Author Manuscript
Author Manuscript
Author Manuscript

Published in final edited form as:
J Phys Act Health. 2015 May ; 12(5): 727–732. doi:10.1123/jpah.2013-0546.

Reliability and Validity of Two Self-report Measures to Assess Sedentary Behavior in Older Adults

Keith P. Gennuso[1], **Charles E. Matthews**[2], and **Lisa H. Colbert**[3]

[1]Department of Population Health Sciences, University of Wisconsin-Madison, Madison, WI

[2]Nutritional Epidemiology Branch, Division of Cancer Epidemiology and Genetics, National Cancer Institute, Bethesda, MD

[3]Department of Kinesiology, University of Wisconsin - Madison, Madison, WI

Abstract

Background—The purpose of this study was to examine the reliability and validity of two currently available physical activity surveys for assessing time spent in sedentary behavior (SB) in older adults.

Methods—Fifty-eight adults (≥65 years) completed the Yale Physical Activity Survey for Older Adults (YPAS) and Community Health Activities Model Program for Seniors (CHAMPS) before and after a 10-day period during which they wore an ActiGraph accelerometer (ACC). Intraclass correlation coefficients (ICC) examined test-retest reliability. Overall percent agreement and a kappa statistic examined YPAS validity. Lin's concordance correlation, Pearson correlation, and Bland-Altman analysis examined CHAMPS validity.

Results—Both surveys had moderate test-retest reliability (ICC: YPAS=0.59 (P<0.001), CHAMPS=0.64 (P<0.001)) and significantly underestimated SB time. Agreement between YPAS and ACC was low (κ=−0.0003); however, there was a linear increase (P< 0.01) in ACC-derived SB time across YPAS response categories. There was poor agreement between ACC-derived SB and CHAMPS (Lin's r=0.005; 95% CI, −0.010 to 0.020), and no linear trend across CHAMPS quartiles (p=0.53).

Conclusions—Neither of the surveys should be used as the sole measure of SB in a study; though the YPAS has the ability to rank individuals, providing it with some merit for use in correlational SB research.

Keywords

aging; physical activity; sitting/standing

Corresponding Author: Keith P. Gennuso, PhD, Department of Population Health Sciences, 575C Warf Office Building, 610 Walnut St., Madison, WI 53726, Office: (608) 262-4380, gennuso@wisc.edu.

INTRODUCTION

The science of sedentary behavior (SB), defined as participation in activities such as sitting and reclining during waking hours that do not substantially increase energy expenditure above rest[1], has advanced considerably over the past decade. Though SB has historically been used to describe limited participation in moderate-vigorous physical activity[2], research linking prolonged sitting to adverse health outcomes while controlling for moderate-vigorous physical activity has provided the evidence needed to identify SB as an independent behavior of interest[3,4]. For instance, data from large prospective cohort studies have shown SB, or proxy measures such as television viewing, to be associated with health outcomes such as an increased risk of all-cause and cardiovascular disease-related mortality[5–8], undesirable cardiometabolic risk factor profiles[9–11], several site-specific cancers[12–14], and type 2 diabetes[15,16]. These associations, however, may be confounded by other factors related to TV viewing including snacking and advertising of unhealthy foods[17].

The most common form of SB measurement has been the use of self-report[18]. Self-report measures quantify time spent in SB by requiring the user to estimate their usual behavior, recall their past behavior, or keep a record of their current behavior as it happens[19]. To accurately estimate time spent in SB, a questionnaire should be tailored to address the particular components of the behavior in a given population. While some factors may be relevant for most populations, others will be distinct to particular groups, such as age groups[20]. For instance, querying time spent sitting at school or work would not be relevant for the majority of the older adult age group. The need to accurately describe SB in the older adult population is especially pertinent given the population shift that will result in a doubling of adults aged ≥65 years by 2050[21] and accelerometer-derived evidence to suggest older adults represent the most sedentary age group, spending approximately 60% to 70% of their waking hours in SB[22]. Although device based measures, such as accelerometers, provide a more valid and reliable estimate of SB, their high cost relative to self-report makes them much more difficult to implement on a large scale[19,23]. This highlights the need for valid and reliable self-report measures of SB specifically tailored for the older adult age group.

To our knowledge, the validation of self-report SB measures in older adults is limited. Gardiner et al.[24] adapted a previous measure of SB for the general adult population to be more relevant to older adults. Test-retest reliability for total SB time was moderate (r = 0.56), while criterion-related validity was poor (r = 0.30) when compared to accelerometer-derived SB time. The criterion-related validity of the International Physical Activity Questionnaire – Short Form (IPAQ) was examined in older adults by Grimm et al.[25] In regards to SB, the single-item sitting time question in the IPAQ was shown to underreport by approximately 4 hours compared to accelerometer. What these findings highlight is the need to explore the accuracy of other self-report options to assess SB in this population. Several self-report measures of physical activity exist for older adults, including the Yale Physical Activity Survey for Older Adults (YPAS) and Community Health Activities Model Program for Seniors (CHAMPS) survey, and SB is either directly or indirectly addressed in these instruments. While the CHAMPS and YPAS were not specifically designed to quantify time spent in SB, a successful repurposing of these surveys resulting in the valid and reliable assessment of SB could prove useful; not only for accurate assessment of SB in future studies of older adults, but also to be able to revisit data from older studies using these surveys with the purposes of SB investigation. To our knowledge, no studies have compared the YPAS, and just one study has compared the CHAMPS, to accelerometer-derived SB time for their ability to accurately assess SB in older adults. The one CHAMPS study[26] used a highly modified version of the original survey with a series of additional questions. Therefore, the purpose of this study was to examine the test-retest reliability and comparative validity of the YPAS and the original CHAMPS surveys to assess total SB time in older adults.

METHODS

Study Population and Experimental Design

The study population for this analysis was selected from a larger study comparing the validity of various objective and self-report measures of physical activity in older adults[27]. A total of 70 men and women aged ≥ 65 years of age were recruited to participate in this study. Initially, participants were asked to wear several physical activity monitors during a ~ 4 day run-in period, where compliance with instruction on wear time was evaluated. This period was followed by two study visits separated by a 10 day measurement period during which the participants were asked to wear the monitors again. During visit 1, participants filled out three physical activity questionnaires, including the YPAS and CHAMPS. The third questionnaire, a modified version of the PASE,[28] was not included in this study because it did not query about time spent in any activities that can be considered SB. After the 10 day measurement period, participants returned for visit 2 where they completed the same self-report physical activity questionnaires and had demographic and anthropometric measurements taken. The study protocol was approved by the University of Wisconsin Health Sciences Institutional Review Board, and all subjects provided written informed consent before study initiation.

Self-reported Sedentary Behavior

The CHAMPS questionnaire was developed to evaluate the effectiveness of a physical activity intervention for older adults by collecting self-reported information on activities performed during waking hours in different domains[29]. Participants are asked to self-report the frequency (times/week) and duration (6 categories ranging from <1 hours/week to ≥9 hours/week) of participation in 41 different activities in a typical week during the past 4 weeks. In order to examine the validity of CHAMPS to accurately estimate total SB time, we created a composite SB score from 9 of the 41 items on the survey. Our criteria for choosing the items were that they 1) are typically performed in a seated or lying position and 2) have a metabolic equivalent of ≤ 1.5 METs according to the most recent update to the Compendium of Physical Activities[30]. The following items met these criteria: visiting with friends or family; attending church; attending club or group meetings; using a computer; doing arts or crafts; attending a concert, movie, lecture or sport event; playing card or board games; playing a musical instrument; and reading. The total weekly duration of SB (hours/week) was calculated by summing the midpoint of the selected duration category for each of the 9 items (e.g. 1.75 hours for the 1–2.5 hour category). This value was divided by 7 to calculate average daily duration of SB (hours/day) because not all participants had 7 days of valid accelerometer data, which is necessary to compare to CHAMPS-reported weekly SB time. In addition, this allows the CHAMPS and YPAS to have a common unit of measure.

The YPAS, described in DiPietro et al.[31], is an interviewer-administered physical activity measure for older adults. Like the CHAMPS, the YPAS queries participants about time spent performing activities in different domains. In the first half of the survey, participants are asked to report the number of hours in a typical week during the past month they performed various specific activities (e.g. swimming, dish washing, etc.). In the second half, participants are provided with response categories for the duration of time spent in broader categories of activities (e.g. vigorous activities, standing, etc.) performed on an average day in the past month. For the purposes of this analysis, we used a single question from the second half of the survey concerning the amount of time spent sitting on an average day. Participant responses were either <3, 3–6, 6–8, or ≥8 hours/day.

Objectively Measured Sedentary Behavior

Objectively measured SB time was derived from data collected using the ActiGraph GT1M (ActiGraph, LLC, Pensacola, FL). Participants were asked to wear the monitor for a 10 day measurement period on an elastic belt over the right hip during all waking hours except in situations with the possibility of water damage. Data, in the form of activity counts per 1-minute epoch, were downloaded from the monitors upon receipt at visit 2. Time spent in SB was estimated by summing minutes for observations falling within established cut points for counts. The amount of time spent in activity of less than 100 counts per minute was considered SB[22] and averaged across valid days to provide an average daily duration (hours/day). A day was considered a valid day with at least 600 minutes (10 hours) of wear without excessive counts (>20,000 counts). Wear time of the monitor was determined by subtracting nonwear time from total daily observation time. Nonwear was defined as periods of at least 60 consecutive minutes of no activity with an allowance for 2 consecutive minutes of observations between 1 and 100 counts. Three valid days were required to be included in the analysis.

Statistical Analysis

Analyses were conducted using SAS (SAS Institute Inc., Cary, NC, USA). All variables used in analyses were assessed for normality, using histograms and values for skewness and kurtosis, and found to be normal. Standard descriptive statistics were performed to describe participant characteristics. Test-retest reliability for repeat administration of the YPAS and CHAMPS over the 10 day testing period was examined by calculating intraclass correlation coefficients (ICC). Prior to examining comparative validity, accelerometer-derived sitting time was adjusted for user wear time by regressing time spent in SB on wear time[32]. This was done because the questionnaires query SB time during all waking hours while the accelerometer-derived SB time may be influenced by what proportion of waking hours it was worn. To be sure this wear time adjustment didn't influence the results we also ran the analysis with the unadjusted variable. To examine the comparative validity of the YPAS, we created a categorical variable of accelerometer-derived sedentary behavior time using the same thresholds as those found in the YPAS sitting question (i.e. <3, 3–6, 6–8, and ≥8 hours/day). Then, overall percent agreement (the number of matching categories between YPAS response categories from visit 2 and the similarly derived categories from the accelerometer) and a kappa statistic[33] were calculated. Because creating an accelerometer-derived sedentary behavior time variable using the YPAS thresholds resulted in categories with zero observations, the kappa statistic was calculated by adding pseudo-observations (i.e. extremely small non-zero values) to those categories. Comparative validity of the CHAMPS was examined by using Lin's concordance correlation coefficient[34], Pearson product-moment correlations, and a Bland-Altman analysis[35,36]. Lastly, generalized linear models were used to examine the linear trend of accelerometer-derived sedentary time across YPAS sitting categories and quartiles of SB from the CHAMPS. The following descriptive scales were used to determine the strength of the validity/reliability: Lin's coefficient (poor, <0.90; moderate, 0.90–0.95; substantial, 0.96–0.99; almost perfect, >0.99)[37], Pearson's coefficient and ICC (poor, <0.30; moderate, 0.30–0.70; substantial, 0.71–0.80; almost perfect, >0.80), and kappa (poor, <0.20; fair, 0.20–0.40; moderate, 0.41–0.60; substantial, 0.61–0.80; almost perfect, >0.80)[38].

RESULTS

Ten of the 70 participants who initially consented dropped out of the study for the following reasons: lost interest/did not have time, $n = 6$; developed health conditions between the run-in and study visits, $n = 2$; found to be ineligible, $n = 1$; reason unknown, $n = 1$; for a total sample size of 60. Of the remaining 60, 2 participants were not included in the analysis for having incomplete CHAMPS data at visit 1 (n=1) and visit 2 (n=1). Characteristics of the remaining 58 participants can be found in Table 1. The majority of participants were female and white, with an average age of 75.1 ± 6.5 years. The typical participant was considered overweight according to body mass index (BMI) and completed at least some college education (80%). The mean ± SD wear time of the ActiGraph was 13.8 ± 1.2 hours/day for 9.7 ± 0.9 valid days.

Both surveys had moderate test-retest reliability across visits. The ICC for the YPAS was 0.588 ($P < 0.001$) and for the CHAMPS was 0.638 ($P < 0.001$). Neither survey had acceptable comparative validity. There was 8.6% agreement between the YPAS and accelerometer-derived SB time. That is, only the 5 participants with ≥8 hours/day of self-reported sitting time accurately categorized their behavior compared to the accelerometer (Table 2). The calculated kappa value was −0.0003 (95% CI, −0.0025 to 0.0019). CHAMPS validity was also poor as evidenced by a Lin's concordance correlation coefficient value of 0.005 (95% CI, −0.010 to 0.020). The strength of the relationship between the CHAMPS and accelerometer-derived SB time was poor as well (Pearson's $r = 0.14$, $P = 0.28$). The Bland-Altman analysis (Figure 2) revealed that the CHAMPS estimate for sedentary behavior was 5.21 hours/day (95% CI, 2.2 to 8.3) lower than accelerometer-derived SB time, and that as SB increased, so did the variability in reporting. Despite the overall poor percent agreement and kappa values, there was a linear trend ($P < 0.01$) in accelerometer-derived SB time across YPAS response categories, suggesting that the YPAS has the ability to accurately rank individuals according to their time spent in SB (Figure 1). No such linear trend was found for the CHAMPS ($P = 0.53$). Models run with the unadjusted accelerometer-derived SB time produced similar results (data not shown).

DISCUSSION

Because of a current lack of acceptable self-report measures for SB in older adults, the validity and reliability of two currently available activity questionnaires to measure SB was assessed. The main finding of this study was that the CHAMPS and YPAS surveys had moderate test-retest reliability and poor comparative validity when quantifying SB. There was very little agreement between the surveys and the criterion of accelerometer-derived time spent in SB (corrected for monitor wear time), as both surveys provided estimates of SB that were significantly lower.

Hekler et al.[26] examined the reliability and validity of an adapted version of the CHAMPS to measure sedentary-through-vigorous intensity activity compared with the criterion of an accelerometer in a sample of 870 older adults (75.3 ± 6.8 years; 56% women) from the Senior Neighbor Quality of Life Study (SNQLS). In this study, the CHAMPS survey was adapted by deleting one item and adding 11 mostly related to transportation. The items used to create a composite SB score in this study were as follows: watching television, reading, sitting and talking with friends, attending an event, riding in a car, traveling by bus, traveling by subway or train, and using a dial-a-ride service. Despite using different questions to create the composite SB score, we found similar results in the current study. Six month test-retest reliability was also acceptable in the SNQLS (ICC = 0.56), though slightly lower than ours, which is to be expected since the retest period was significantly longer. Also, like the current study, Hekler et al. found significantly lower total SB time on the CHAMPS (−6.8 hours/day; 95% CI, −2.9 to −10.7 hours/day) and the same weak correlation with accelerometer-derived SB time (r = 0.12, $P < 0.001$). These results suggest neither the original version of the CHAMPS by Stewart nor Hekler's adapted version is appropriate to validly measure SB.

The test-retest reliability of the YPAS-queried sitting time in the current study is slightly better than has been previously reported[31,39,40]; likely due to a 10-day measurement period being easier to recall compared to 2-week or longer recall periods. To date, the criterion-related validity of the YPAS to measure time spent in SB in older adults using accelerometer-derived SB time as the criterion has not been investigated. However, several studies[31,39–41] have compared this survey's sitting index to several physical activity-related constructs, including predicted maximal oxygen consumption, anthropometric measures, cardiovascular-related measures, and total accelerometer-derived physical activity counts, to examine its construct validity. Significant correlations were found between the YPAS sitting index and diastolic blood pressure (r = 0.53, $P = 0.01$)[31], weight (r = 0.20, $P = 0.048$)[39], and skinfold measures (r = 0.02, $P = 0.03$)[40]. No studies found significant inverse correlations between the YPAS sitting index and estimated oxygen consumption or accelerometer-derived physical activity counts. Together with the results of the current study, this suggests the YPAS, like the CHAMPS, is not appropriate to validly measure SB time. However, the significant linear trend in accelerometer-derived SB time across YPAS response categories suggests that this survey has merit in its ability to accurately rank or classify individuals according to their time spent in SB.

Both surveys significantly underestimated SB time when compared to an accelerometer. One possible explanation for this discrepancy is error introduced by the user, as described thoroughly by Matthews et al.[42]. Whereas as an accelerometer takes minute by minute measurements of SB throughout the day, the CHAMPS an YPAS rely on reollection. Recalling routine daily activities, such as SB, is a daunting cognitive task, especially for older adults. Activities that are the most prevalent are misreported more frequently. Therefore, an activity such as sitting, which is performed dozens of times a day at various bout lengths has the potential for substantial misreporting. Several explanations as to why both surveys underreport SB time when compared to an accelerometer that are not associated with the user could also be proposed. In regards to the CHAMPS, it is possible the sedentary behaviors assessed on the survey do not reflect the full range of sedentary behaviors older adults do in daily life, and that would potentially be flagged as SB by the accelerometer. For instance, time spent in the most common sedentary activities, watching television and driving[43], would be captured by the accelerometer but not the CHAMPS. Despite this, Hekler et al.[26] included TV watching time and still had significant underreporting of SB. Another explanation proposed by Marshall and Merchant[44] concerns how the currently accepted definition of SB, which includes criteria for both postural topography and metabolic cost can lead to measurement error. For instance, when SB is quantified with a hip-worn accelerometer as time spent below a certain intensity threshold, it is assumed that the posture during this time is either sitting or lying. This assumption could introduce error when, for example, standing quietly is registered as SB time by the accelerometer but not reported by the YPAS user as sitting time. Violation of this assumption would more likely affect comparisons with the YPAS than the CHAMPS, because the former only queries sitting time while the latter includes questions for activities that include standing while being sedentary (e.g. attending church).

One of the strengths of this study was the inclusion of an objective measure of physical activity alongside the self-report, which allowed for assessment of comparative validity. A limitation, though, is the use of a hip-mounted accelerometer to estimate time spent in SB which is also susceptible to measurement error. For instance, Kozy-Keadle et al. found the ActiGraph accelerometer to significantly underestimate sitting time compared to the criteria of direct observation[45] and the activPAL[46], a thigh-worn accelerometer able to detect changes in posture. However, the differences were less than 5%. Another unavoidable, but potentially significant, source of measurement error in the study is the manner in which SB time was estimated using the CHAMPS. As is specified by Stewart et al.[29], we created new duration variables for each activity using the midpoint of the selected duration category. An extreme example of how this could introduce error is where two participants are coded as the same duration though their actual time spent in the activity could differ as much as 1.5 hours (e.g. for the 1–2.5 hour category). If this pattern continued for all 9 activities, a true difference of up to 13.5 hours could separate two individuals with the same CHAMPS-estimated SB time.

Self-report measures of health behavior, in general, share strengths over objective measures, like accelerometers, that include low cost, low participant burden, ease of administration and ability assess information about the domain of activity being performed[47]. However, in regards to self-report measure of SB for older adults, it is clear that more work needs to be done. Recent reports by Matthews et al.[48] and Clark et al.[49] describe promising results from previous-day recall (PDR) measures for sedentary behaviors. An advantage of the PDR over questionnaires, such as the CHAMPS and YPAS, is that they allow respondents to reply on recent episodic memory rather than the use of estimation strategies. The recall of Matthews et al.[48] showed excellent correlations of r = 0.68–0.81 with the ActivPAL and had low person-specific bias. We are optimistic that the findings of future studies examining measurement properties of the PDR in older adult specific samples will determine that such measures can provide useful estimates of SB time for this particular age group.

In summary, the CHAMPS and YPAS measures of SB had moderate test-retest reliability and poor criterion-related validity when quantifying SB. As these instruments were not developed for the purpose of quantifying SB, this is not surprising. Given the poor comparative validity, we suggest that neither measure be repurposed and used as the sole measure of SB in a study; however, a linear trend across YPAS response categories for accelerometer-derived SB time indicates that this survey has the ability to accurately rank individuals. Accordingly, this measure could have some merit for use in correlational SB research. Future work is needed to specifically develop and then test measures of self-reported SB.

ACKNOWLEDGMENTS

The present work benefited from the input of Dr. Ronald E. Gangnon who provided valuable assistance to the statistical analysis of the research summarized here, and from Heidi Walaski, Jeanne Stublaski, Barbara Woodhouse, Linda Harris, Howard Bailey, Brad Julius, Brent Johnson, Jaclyn Krupsky, and Aimee Mastrangelo, for assistance with the data collection and management.

FUNDING DISCLOSURE

The project described was supported by R21AG025839 from the National Institutes of Health; the Graduate School, University of Wisconsin-Madison, and by the Clinical and Translational Science Award (CTSA) program, through the NIH National Center for Advancing Translational Sciences (NCATS), grant UL1TR000427. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

REFERENCES

1. Sedentary Behaviour Research Network. Letter to the editor: standardized use of the terms "sedentary" and "sedentary behaviours". Appl Physiol Nutr Metab. 2012; 37(3):540–542. [PubMed: 22540258]
2. Pate RR, O'Neill JR, Lobelo F. The evolving definition of "sedentary". Exerc Sport Sci Rev. 2008; 36(4):173–178. [PubMed: 18815485]
3. Dunstan DW, Howard B, Healy GN, Owen N. Too much sitting - A health hazard. Diabetes Res Clin Pract. 2012; 97(3):368–376. [PubMed: 22682948]
4. Thorp AA, Owen N, Neuhaus M, Dunstan DW. Sedentary behaviors and subsequent health outcomes in adults a systematic review of longitudinal studies, 1996–2011. Am J of Prev Med. 2011; 41(2):207–215. [PubMed: 21767729]
5. Dunstan DW, Barr EL, Healy GN, et al. Television viewing time and mortality: the Australian Diabetes, Obesity and Lifestyle Study (AusDiab). Circulation. 2010; 121(3):384–391. [PubMed: 20065160]
6. Katzmarzyk PT, Church TS, Craig CL, Bouchard C. Sitting time and mortality from all causes, cardiovascular disease, and cancer. Med Sci Sports and Exerc. 2009; 41(5):998–1005. [PubMed: 19346988]

7. Patel AV, Bernstein L, Deka A, et al. Leisure time spent sitting in relation to total mortality in a prospective cohort of US adults. Am J Epidemiol. 2010; 172(4):419–429. [PubMed: 20650954]

8. Wijndaele K, Brage S, Besson H, et al. Television viewing time independently predicts all-cause and cardiovascular mortality: the EPIC Norfolk study. Int J Epidemiol. 2011; 40(1):150–159. [PubMed: 20576628]

9. Helmerhorst HJ, Wijndaele K, Brage S, Wareham NJ, Ekelund U. Objectively measured sedentary time may predict insulin resistance independent of moderate- and vigorous-intensity physical activity. Diabetes. 2009; 58(8):1776–1779. [PubMed: 19470610]

10. Hancox RJ, Milne BJ, Poulton R. Association between child and adolescent television viewing and adult health: a longitudinal birth cohort study. Lancet. 2004; 364(9430):257–262. [PubMed: 15262103]

11. Beunza JJ, Martínez-González MA, Ebrahim S, et al. Sedentary behaviors and the risk of incident hypertension: the SUN Cohort. Am J Hypertens. 2007; 20(11):1156–1162. [PubMed: 17954361]

12. Friberg E, Mantzoros CS, Wolk A. Physical activity and risk of endometrial cancer: a population-based prospective cohort study. Cancer Epidemiol Biomarkers Prev. 2006; 15(11):2136–2140. [PubMed: 17057024]

13. Howard RA, Freedman DM, Park Y, Hollenbeck A, Schatzkin A, Leitzmann MF. Physical activity, sedentary behavior, and the risk of colon and rectal cancer in the NIH-AARP Diet and Health Study. Cancer Causes Control. 2008; 19(9):939–953. [PubMed: 18437512]

14. Patel AV, Rodriguez C, Pavluck AL, Thun MJ, Calle EE. Recreational physical activity and sedentary behavior in relation to ovarian cancer risk in a large cohort of US women. Am J Epidemiol. 2006; 163(8):709–716. [PubMed: 16495470]

15. Hu FB, Leitzmann MF, Stampfer MJ, Colditz GA, Willett WC, Rimm EB. Physical activity and television watching in relation to risk for type 2 diabetes mellitus in men. Arch Intern Med. 2001; 161(12):1542–1548. [PubMed: 11427103]

16. Hu FB, Li TY, Colditz GA, Willett WC, Manson JE. Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. JAMA. 2003; 289(14):1785–1791. [PubMed: 12684356]

17. Williams DM, Raynor HA, Ciccolo JT. A review of TV viewing and its association with health outcomes in adults. Am J Lifestyle Med. 2008; 2(3):250–259.

18. Harvey JA, Chastin SF, Skelton DA. Prevalence of sedentary behavior in older adults: a systematic review. Int J Environ Res Public Health. 2013; 10(12):6645–6661. [PubMed: 24317382]

19. Healy GN, Clark BK, Winkler EA, Gardiner PA, Brown WJ, Matthews CE. Measurement of adults' sedentary time in population-based studies. Am J Prev Med. 2011; 41(2):216–227. [PubMed: 21767730]

20. Owen N, Sugiyama T, Eakin EE, Gardiner PA, Tremblay MS, Sallis JF. Adults' sedentary behavior determinants and interventions. Am J Prev Med. 2011; 41(2):189–196. [PubMed: 21767727]

21. World Health Organization (WHO). Global health and ageing. 2011. http://www.who.int/ageing/publications/global_health/en/.

22. Matthews CE, Chen KY, Freedson PS, et al. Amount of time spent in sedentary behaviors in the United States, 2003–2004. Am J Epidemiol. 2008; 167(7):875–881. [PubMed: 18303006]

23. Atkin AJ, Gorely T, Clemes SA, et al. Methods of Measurement in epidemiology: sedentary Behaviour. Int J Epidemiol. 2012; 41(5):1460–1471. [PubMed: 23045206]

24. Gardiner PA, Clark BK, Healy GN, Eakin EG, Winkler EA, Owen N. Measuring older adults' sedentary time: reliability, validity, and responsiveness. Med Sci Sports Exerc. 2011; 43(11):2127–2133. [PubMed: 21448077]

25. Grimm EK, Swartz AM, Hart T, Miller NE, Strath SJ. Comparison of the IPAQ-Short Form and accelerometry predictions of physical activity in older adults. J Aging Phys Act. 2012; 20(1):64–79. [PubMed: 22190120]

26. Hekler EB, Buman MP, Haskell WL, et al. Reliability and validity of CHAMPS self-reported sedentary-to-vigorous intensity physical activity in older adults. J Phys Act Health. 2012; 9(2):225–236. [PubMed: 22368222]

27. Colbert LH, Matthews CE, Havighurst TC, Kim K, Schoeller DA. Comparative validity of physical activity measures in older adults. Med Sci Sports Exerc. 2011; 43(5):867–876. [PubMed: 20881882]
28. Washburn RA, Smith KW, Jette AM, Janney CA. The Physical Activity Scale for the Elderly (PASE): development and evaluation. J Clin Epidemiol. 1993; 46(2):153–162. [PubMed: 8437031]
29. Stewart AL, Mills KM, King AC, Haskell WL, Gillis D, Ritter PL. CHAMPS physical activity questionnaire for older adults: outcomes for interventions. Med Sci Sports Exerc. 2001; 33(7): 1126–1141. [PubMed: 11445760]
30. Ainsworth BE, Haskell WL, Herrmann SD, et al. 2011 Compendium of Physical Activities: a second update of codes and MET values. Med Sci Sports Exerc. 2011; 43(8):1575–1581. [PubMed: 21681120]
31. Dipietro L, Caspersen CJ, Ostfeld AM, Nadel ER. A survey for assessing physical activity among older adults. Med Sci Sports Exerc. 1993; 25(5):628–642. [PubMed: 8492692]
32. Healy GN, Matthews CE, Dunstan DW, Winkler EA, Owen N. Sedentary time and cardio-metabolic biomarkers in US adults: NHANES 2003–06. Eur Heart J. 2011; 32(5):590–597. [PubMed: 21224291]
33. Cohen J. A coefficient of agreement for nominal scales. Educ PsycholMeas. 1960; 20:37–46.
34. Lin LI. A concordance correlation coefficient to evaluate reproducibility. Biometrics. 1989; 45(1): 255–268. [PubMed: 2720055]
35. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. Lancet. 1986; 1(8476):307–310. [PubMed: 2868172]
36. Bland JM, Altman DG. Measuring agreement in method comparison studies. Stat Methods Med Res. 1999; 8(2):135–160. [PubMed: 10501650]
37. McBride, GB. Using statistical methods for water quality management: issues, options and solutions. Wiley, Hoboken, NJ: 2005.
38. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977; 33(1):159–174. [PubMed: 843571]
39. De Abajo S, Larriba R, Marquez S. Validity and reliability of the Yale Physical Activity Survey in Spanish elderly. J Sports Med Phys Fitness. 2001; 41(4):479–485. [PubMed: 11687767]
40. Schuler PB, Richardson MT, Ochoa P, Wang MQ. Accuracy and repeatability of the Yale physical activity survey in assessing physical activity of older adults. Percept Mot Skills. 2001; 93(1):163–177. [PubMed: 11693682]
41. Young DR, Jee SH, Appel LJ. A comparison of the Yale Physical Activity Survey with other physical activity measures. Med Sci Sports Exerc. 2001; 33(6):955–961. [PubMed: 11404661]
42. Matthews CE, Moore SC, George SM, Sampson J, Bowles HR. Improving self-reports of active and sedentary behaviors in large epidemiologic studies. Exerc Sport Sci Rev. 2012; 40(3):118–126. [PubMed: 22653275]
43. Tudor-Locke C, Leonardi C, Johnson WD, Katzmarzyk PT. Time spent in physical activity and sedentary behaviors on the working day: the American time use survey. J Occup Environ Med. 2011; 53(12):1382–1387. [PubMed: 22104979]
44. Marshall SJ, Merchant G. Advancing the science of sedentary behavior measurement. Am J Prev Med. 2013; 44(2):190–191. [PubMed: 23332338]
45. Kozey-Keadle S, Libertine A, Lyden K, Staudenmayer J, Freedson PS. Validation of wearable monitors for assessing sedentary behavior. Med Sci Sports Exerc. 2011; 43(8):1561–1567. [PubMed: 21233777]
46. Kozey-Keadle S, Libertine A, Staudenmayer J, Freedson P. The Feasibility of Reducing and Measuring Sedentary Time among Overweight, Non-Exercising Office Workers. J Obes. 2012; 2012:282303. [PubMed: 22175004]
47. Strath SJ, Kaminsky LA, Ainsworth BE, et al. Guide to the assessment of physical activity: Clinical and research applications: a scientific statement from the American Heart Association. Circulation. 2013; 128(20):2259–2279. [PubMed: 24126387]
48. Matthews CE, Keadle SK, Sampson J, et al. Validation of a previous-day recall measure of active and sedentary behaviors. Med Sci Sports Exerc. 2013; 45(8):1629–1638. [PubMed: 23863547]

49. Clark BK, Winkler E, Healy GN, et al. Adults' past-day recall of sedentary time: reliability, validity, and responsiveness. Med Sci Sports Exerc. 2013; 45(6):1198–1207. [PubMed: 23274615]

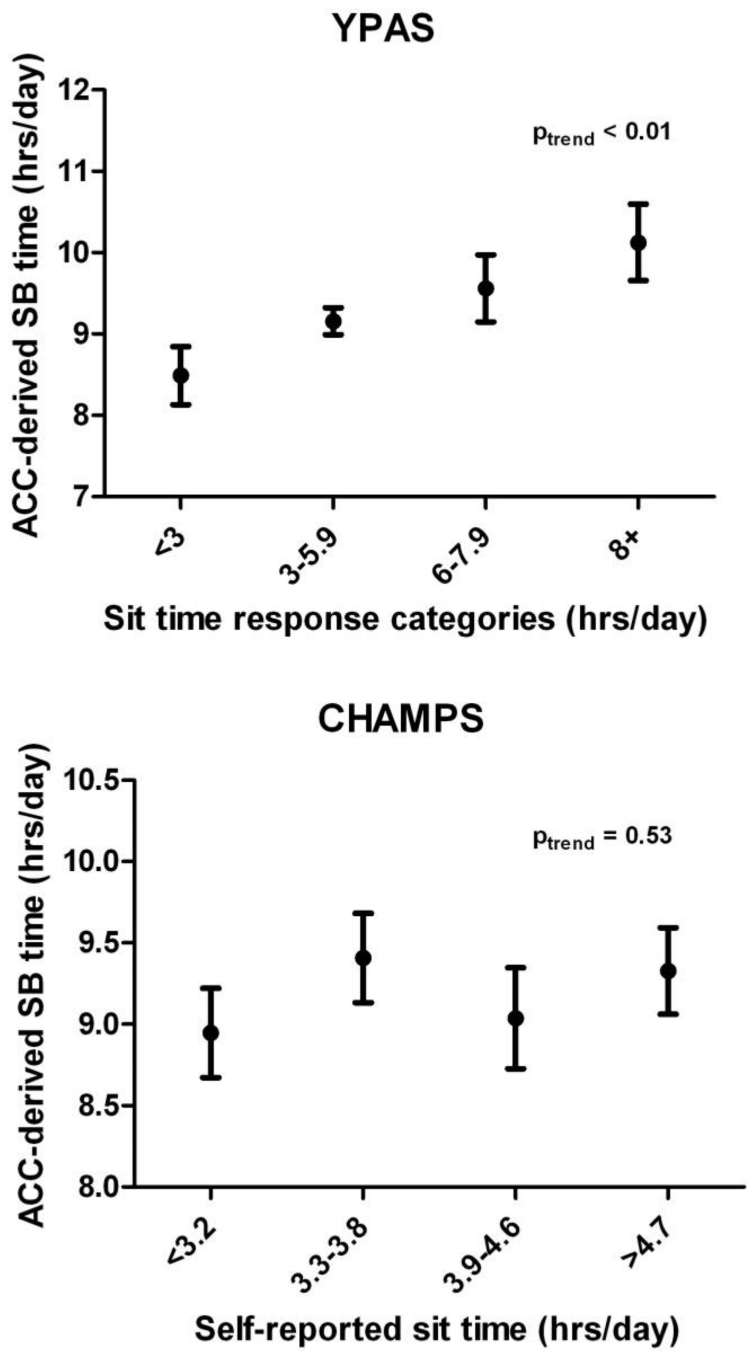

Figure 1.
A comparison of YPAS and CHAMPS self-reported sitting time with accelerometer-derived SB time.a

[a] Values are expressed as least squares mean (standard error), adjusted for accelerometer wear time.

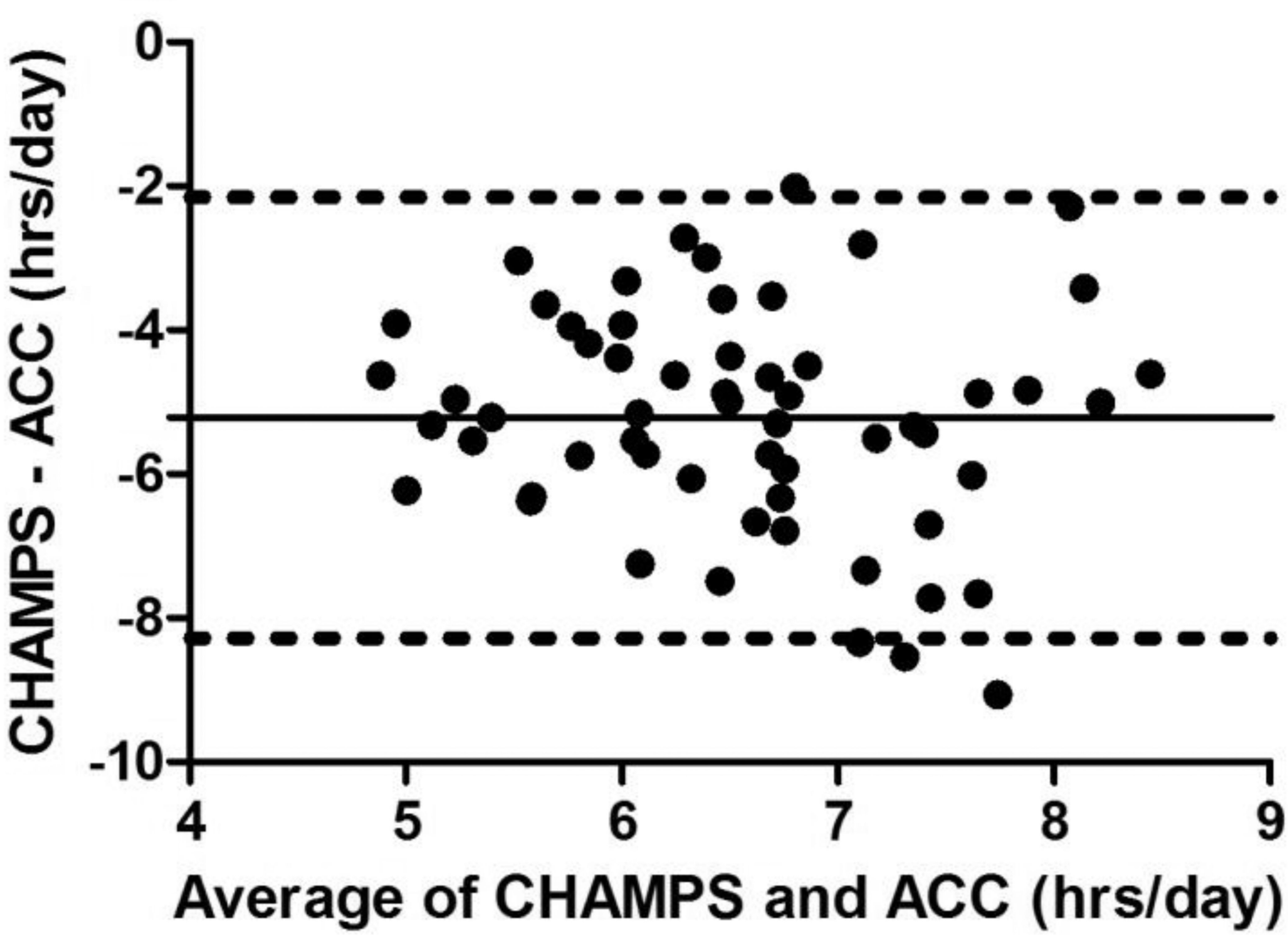

Figure 2.

Bland-Altman plot of the difference between CHAMPS and accelerometer-derived SB time against the average of the two measures.a

[a] Solid line indicates the mean and dashed lines indicate 95% CI. Accelerometer-derived SB time is adjusted for user wear time.

Table 1

Subject characteristics (n=58).[a]

Characteristic	Value
Female (%)	79
White (%)	98
Age (yr)	75.1 ± 6.5
Age range (yr)	66 – 88
BMI ($kg \cdot m^{-2}$)	28.5 ± 20.9
BMI categories (%)	
Normal	50
Overweight	33
Obese	17
Current smoker[b] (%)	4
Education[b] (%)	
≤High school	20
College	48
≥Graduate work	32
Accelerometer-derived SB (hrs/day)	9.2 ± 1.3
% Wear time in SB	66.6 ± 8.0
% Wear time in SB range	46.2 – 88.5

[a]Presented as percent of group or mean ± SD.

[b]Data are missing for smoking and education in four subjects.

Table 2

Cross-tabulation of Accelerometer-derived SB time and YPAS sitting index response categories

YPAS sitting index response categories (hrs/day)	Accelerometer-derived SB time[a] (hrs/day)			
	0–3	**3–6**	**6–8**	**8+**
0–3	0	0	7	8
3–6	0	0	0	39
6–8	0	0	0	6
8+	0	0	0	5

[a]Adjusted for monitor wear time