Hispanic White, Non-Hispanic Black, Hispanic), and education was obtained via questionnaire. Current smoking was assessed by self-report on the questionnaire nearest to the OPACH study baseline. Height, body weight, and physical functioning (Short Physical performance Battery; SPPB) was measured during the WHI Long Life Study in-home visit prior to accelerometer wear (LaCroix et al., 2017). Body mass index (BMI; kg/m^2) was computed from measured height and weight. The proportion of women with missing information on any of these covariates ranged from 0.5–14.4%.

Statistical Analysis

We first examined the characteristics of women, overall, and by race/ethnic groups. We then examined these characteristics among groups of women defined by age tertiles (63 to <75, 75 to <82, ≥82), clinical BMI categories (<25, 25 to <30, ≥30 kg/m^2), and categories of SPPB score originally defined in the Established Populations for the Epidemiological Study of the Elderly (LaCroix et al., 2017) (1–6, 7–9, 10–12; higher score is better). Analyses on accelerometer measures were adjusted for differences in awake wear time of the device. In a main set of analyses, we calculated Spearman correlations between accelerometer measures of PA or SB and their corresponding questionnaire measures among all women and in subgroups of women stratified by race/ethnicity, age, BMI, and SPPB score. Additionally, we calculated the correlations separately for women defined jointly by both race/ethnicity and age, and both race/ethnicity and SPPB score. We nominally defined correlations of $r < 0.10$ as weak, 0.10–0.49 as moderate, 0.50–0.70 as strong, and >0.70 as very strong (Cohen, 1988). Accelerometer measures are reported only for adherent wear days. Variation in measurement accuracy across assessment methods not only could lead to discrepancies in describing the amount of PA or SB of a population, but could also result in differences in associations with a defined health indicator. We, therefore, examined associations of questionnaire and device measures with the presence of poorer self-rated general health status, which is associated with higher all-cause mortality risk in OPACH women (LaMonte, Buchner, et al., 2017). In these analyses, the relative odds of poorer health were estimated for a 1-SD unit increment in either PA or SB, controlling for age, race/ethnicity, education, current smoking, and BMI. Models evaluating accelerometer measures were additionally adjusted for device awake wear time.

Results

The 5,992 participants in this study were racially and ethnically diverse, with 50% being non-Hispanic White, 33% non-Hispanic Black, and 17% Hispanic women (Table 1). Their mean age was 78.6 (*SD*, 6.7) years, and White women were older than Blacks or Hispanics. Education varied by race/ethnicity with about 20% of women overall having high school or less education, and 32–48% of women having college degrees. Few women (2–4%) reported being current smokers. Their mean BMI was in the overweight range (i.e., 25.0–29.9 kg/m^2), with Black women being, on average, heavier for height than the other two groups. SPPB scores tended to be highest among Hispanic women and lowest among White women.

Estimates of PA and SB differed between the questionnaire assessments, and differed between questionnaire and device measures (Table 1). Using the WHI questionnaire, the mean time spent in total recreational PA (i.e., walking, light-intensity activity and MVPA) was 180 min/wk, and walking alone, 82 min/wk. The mean time in yard work and strenuous household chores combined was 165 min/wk. In general, Hispanic women reported the most PA; White women, the least. For reported sitting, the average among all women was about 7 hr/day (2,917 min/wk), with White women sitting most and Hispanic women least.

Using the CHAMPS questionnaire, the reported time spent on all PA combined was 600 min/wk; walking, 167 min/wk. Both these estimates were approximately double the time reported on the WHI questionnaire. As with the WHI questionnaire, Hispanic women reported the highest amounts of PA.

Using the CARDIA SB questionnaire, the average reported sitting time was approximately 8 hr/day (3,384 min/wk). In contrast to the WHI questionnaire, Black women reported the most sitting on this questionnaire. Similar to the WHI questionnaire, Hispanic women reported the least sitting time.

With regard to accelerometer measures, women wore this device for a mean of 14.9 (*SD*, 1.3) hr/day with similar wear times across race/ethnic groups. The time spent on total PA was higher than questionnaire estimates, totaling 2,365.8 (*SD*, 677.1) min/wk. As with the questionnaire assessments, Hispanic women recorded the most PA. For SB, the mean was approximately 9 h/day (*SD*, 1.7 h/d; 3,888.9 (*SD*, 695.8) min/wk) with Hispanic women having the lowest mean, parallel to self-reports. All accelerometer measures were higher than corresponding self-reports, and by a large margin for some measures. For example, the WHI questionnaire estimate for time in MVPA was 21% of that from device assessment; the CARDIA questionnaire estimate for sitting was 89% of sedentary behavior as assessed with the accelerometer.

Because of the age difference across race/ethnicity in Table 1, we repeated analysis of mean PA and SB measures across race/ethnicity groups controlling for age. Results were similar to those shown in the table (data not shown).

We next examined variations by age, BMI, and SPPB score, for each assessment method (Table 2). For the WHI questionnaire, PA was lower at older ages, while sitting was higher. This inverse pattern

Table 1 Characteristics of Study Participants

Characteristic	All	Non-Hispanic White	Non-Hispanic Black	Hispanic/Latina
N	5,992	2,985	1,993	1,014
Age, y; *M* (*SD*)	78.6 (6.7)	82.0 (5.7)	75.5 (5.9)	75.2 (5.8)
Education, %				
≤High school	20.2	21.8	15.5	24.9
Some college	38.6	38.6	36.1	43.2
≥College graduate	41.2	39.7	48.4	31.9
Current smoker, %	2.9	2.3	4.0	2.6
Body mass index, kg/m^2 *M* (*SD*)	28.1 (5.7)	27.2 (5.4)	29.6 (6.0)	27.7 (5.4)
Body mass index (kg/m^2), %				
Underweight (<18.5)	1.4	1.9	1.1	0.6
Normal weight (18.5 to <25.0)	31.3	36.5	21.4	34.9
Overweight (25.0 to <30)	36.2	36.2	36.0	36.7
Obese (≥30)	31.1	25.5	41.5	27.8
Short Physical Performance Battery score, %				
1–6	22.6	25.4	22.0	15.6
7–9	42.3	40.9	47.8	37.4
10–12	34.8	33.7	30.2	47.0
Self-reported physical activity and sitting, WHI questionnaire, min/wk; *M* (*SD*)				
Total recreational physical activity	179.6 (189.5)	167.4 (178.3)	180.3 (190.1)	214.2 (214.2)
Walking	82.3 (104.9)	74.8 (96.7)	81.2 (107.2)	106.8 (119.1)
Light-intensity activity	23.7 (59.1)	25.9 (61.8)	21.3 (54.9)	22.1 (59.1)
Moderate-to-vigorous intensity activity	73.5 (110.6)	66.7 (103.8)	77.8 (112.1)	85.2 (124.8)
Yard work	47.7 (103.4)	57.5 (115.9)	28.9 (71.4)	55.0 (111.7)
Strenuous household chores	117.6 (109.9)	114.9 (109.9)	108.4 (100.3)	144.1 (123.7)
Sitting	2,916.6 (1,338.1)	3,106.5 (1,299.2)	2,885.6 (1395.7)	2,418.8 (1,196.0)
Self-reported physical activity, CHAMPS questionnaire, min/wk; *M* (*SD*)				
All activities	600.4 (506.0)	601.9 (493.4)	560.6 (487.5)	674.3 (566.7)
Walking	167.3 (197.4)	165.7 (190.3)	158.5 (194.4)	189.1 (221.0)
Light-intensity activity	377.8 (309.7)	393.2 (314.1)	340.4 (283.6)	406.1 (338.3)
Moderate-to-vigorous intensity activity	222.6 (290.3)	208.7 (273.6)	220.2 (289.6)	268.3 (332.0)
Self-reported sitting, CARDIA questionnaire, min/wk; *M* (*SD*)				
Total	3,384.0 (1,363.7)	3,222.3 (1184.9)	3,794.9 (1550.5)	3,060.7 (1279.9)
Weekdays	2,467.5 (1,018.4)	2,340.0 (884.3)	2,776.5 (1155.7)	2,241.9 (962.7)
Weekend	916.5 (410.7)	882.3 (356.0)	1,018.4 (473.9)	818.9 (388.4)
Accelerometer-assessed physical activity and sedentary behavior,[a] min/wk; *M* (*SD*)				
Total wear time	6,254.7 (542.5)	6,268.2 (495.7)	6,231.9 (599.1)	6,259.8 (556.2)
Low light-intensity activity	1,322.8 (349.7)	1,262.7 (341.9)	1,332.5 (356.2)	1,362.2 (330.9)
High light-intensity activity	688.2 (247.9)	669.9 (250.2)	639.9 (234.8)	780.1 (244.7)
Moderate-to-vigorous intensity activity	354.8 (241.3)	330.7 (240.0)	335.3 (217.0)	437.0 (262.6)
Sedentary time	3,888.9 (695.8)	4004.8 (670.9)	3,681.9 (715.7)	3680.5 (697.9)

[a]Low light-intensity activity, 19–225 counts/15 s; high light-intensity activity, 226–518 counts/15 s; moderate-to-vigorous intensity activity, ≥519 counts/15 s.

in PA also was observed with higher BMI levels. PA progressively increased with higher SPPB physical function scores.

The CHAMPS questionnaire showed similar trends with PA—lower levels with older ages and higher BMI, and higher levels with greater physical function scores.

The CARDIA questionnaire estimates of sitting, however, did not parallel the trend observed for the WHI questionnaire; with older ages, reported sitting time was lower. Similar to the WHI questionnaire, sitting time increased at higher BMI and decreased at higher SPPB scores. Accelerometer measures of PA and SB showed similar patterns to the WHI questionnaire measures: decreasing PA and increasing sedentary time with older age, and also with higher BMI. With higher levels of physical functioning, sedentary time was lower and PA was higher.

Self-reported PA and SB were moderately correlated between questionnaires. For the WHI and CHAMPS, Spearman correlations were 0.47, 0.15, 0.51, and 0.44 for total, light, MVPA, and walking activities, respectively. The correlation between WHI and CARDIA sitting time was r = 0.42. Table 3 shows the Spearman correlation coefficients between self-reported and accelerometer-assessed PA and

Table 2 Self-Reported and Accelerometer-Assessed Physical Activity and Sedentary Behavior by Age, BMI, and SPPB Score

	Age, years			BMI, kg/m²			SPPB score		
	63 to <75	75 to <82	≥82	<25	25 to <30	≥30	1–6	7–9	10–12
N	1,851	1,784	1,970	1,834	2,032	1,746	1,148	2,173	1,781
Self-reported physical activity and sitting, WHI questionnaire, min/wk; *M* (*SD*)									
Total recreational physical activity	212.5 (209.6)	183.2 (187.0)	149.0 (169.2)	215.1 (207.7)	186.2 (182.5)	141.6 (174.2)	127.2 (157.2)	172.0 (184.0)	233.3 (207.9)
Walking	96.9 (115.0)	85.2 (105.0)	68.9 (95.6)	104.0 (116.0)	85.0 (104.3)	58.9 (89.7)	57.3 (87.6)	80.0 (101.5)	106.7 (117.1)
Light-intensity activity	26.7 (63.4)	21.7 (54.1)	22.4 (58.7)	27.6 (68.0)	23.7 (55.0)	20.7 (55.4)	18.9 (53.6)	22.5 (57.8)	28.7 (64.9)
MVPA	88.9 (118.0)	76.3 (115.0)	57.8 (97.8)	83.4 (117.3)	77.4 (112.7)	62.1 (103.2)	51.1 (89.4)	69.5 (108.9)	97.8 (124.7)
Yard work	53.0 (111.3)	46.1 (97.6)	43.6 (101.0)	59.3 (114.7)	49.4 (105.0)	33.5 (87.0)	29.2 (81.9)	48.3 (106.9)	59.3 (110.9)
Strenuous household chores	131.3 (115.6)	120.5 (109.0)	101.9 (102.3)	124.7 (114.4)	119.0 (108.8)	108.1 (104.1)	93.3 (96.6)	119.8 (108.4)	132.6 (116.8)
Sitting	2,819.3 (1,350.1)	2,777.6 (1,289.8)	3,111.7 (1,354.8)	2,719.0 (1,264.8)	2,889.6 (1,257.7)	3,148.2 (1,450.0)	3160.0 (1426.6)	2897.8 (1309.8)	2752.2 (1256.6)
Self-reported physical activity, CHAMPS questionnaire, min/wk; *M* (*SD*)									
All activities	676.7 (558.9)	618.1 (504.3)	517.8 (439.1)	657.0 (515.9)	612.4 (492.6)	538.0 (510.0)	464.9 (428.9)	598.0 (514.8)	711.6 (525.4)
Walking	196.4 (218.4)	169.6 (195.9)	141.2 (173.4)	187.5 (205.8)	169.3 (196.1)	142.9 (186.6)	120.8 (169.8)	163.8 (191.8)	204.7 (214.1)
Light-intensity activity	391.8 (321.7)	388.3 (303.4)	358.3 (299.0)	402.0 (314.8)	383.9 (301.1)	350.7 (316.2)	321.8 (293.3)	382.7 (311.7)	419.3 (317.7)
MVPA	284.9 (331.4)	229.8 (294.0)	159.5 (224.6)	255.1 (305.8)	228.4 (290.4)	187.3 (273.7)	143.1 (220.9)	215.3 (294.6)	292.4 (315.0)
Self-reported sitting, CARDIA questionnaire, min/wk; *M* (*SD*)									
Total	3,486.3 (1,504.3)	3,408.7 (1,349.8)	3,274.0 (1,252.8)	3,053.1 (1,233.8)	3,369.1 (1,296.9)	3,691.5 (1,433.8)	3,446.1 (1315.9)	3,447.3 (1382.5)	3,197.2 (1253.5)
Weekdays	2,532.6 (1,118.7)	2,492.1 (1,008.3)	2,389.8 (941.6)	2,228.2 (925.7)	2,451.9 (971.3)	2,693.8 (1,068.4)	2,514.7 (984.4)	2,506.1 (1,029.4)	2,327.3 (940.5)
Weekend	953.8 (449.3)	916.6 (410.7)	884.2 (376.4)	824.9 (368.9)	917.2 (392.8)	997.7 (438.5)	929.3 (408.2)	937.3 (423.8)	878.3 (381.3)
Accelerometer-assessed physical activity and sedentary behavior,[a] min/wk; *M* (*SE*)									
Low light-intensity activity	1,363.1 (7.6)	1,338.3 (7.7)	1,281.2 (7.4)	1,399.5 (7.5)	1318.1 (7.1)	1255.1 (7.7)	1,274.9 (9.6)	1,340.3 (6.9)	1,354.8 (7.7)
High light-intensity activity	730.9 (5.4)	697.9 (5.5)	642.7 (5.3)	776.6 (5.2)	697.1 (4.9)	593.4 (5.4)	597.7 (6.7)	698.5 (4.9)	754.5 (5.4)
MVPA	462.6 (5.1)	355.6 (5.2)	261.2 (4.9)	397.4 (5.5)	355.5 (5.2)	316.9 (5.6)	255.5 (6.7)	347.8 (4.8)	447.1 (5.4)
Sedentary time	3700.2 (14.3)	3864.9 (14.5)	4071.7 (13.8)	3681.5 (14.1)	3884.4 (13.4)	4089.5 (14.5)	4,129.1 (17.9)	3870.6 (12.9)	3700.8 (14.4)

Note. BMI = body mass index; MVPA = moderate-to-vigorous intensity activity; SPPB = Short Physical Performance Battery.
[a]Adjusted for awake wear time; low light-intensity activity, 19–225 counts/15 s; high light-intensity activity, 226–518 counts/15 s; moderate-to-vigorous intensity activity, ≥519 counts/15 s.

Table 3 Spearman Correlations[a] Among Self-Reported and Accelerometer-Assessed Physical Activity and Sedentary Behavior

Self-Reported Measure, WHI Questionnaire	Total recreational PA, min/wk	Total recreational PA, min/wk	Light-intensity activity, min/wk	MVPA, min/wk	Sitting time, min/wk
Accelerometer-Assessed Measure	**Total vector magnitude, counts/wk**	**Total PA, min/wk**	**Light-intensity activity, min/wk**	**MVPA, min/wk**	**Sedentary time, min/wk**
All Women	0.34	0.28	0.04	0.24	0.31
Race/Ethnicity					
Non-Hispanic White	0.38	0.31	0.07	0.24	0.33
Non-Hispanic Black	0.32	0.23	0.02	0.24	0.23
Hispanic	0.34	0.23	0.01	0.23	0.28
Age, years					
63 to <75	0.35	0.24	0.01	0.23	0.28
75 to <82	0.36	0.26	0.01	0.22	0.29
≥82	0.32	0.28	0.06	0.19	0.32
BMI Group, kg/m^2					
<25	0.39	0.27	0.06	0.23	0.33
25 to <30	0.29	0.21	0.02	0.21	0.26
≥30	0.32	0.26	0.02	0.26	0.30
SPPB score					
1–6	0.32	0.28	0.04	0.21	0.27
7–9	0.29	0.21	0.02	0.21	0.29
10–12	0.34	0.23	0.02	0.19	0.30
Self-Reported Measure, CHAMPS/CARDIA Questionnaire	**All activities (CHAMPS), min/wk**	**All activities (CHAMPS), min/wk**	**Light-intensity activity (CHAMPS), min/wk**	**MVPA (CHAMPS), min/wk**	**Total sitting time (CARDIA), min/wk**
Accelerometer-Assessed Measure	**Total vector magnitude, counts/wk**	**Total PA, min/wk**	**Light-intensity activity, min/wk**	**MVPA, min/wk**	**Sedentary time, min/wk**
All Women	0.34	0.29	0.16	0.34	0.28
Race					
Non-Hispanic White	0.36	0.32	0.20	0.36	0.31
Non-Hispanic Black	0.32	0.27	0.13	0.32	0.25
Hispanic	0.31	0.24	0.11	0.31	0.31
Age, years					
63 to <75	0.29	0.25	0.11	0.31	0.31
75 to <82	0.34	0.27	0.15	0.33	0.27
≥82	0.32	0.28	0.19	0.28	0.29
BMI Group, kg/m^2					
<25	0.35	0.29	0.12	0.38	0.28
25 to <30	0.29	0.25	0.14	0.32	0.23
≥30	0.32	0.26	0.14	0.33	0.21
SPPB score					
1–6	0.32	0.29	0.22	0.28	0.19
7–9	0.30	0.26	0.14	0.31	0.27
10–12	0.26	0.20	0.07	0.29	0.29

Note. MVPA = moderate-to-vigorous intensity activity; BMI = body mass index; SPPB = Short Physical Performance Battery; PA = physical activity. $p < .05$ for $|r| > 0.03$.
[a]Adjusted for awake wear time.

SB. For accelerometer-assessed total PA, two metrics were used: total vector magnitude counts over the week of wear (adherent days) and total minutes per week of PA, with the former yielding higher correlations than the latter.

Among all women, in general, PA and SB, except for light PA, showed moderate correlations ($r \approx 0.2$–0.3) when comparing questionnaire and device measures (Table 3). WHI questionnaire measures of light intensity PA were weakly correlated ($r = 0.01$–0.06) with device measures; whereas correlations for CHAMPS measures of light PA were more variable ($r = 0.07$–0.22). The highest magnitude of correlation was observed between WHI total recreational PA and accelerometer total vector magnitude counts ($r = 0.36$). For

MVPA, the CHAMPS questionnaire showed higher correlation than the WHI questionnaire ($r = 0.34$ vs. 0.24 respectively). For sitting, the WHI and CARDIA questionnaires showed comparable correlations ($r = 0.31$ vs. 0.28 respectively)

We then examined correlations among subgroups of women. In general, higher correlations for the different measures were observed in non-Hispanic White women than the other race/ethnic groups. There were no clear patterns in correlations between different measures according to categories of age or SPPB scores. Higher correlations generally were present among normal weight women than heavier women.

To further understand how race/ethnicity, age, and SPPB score could be influencing correlations among different measures of PA and SB, we examined the correlations according to jointly defined subgroup classifications. With regard to combined race/ethnic and age subgroups (Supplementary Table 1 [available online]), for all questionnaire measures compared with accelerometer measures, non-Hispanic and Hispanic women had similar patterns: lowest correlation for total PA and MVPA among the oldest women; for SB, highest correlation among women aged 75 to <82 years. For non-Hispanic Black women, the patterns for age were less clear.

With regard to combined race/ethnic and SPPB score subgroups (Supplementary Table 2 [available online]), the patterns of correlations were inconsistent: within each race/ethnic group, the highest performing SPPB score subgroup did not always show the highest correlations for PA, nor did the lowest performing SPPB score subgroup consistently show the highest correlations for SB.

In order to understand the magnitude of misclassification on PA and SB that would occur using questionnaires at the correlations with accelerometer measures observed herein, we cross-classified questionnaire and accelerometer measured time (min/week) spent in total PA, MVPA, light PA, and sitting (data not shown). Correct classification by questionnaire (WHI, CHAMPS) into the lowest quartile of accelerometer PA measure was 39.3% and 40.5% for total PA, 60.9% and 40.5% for MVPA, and 0% and 33.2% for light PA. Correct classification into the highest quartiles was 36.7% and 37.4% for total PA, 36.5% and 43.3% for MVPA, 24.4% and 30.1% for light PA. Overall agreement (weighted Kappa [95% CI]) between questionnaire and accelerometer was .19 (.17, .21) for total PA on each questionnaire, .16 (.14, .17) and .23 (.21, .25) for MVPA, and .01 (–.01, .03) and .10 (.08, .12) for light PA. For SB, correct classification into the lowest quartile for WHI and CARDIA was 54.5% and 38.6%, and into the highest quartile was 30.9% and 35.1%. Kappa coefficients for overall agreement between questionnaire and accelerometer were .20 (.18, .22) and .16 (.14, .18) for WHI and CARDIA, respectively. We explored whether distinguishing characteristics existed for those correctly classified by questionnaire relative to accelerometer measures. Mean age, BMI and SPPB score, and proportions of race/ethnicity, current smoking, and poor self-rated health were similar between those correctly and not correctly classified on WHI and CHAMPS total PA, and on WHI and CARDIA SB (data not shown).

Finally, because variation in measurement accuracy across methods could result in differences in associations with a defined health indicator, we examined associations of questionnaire and device measures with the presence of poorer self-rated general health status. Statistically significant inverse associations (ORs = 0.61–0.94) were observed with poorer self-rated health for all PA measures (Table 4). Some variability in the magnitudes of these associations was evident; with accelerometer and CHAMPS tending to be closer to each other than WHI. Higher SB was significantly positively associated with poorer health for all measures; accelerometer demonstrating the largest magnitude compared with WHI and CARDIA.

Table 4 Multivariable Associations for Questionnaire and Accelerometer Measures with Self-Reported Poorer Health Status

Exposure Variable (*SD* unit, min/wk)	Odds Ratio[a]	95% CI[a]	*p*-value
Total Physical Activity			
Accelerometer (674.6)	0.72	0.68, 0.77	<.001
WHI (190.1)	0.65	0.61, 0.69	<.001
CHAMPS (508.1)	0.73	0.69, 0.78	<.001
Light Physical Activity			
Accelerometer (535.9)	0.83	0.78, 0.88	<.001
WHI (59.5)	0.94	0.89, 0.99	.04
CHAMPS (310.2)	0.84	0.79, 0.89	<.001
Moderate-to-Vigorous Physical Activity			
Accelerometer (243.4)	0.61	0.57, 0.65	<.001
WHI (111.2)	0.74	0.69, 0.79	<.001
CHAMPS (290.7)	0.68	0.64, 0.73	<.001
Sitting			
Accelerometer (694.9)	1.40	1.32, 1.49	<.001
WHI (1,318.6)	1.27	1.20, 1.35	<.001
CARDIA (1,339.1)	1.19	1.13, 1.27	<.001

[a]The odds ratios are for a 1-SD unit increment in exposure (min/wk); adjusted for age, race/ethnicity, education, current smoking, and BMI (and for awake wear time in accelerometer models).

Discussion

Results of the present study indicate that questionnaires have moderate correlations at best with PA and SB in ambulatory community-dwelling women, aged 60 and older. Overall, correlations with device measures were comparable across questionnaire assessments, with correlations of $r = 0.36$ and 0.32 for total PA on WHI and CHAMPS, and 0.31 and 0.27 for total sitting time on WHI and CARDIA. Correlations were more variable for MVPA ($r = 0.24$ on WHI, $r = 0.34$ on CHAMPS). The impact of correlations in the low to moderate range on ordering a study population according to levels of total PA is profound. When quartiles of total PA defined by questionnaire and accelerometer measurements were cross-tabulated, only ≈40% of older women were classified into the lowest quartile of accelerometer-measured total PA by the questionnaires. Only 37% of women were classified into the highest quartile of accelerometer-measured total PA by the questionnaires. Thus, more than half of women are classified into different quartiles of total PA depending on which measurement technique is employed (overall agreement, Kappa = .19, each). There were no clear participant characteristics differing between concordant and discordant PA measurement quartiles. Similar agreement levels were observed for MVPA. Questionnaire and accelerometer measures of total- and MVPA should be viewed as measuring different behaviors with some overlap, but essentially no equivalency between the two methods.

In contrast, light intensity PA has essentially no correlation between WHI and the accelerometer measure ($r = 0.04$); and the correlation between CHAMPS and the accelerometer is present but still soberingly low ($r = 0.16$). Thus, an accurate measurement of light PA appears difficult to obtain from self-report based on the questionnaires studied here. Because light intensity PA accounts for the largest proportion of daily activity time in older adults and, consistent with OPACH results, likely contribute to health benefits of PA (LaMonte, Buchner, et al., 2017; LaMonte, Lewis, et al., 2017), further research should investigate how to improve measurement of light intensity PA by questionnaire.

Interestingly, mean minutes in PA was underestimated by questionnaire as compared with accelerometer in the present study (Table 1), which is contrary to findings of other studies in which overestimation of PA was seen with self-report (Banda et al., 2010). One possibility is that questionnaires are not surveying completely the types of PA that are relevant to older women's lives, which could result in lower amounts of PA, on average, captured by questionnaire as compared to an accelerometer. In fact, this same finding was reported in a study on older women, whose mean age was 70 at the time of questionnaire and accelerometer assessments (Shiroma et al., 2015). Another important observation in the present study was that each method (accelerometer, WHI, CHAMPS, CARDIA) showed Hispanic/Latino women to be more active and less sedentary than non-Hispanic whites and blacks. This finding is of interest given the importance of understanding and reducing health disparities in an aging population. Also of interest was that associations with prevalent self-reported poorer health status were all of the same direction for questionnaire and device measures, with modest variability in the magnitude of associations evident. To our knowledge, this is the largest study to date to evaluate multiple questionnaire assessments of PA and SB in relation to triaxial accelerometer measures using calibrated count cutpoints among racial-ethnically diverse older women. Our findings align with previous observations of substantial variation in the amount of PA and sedentary time self-reported across questionnaire assessments (Marshall et al., 2010; Pettee Gabriel et al., 2009; Rosenberg et al., 2010), and underscore the important role that device measures have in improving assessment of these complex behaviors, especially light intensity PA (Colbert & Schoeller, 2011; Loney, Standage, Thompson, Sebire, & Cumming, 2011).

Other studies have evaluated how questionnaire assessments of PA and SB compare with accelerometer measures. Detailed comparison of study findings is challenging because of differences in questionnaire items, scoring units, and recall intervals, as well as differences in the type of accelerometer, cutpoints used to categorize accelerometer measures, and how data are analyzed and summarized for reporting. Generally, in younger and middle-aged adults, correlations with accelerometer measures have been moderate to strong for self-reported total- and moderate-to-vigorous PA ($r \approx 0.30$–0.71) (Banda et al., 2010; Craig et al., 2003; Hagstromer et al., 2006; Jacobs et al., 1993; Pettee Gabriel et al., 2009), and moderate for self-reported sitting time ($r \approx 0.14$–0.51) (Craig et al., 2003; Gardiner et al., 2011; Marshall et al., 2015; Visser & Koster, 2013). Light intensity PA assessed by questionnaire has largely been uncorrelated with accelerometer measures (Jacobs et al., 1993; Pettee Gabriel et al., 2009). In studies that reported results on older (i.e., ≥60 years) men and women combined, results tended to be similar as those from studies on younger and middle-aged adults (Colbert et al., 2011; Copeland & Esliger, 2009; Harris et al., 2009; Hekler et al., 2012; Oguma et al., 2017). We observed correlations between CHAMPS and accelerometer for total-, light- and MVPA in the overall OPACH cohort that were similar to other published findings (Colbert et al., 2011; Harada et al., 2001; Hekler et al., 2012); our analysis adjusting for differences in device wear time, whereas these other investigations did not.

Studies conducted specifically on older women provide a more refined comparison with the present results. In 116 Swedish women, aged 56–75, a positive linear regression correlation ($\beta = 0.38$) was observed between questionnaire and accelerometer total PA (Orsini et al., 2008). Among 1,033 British women, aged 60–83 years, in the Whitehall II Study, a correlation of $r = 0.32$ was observed between self-reported and accelerometer total PA (Sabia et al., 2014). Moderate correlations ($r = 0.22$–0.39) between self-reported and accelerometer MVPA were observed in 10,115 women, mean age 70 years, in the Women's Health Study; correlations varied according to type of accelerometer (uniaxial or triaxial) and cutpoints used to define MVPA (Shiroma et al., 2015). Finally, among 87 women, aged 65–89 years, the correlation of total- and moderate-intensity PA assessed using CHAMPS with accelerometer was $r = 0.31$ and $r = 0.41$ (Harada et al., 2001). In the present study among the overall cohort, wear-time adjusted correlations for total physical activity (both WHI and CHAMPS, $r = 0.28$) are comparable to the correlations in Whitehall II women (Sabia et al., 2014) and others (Harada et al., 2001). Likewise, correlations with MVPA for WHI ($r = 0.24$) and CHAMPS ($r = 0.34$) are similar to those reported in the Women's Health Study (Shiroma et al., 2015). The similarity of these correlations is noteworthy given the differences in self-report questionnaire items and scoring, and accelerometer measures used across these studies on older women.

PA and SB in older adults, whether assessed using questionnaires or device measures, varies according to factors such as age, race/ethnicity, BMI, and level of physical functioning (Keadle, McKinnon, Graubard, & Troiano, 2016; Rosenberg et al., 2016). We observed variation in the magnitude of correlations between self-reported and accelerometer assessments according to these participant characteristics. For the WHI, correlations tended to be stronger for Non-Hispanic White women on each PA measures and on SB as compared to Non-Hispanic Black and Hispanic women. Likewise, correlations tended to be stronger among the oldest women and in whose BMI was <25 and whose SPPB score was low (1–6) except for MVPA which was correlated strongest in younger women, and SB for which correlations were strongest at high SPPB scores (10–12). Results for the CHAMPS and CARDIA tended to parallel those for the WHI. The small number of previous studies that have reported subgroup comparisons of correlations between questionnaire and device measures had results similar to those observed herein for age, race/ethnicity and BMI (Banda et al., 2010; Harada et al., 2001; Sabia et al., 2014), with few exceptions (Orsini et al., 2008).

An important question that cannot be directly answered by the results of the present study is whether the differences in correlations between questionnaire and device measures observed herein and in previous investigations are meaningful for epidemiologic studies? Available evidence (Harada et al., 2001; Jacobs et al., 1993; Pettee Gabriel et al., 2009; Sabia et al., 2014; Shiroma et al., 2015), including the present results, suggest that self-reported and accelerometer-measured PA are at best moderately correlated and should be seen as related but different construct measures. When attempting to characterize the various domains of a complex behavior like free-living PA, especially in the absence of a gold standard field measure, measurement error is to be expected (LaMonte, Ainsworth, & Reis, 2006). Questionnaires are inherently imperfect measurement instruments (LaMonte et al., 2006). Things such as age, sex, and cultural relevance, clarity of item wording and construct cues, thoroughness of coverage on specific domains of interest, recall time frame, mode of administration, questionnaire length, response scales and scoring metrics tend to differ among questionnaires, and can influence the ability of the instrument to quantify the underlying exposure of interest. In the present study, light intensity PA was assessed poorly compared to accelerometer ($r = 0.01–0.07$) by WHI, but somewhat better ($r = 0.07 – 0.22$) by CHAMPS, which contains a greater number of items relevant to this type of activity in older adults as compared to the single item and limited cuing on WHI. MVPA also was measured somewhat better using the multi-item CHAMPS compared to the single-item WHI. Double reporting of frequencies and durations on questionnaire items can spuriously increase levels of PA or SB on questionnaires compared with device measures (Hekler et al., 2012). Differences in time frames of measurement for questionnaire (e.g., usual activity, typical day, past 4 weeks) and accelerometer (e.g., 7 days) also could result in discrepancies in the amount of time spent in PA and SB by each method, which might have occurred to an extent in the present study.

When evaluating results from studies such as the present, what should reasonably be expected when comparing simplistic questionnaires such as WHI, or even more elaborate ones such as CHAMPS, with device-measured PA? Questionnaires have several potential sources of unwanted variation in self-report measures (noted above), and an accelerometer device is orders of magnitude more sensitive to actual human movement including movements associated with intentional physical activity and those involved in other aspects of daily life during waking hours. So, how much shared variation should we really expect between questionnaire and accelerometers—1% ($r = 0.10$), 10% ($r = 0.32$), 25% ($r = 0.50$), 50% ($r = 0.70$)? Perhaps part of the answer has to do with the underlying objective of measuring PA. If the objective is a detailed account of all activities and their associated energy expenditure throughout the day, then a comprehensive questionnaire demonstrating a large shared variation with accelerometer measures on the same PA behaviors would be desired. If the objective is to rank order a defined population based on levels of their usual intentional PA habits so that one can then evaluate whether an association exists with a given disease, then a questionnaire demonstrating moderate shared variation with accelerometer measures may be satisfactory, acknowledging that the rank order will differ substantially from an accelerometer measure. Another part of the answer to the above question has to do with the criterion measure against which the self-report is correlated. If the criterion measure does not correlate strongly with the underlying exposure construct of interest (e.g., light intensity PA), then correlations between questionnaires and the presumed criterion for the exposure will be error prone and inaccurate (Wareham & Rennie, 1998). In the present study, and others (Harada et al., 2001; Jacobs et al., 1993; Pettee Gabriel et al., 2009; Sabia et al., 2014; Shiroma et al., 2015), accelerometers are assumed to be an appropriate criterion against which to correlate responses to questionnaires assessing multiple PA domains. The choice of cutpoints used to define accelerometer measured PA and SB is well recognized to influence classification of these behaviors in adults (Colbert & Schoeller, 2011; Evenson et al., 2015; Ham, Reis, Strath, Dubose, & Ainsworth, 2007). While accelerometers are now considered to be a more objective device-based measurement option (Lee & Shiroma, 2014), the fact is that a true gold standard field measure of free-living PA does not exist (LaMonte et al., 2006). Thus, some of the variability in correlations reported between questionnaire and accelerometers may reflect the inadequacy of the device in measuring complex PA constructs.

Understanding the agreement between self-report and device measures of PA and SB is relevant in the context of measurement accuracy and potential misclassification on these frequently studied health behaviors, especially in older adults where recall may be impaired by aging. An important methodologic extension of these measurement concerns pertains to the comparability of estimated associations with health indicators for self-reported and device measured exposures. Few studies have evaluated this issue. Mean differences in BMI were larger according to levels of light and total PA, and SB assessed by the CHAMPS compared with accelerometer measures in adults aged 70–89 years (Bann et al., 2015). We evaluated the comparability of associations between questionnaire and device measures with poorer self-rated health. Our definition of poorer self-rated health was associated with more than a two-fold higher age-adjusted mortality risk over three years follow-up in OPACH women (LaMonte, Buchner, et al., 2017). Adjusted odds ratios for poorer health for questionnaire and accelerometer measures were of the same direction and of similar magnitude for the various measures of PA. Associations with sitting exposure were more inconsistent across assessments. Future work in OPACH comparing questionnaire and accelerometer assessments on disease development and mortality will add further understanding about the use of different methods of assessing PA and SB when examining epidemiologic associations with health in later life.

Study strengths include the large sample size of more than 5,000 multiethnic community-dwelling older women with a wide range of age, PA and physical functioning levels; and the use of the CHAMPS questionnaire, which was designed specifically for older adults. Use of a triaxial accelerometer enhances detection of movement among individuals with limited movement patterns, and study-specific calibrated accelerometer cutpoints enhances accuracy of classifying time spent in PA and SB. Accelerometers, while often used as a criterion measure to evaluate questionnaire performance, do have limitations (LaMonte et al., 2006; Lee & Shiroma, 2014). A consensus gold standard measure of free-living PA and SB currently does not exist. Therefore, when assuming accelerometers to be a criterion measure, one must recognize that comparisons with questionnaires would be influenced by any measurement error introduced by the device as well as that owed to self-report. Sedentary time may differ between weekday and weekend days (Marshall et al., 2010; Marshall et al., 2015; Rosenberg et al., 2010; Wijndaele et al., 2014); we were not able to differentiate sedentary measures in the present study. A combined accelerometer and inclinometer likely provides a more complete assessment of SB (Healy et al., 2011). Participants were not given explicit directions as to timing of PA and SB questionnaires relative to the accelerometer wear interval. Thus, it is possible that women who completed the questionnaire nearer the end of accelerometer wear could have been somewhat more sensitive to recalling their PA and sitting times compared to women completing the questionnaire at the start of the wear interval. The WHI questionnaire item for light physical activity ("mild exercise") prompts respondents to think about activities that for some participants are at the low end of moderate intensity. This, in turn, could influence correlations with accelerometer-measured light intensity. It is possible that activities such as cycling, or those involving the upper body may have been underestimated by the accelerometers and could potentially lead to discordance with self-reports in which time spent in such activities is high. Likewise, because type of activity being performed is not yet easily discernible from accelerometers, it was not possible to evaluate whether specific activities recorded on the CHAMPS might correlate more strongly than others with device measures in older women. The majority of women in this investigation were nonsmokers with good to excellent objectively measured physical functioning when the questionnaire and accelerometer assessments were completed. This should be considered when generalizing findings of our study.

Conclusions

Promoting PA and reducing SB are critical components of enhancing public health, and current recommendations are based heavily on evidence derived from questionnaire assessments of these behaviors. Concern about the accuracy of questionnaire assessed PA and SB is not new (Loney et al., 2011; Sallis & Saelens, 2000; van Uffelen et al., 2011). Device measures provide an opportunity for improved assessments of these behaviors. Future studies should determine whether measured associations for PA and SB with disease incidence and mortality outcomes vary appreciably when based on device opposed to questionnaire assessments. Monitoring devices, such as accelerometers, are becoming more feasible for use in epidemiologic studies (Colbert & Schoeller, 2011; Lee & Shiroma, 2014). Cutpoint standardization for defining PA and sedentary domains is needed to facilitate greater utilization of monitoring devices in measuring these behaviors and their association with disease (Evenson et al., 2015; Ham et al., 2007; Lee & Shiroma, 2014; Shiroma et al., 2015).

The present study demonstrated that questionnaire and accelerometer measures of PA and SB are moderately correlated, except for light intensity activities. The magnitude of correlations observed in the present study and the evidence to date suggest that study populations will be classified quite differently into high and low levels of each behavior depending on the methods used to measure the behavior. This has important implications for interpreting how much and how intense PA must be to result in health benefits, and in translating the evidence into guideline recommendations. While device assessments are increasingly used, many studies or surveys will continue to use questionnaires for feasibility reasons. Based on our findings, and others, we believe that questionnaire and device measures of PA and SB, while related, are capturing different aspects of the human movement construct. This is especially true for light-intensity PA, which is very poorly reflected in the questionnaire measure. Further work is needed to develop better questionnaire assessment of this common and relevant behavior in older adults.

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Supplement Table 1. Spearman Correlations[a] among Self-Reported and Accelerometer-Assessed Physical Activity and Sedentary Behavior, by jointly classified Race/Ethnicity and Age

Self-Reported Measure, WHI Questionnaire	Total recreational PA, min/wk	Total recreational PA, min/wk	Light-intensity activity, min/wk	MVPA, min/wk	Sitting time, min/wk
Accelerometer-Assessed Measure	Total vector magnitude, counts/wk	Total PA, min/wk	Light-intensity activity, min/wk	MVPA, min/wk	Sedentary time, min/wk
Non-Hispanic White					
63 to <75 years	0.41 (<0.0001)	0.29 (<0.0001)	0.06 (0.26)	0.31 (<0.0001)	0.26 (<0.0001)
75 to <82 years	0.39 (<0.0001)	0.29 (<0.0001)	0.04 (0.25)	0.21 (<0.0001)	0.35 (<0.0001)
≥82 years	0.31 (<0.0001)	0.27 (<0.0001)	0.05 (0.05)	0.18 (<0.0001)	0.32 (<0.0001)
Non-Hispanic Black					
63 to <75 years	0.28 (<0.0001)	0.19 (<0.0001)	0.01 (0.85)	0.18 (<0.0001)	0.25 (<0.0001)
75 to <82 years	0.32 (<0.0001)	0.21 (<0.0001)	0.02 (0.53)	0.24 (<0.0001)	0.21 (<0.0001)
≥82 years	0.34 (<0.0001)	0.28 (<0.0001)	0.06 (0.33)	0.19 (0.002)	0.28 (<0.0001)
Hispanic/Latina					
63 to <75 years	0.38 (<0.0001)	0.26 (<0.0001)	0.01 (0.79)	0.26 (<0.0001)	0.29 (<0.0001)
75 to <82 years	0.33 (<0.0001)	0.22 (<0.0001)	-0.03 (0.56)	0.22 (<0.0001)	0.24 (<0.0001)
≥82 years	0.18 (0.037)	0.11 (0.20)	0.12 (0.17)	0.13 (0.12)	0.21 (0.014)

Self-Reported Measure, CHAMPS/CARDIA Questionnaire	All activities (CHAMPS), min/wk	All activities (CHAMPS), min/wk	Light-intensity activity (CHAMPS), min/wk	MVPA (CHAMPS), min/wk	Total sitting time (CARDIA), min/wk
Accelerometer-Assessed Measure	Total vector magnitude, counts/wk	Total PA, min/wk	Light-intensity activity, min/wk	MVPA, min/wk	Sedentary time, min/wk
Non-Hispanic White					
63 to <75 years	0.31 (<0.0001)	0.29 (<0.0001)	0.14 (0.007)	0.33 (<0.0001)	0.33 (<0.0001)
75 to <82 years	0.32 (<0.0001)	0.27 (<0.0001)	0.15 (<0.0001)	0.33 (<0.0001)	0.35 (<0.0001)

≥82 years	0.31 (<0.0001)	0.29 (<0.0001)	0.21 (<0.0001)	0.28 (<0.0001)	0.29 (<0.0001)
Non-Hispanic Black					
63 to <75 years	0.27 (<0.0001)	0.25 (<0.0001)	0.13 (0.0001)	0.28 (<0.0001)	0.25 (<0.0001)
75 to <82 years	0.29 (<0.0001)	0.25 (<0.0001)	0.15 (<0.0001)	0.28 (<0.0001)	0.20 (<0.0001)
≥82 years	0.23 (0.0001)	0.15 (0.014)	0.04 (0.50)	0.25 (<0.0001)	0.32 (<0.0001)
Hispanic/Latina					
63 to <75 years	0.23 (<0.0001)	0.18 (<0.0001)	0.05 (0.24)	0.25 (<0.0001)	0.32 (<0.0001)
75 to <82 years	0.36 (<0.0001)	0.31 (<0.0001)	0.18 (0.0008)	0.33 (<0.0001)	0.27 (<0.0001)
≥82 years	0.18 (0.035)	0.13 (0.13)	0.11 (0.19)	0.17 (0.05)	0.31 (0.0003)

MVPA, moderate-to-vigorous intensity activity; PA, physical activity

[a] adjusted for awake wear time; numbers in parentheses are p-values

Supplement Table 2. Spearman Correlations[a] among Self-Reported and Accelerometer-Assessed Physical Activity and Sedentary Behavior, by jointly classified Race/Ethnicity and SPPB Score

Self-Reported Measure, WHI Questionnaire	Total recreational PA, min/wk	Total recreational PA, min/wk	Light-intensity activity, min/wk	MVPA, min/wk	Sitting time, min/wk
Accelerometer-Assessed Measure	Total vector magnitude, counts/wk	Total PA, min/wk	Light-intensity activity, min/wk	MVPA, min/wk	Sedentary time, min/wk
Non-Hispanic White					
SPPB score 1-6	0.36 (<0.0001)	0.30 (<0.0001)	0.05 (0.19)	0.23 (<0.0001)	0.31 (<0.0001)
SPPB score 7-9	0.29 (<0.0001)	0.23 (<0.0001)	0.04 (0.21)	0.18 (<0.0001)	0.31 (<0.0001)
SPPB score 10-12	0.34 (<0.0001)	0.25 (<0.0001)	0.06 (0.10)	0.18 (<0.0001)	0.30 (<0.0001)
Non-Hispanic Black					
SPPB score 1-6	0.28 (<0.0001)	0.25 (<0.0001)	-0.02 (0.70)	0.19 (0.0002)	0.06 (0.29)
SPPB score 7-9	0.26 (<0.0001)	0.15 (<0.0001)	0.01 (0.77)	0.22 (<0.0001)	0.25 (<0.0001)
SPPB score 10-12	0.29 (<0.0001)	0.19 (<0.0001)	0.01 (0.88)	0.17 (<0.0001)	0.26 (<0.0001)
Hispanic/Latina					
SPPB score 1-6	0.21 (0.016)	0.22 (0.009)	0.09 (0.30)	0.08 (0.35)	0.31 (0.0002)
SPPB score 7-9	0.32 (<0.0001)	0.22 (<0.0001)	0.00 (0.95)	0.22 (<0.0001)	0.22 (<0.0001)
SPPB score 10-12	0.35 (<0.0001)	0.21 (<0.0001)	0.02 (0.69)	0.22 (<0.0001)	0.26 (<0.0001)

Self-Reported Measure, CHAMPS/CARDIA Questionnaire	All activities (CHAMPS), min/wk	All activities (CHAMPS), min/wk	Light-intensity activity (CHAMPS), min/wk	MVPA (CHAMPS), min/wk	Total sitting time (CARDIA), min/wk
Accelerometer-Assessed Measure	Total vector magnitude, counts/wk	Total PA, min/wk	Light-intensity activity, min/wk	MVPA, min/wk	Sedentary time, min/wk
Non-Hispanic White					
SPPB score 1-6	0.33 (<0.0001)	0.29 (<0.0001)	0.23 (<0.0001)	0.27 (<0.0001)	0.25 (<0.0001)
SPPB score 7-9	0.32 (<0.0001)	0.28 (<0.0001)	0.15 (<0.0001)	0.35 (<0.0001)	0.32 (<0.0001)

SPPB score 10-12	0.26 (<0.0001)	0.21 (<0.0001)	0.11 (0.002)	0.27 (<0.0001)	0.34 (<0.0001)
Non-Hispanic Black					
SPPB score 1-6	0.31 (<0.0001)	0.28 (<0.0001)	0.21 (<0.0001)	0.26 (<0.0001)	0.08 (0.14)
SPPB score 7-9	0.27 (<0.0001)	0.22 (<0.0001)	0.11 (0.001)	0.25 (<0.0001)	0.23 (<0.0001)
SPPB score 10-12	0.17 (<0.0001)	0.15 (0.001)	0.00 (0.94)	0.25 (<0.0001)	0.30 (<0.0001)
Hispanic/Latina					
SPPB score 1-6	0.24 (0.006)	0.31 (0.0002)	0.22 (0.01)	0.19 (0.02)	0.34 (<0.0001)
SPPB score 7-9	0.22 (<0.0001)	0.18 (0.001)	0.10 (0.06)	0.21 (0.0001)	0.26 (<0.0001)
SPPB score 10-12	0.25 (<0.0001)	0.17 (0.0004)	0.05 (0.28)	0.29 (<0.0001)	0.27 (<0.0001)

MVPA, moderate-to-vigorous intensity activity; PA, physical activity; SPPB, Short Physical Performance Battery

[a] adjusted for awake wear time; numbers in parentheses are p-values.