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Objective vs. Self-report Sedentary Behavior in Overweight and Obese Young Adults

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Abstract

Background—Sedentary behavior (SED) has been measured almost exclusively by self-reported total SED or television time in longitudinal studies. This manuscript aimed to compare self-reported vs. objectively-measured SED.

Methods—Among overweight and obese young adults enrolled in a weight loss trial, baseline SED was assessed by three methods: 1) a questionnaire assessing eight common SEDs (SED_Q), 2) one question assessing SED from the Global Physical Activity Questionnaire (SED_{GPAQ}), and 3) a monitor worn on the arm (SED_{OBJ}). Also, television time (SED_{TV}) was isolated from the SED_Q. SED measures were compared using Spearman's correlations, signed-rank tests, and Bland-Altman plots.

Results—In 448 participants, SED_Q and SED_{GPAQ} were only weakly associated with SED_{OBJ} ($r_s=0.21$; $p<0.001$, $r_s=0.32$; $p<0.001$, respectively). Compared to SED_{OBJ}, SED_Q more often overestimated SED_{OBJ} (median difference: 1.1 hours/day; $p<0.001$), while SED_{GPAQ} more often underestimated SED_{OBJ} (median difference: -0.7 hours/day; $p<0.001$). The correlation between SED_{TV} and SED_{OBJ} was not significantly different from 0 ($r_s=0.08$; $p=0.08$).

Conclusions—SED_Q and SED_{GPAQ} were weakly correlated with, and significantly different from, SED_{OBJ} in overweight and obese young adults. SED_{TV} was not related to SED_{OBJ}. The poor associations of self-reported and objectively-measured SED could affect interpretation and comparison across studies relating SED to adverse health outcomes.

INTRODUCTION

Sedentary behavior (SED) or time spent sitting or reclining at very low intensities (e.g. 1.0–1.5 metabolic equivalents (METs))¹ is ubiquitous in industrialized countries. Several systematic or expert reviews have concluded that the current evidence supports an

association between more SED and an increased risk of diabetes, cardiovascular disease, and mortality, independent of moderate-to-vigorous physical activity (MVPA).^{2–4} A recent meta-analysis including 6 longitudinal studies found that 10 hours/day of SED, compared to 0–3 hours/day of SED, increased the risk of all-cause mortality by 34%.⁵

Though these reports indicate a potential role for SED in the development of cardiometabolic disease and mortality, a major limitation of the literature is that longitudinal studies in population-based cohorts have almost exclusively measured SED by self-report questionnaires.^{3, 6} Such questionnaires rely on participant perceptions or recall of previous SED. In contrast, studies using objective monitoring of activity by accelerometer or multi-sensor devices are able to capture SED at the minute (or smaller) level in a field setting.

Considering the paucity of research investigating longitudinal relationships between objectively-measured SED and the risk of disease and mortality, understanding relationships between self-reported and objective SED would be useful. However, few studies have compared SED measured by self-report to objective methods, in particular to multi-sensor devices. Our objective was to compare three different measures of self-reported SED with objective SED measured by a multi-sensor armband using baseline data among overweight or obese young adult participants in the Innovative Approaches to Diet, Exercise, and Activity (IDEA) Study, which is part of the Early Adult Reduction of weight through LifestYle intervention (EARLY) trials Consortium.⁷ In addition, to illustrate how methods of assessment could influence associations with health-related outcomes, we assessed cross-sectional relationships of SED (self-report and objective) with measures of fitness and adiposity.

METHODS

Sample and Study Design

This study uses baseline data collected as part of the IDEA Study, which is a 2-year, randomized clinical weight loss trial. Participants were recruited from the greater Pittsburgh area between November 2010 and October 2012. Basic inclusion criteria for the IDEA Study included age 18–35 years, body mass index (BMI) between 25.0 to <40.0 kg/m², clearance from the participant's personal physician to participate in the study, and clearance from the study physician to participate based on the results of a graded exercise stress test completed during screening. Exclusion criteria included history of weight loss surgery, recent weight loss >5%, active cancer treatment, treatment for diabetes mellitus, recent, current, or planned pregnancy, current treatment for an eating disorder, cardiovascular disease, and medications affecting heart rate, blood pressure responses to exercise, or metabolism. The study was approved by the University of Pittsburgh's Institutional Review Board. All participants gave informed consent to participate in the study.

To be included in this analysis, participants had to have complete baseline data for all SED measurements and covariates (described below).

Measurement of Sedentary Time

Objective SED (SED_{OBJ}) was assessed using a SenseWear Armband (SWA) (BodyMedia, Inc., Pittsburgh, PA) that did not provide feedback. The SWA is a small, multi-sensor device worn on the midline of the triceps with an elastic band and captures acceleration along with heat flux, skin temperature, and galvanic skin response. Participants were instructed to wear the armband at all times for 7 days except when bathing, swimming, or sleeping. Data were included if participants had ≥10 hours/day of wear time on ≥4 days. The SWA has been validated for assessing free-living, total energy expenditure using doubly labelled water as the gold standard, with recent studies showing correlations ranging from 0.73–0.89.^{8–10}

Data were processed using proprietary algorithms provided by the manufacturer (SenseWear Professional version 7.0). These algorithms combine data from the armband with user-entered participant parameters (age, sex, height, weight, and handedness) to give estimates of energy expenditure for each minute of wear time, which were converted to metabolic equivalents (METs). In addition, the SWA classifies activity as awake or asleep. Consistent with data-handling practice standards for other accelerometers¹¹ and the definition of SED, which excludes sleep¹, SED_{OBJ} was calculated as the sum of awake minutes for which energy expenditure was <1.5 METs and converted to hours/day. To account for different amounts of wear time,^{12–14} we calculated percentage of wear time spent in SED (%SED_{OBJ}) as the total minutes in SED_{OBJ} divided by total minutes of awake wear time.

Self-reported SED was measured using two questionnaires. The EARLY Trials Sedentary Behavior Questionnaire was a modified version of the Sedentary Behavior Questionnaire developed for the Coronary Artery Risk Development in Young Adults (CARDIA) Study (<http://www.cardia.dopm.uab.edu/images/more/pdf/Year25/CARDIA/Form91.pdf>). The CARDIA questionnaire measures six *non-work-related* SED (TV, computer or video games, office work, reading or other recreation, using a phone, and transportation) separately for ‘typical’ weekdays and weekends. Participants choose the amount of time spent in each behavior in categories ranging from none to a maximum of 6 hours/day. The EARLY Consortium modified this questionnaire by adding two questions, in a similar format, to capture *work or school-related* SED either using a computer or doing non-computer tasks (e.g. paperwork). Time spent in all eight activities was summed separately for weekdays and weekends and a weighted average was calculated (SED_Q). A weighted average of >24 hours/day by the SED_Q was truncated at 24 hours/day (n=10 participants). Because many observational studies use TV time as a surrogate for SED,^{2, 15–17} a weighted average of time spent watching TV was isolated from this questionnaire as another measure of SED (SED_{TV}). Importantly, the objective measures cannot distinguish specific types of SED.

The second questionnaire used to estimate SED was the Global Physical Activity Questionnaire (GPAQ)¹⁸ which asks participants a single question about ‘time spent sitting or reclining’ on a ‘typical day’, providing a summary measure of SED (SED_{GPAQ}).

Demographic and Covariate Measurements

Demographic characteristics of participants (sex, age, race, education level, and household income) were self-reported. BMI was calculated as kg/m² with weight measured by a

calibrated, digital scale and height measured using a wall-mounted stadiometer in bare feet wearing a lightweight hospital gown. Body fat (%) was measured by a total body scan with a GE Lunar iDXA dual-energy x-ray absorptiometer (Lunar, Inc., Madison, WI).

Cardiorespiratory fitness was evaluated by a graded, exercise test to 85% of age-predicted maximal heart rate (calculated as 220 bpm minus age). The test used a standardized protocol on a motorized treadmill where participants began at 0% grade and 80.4 m/min and grade was increased by 1% every minute until the target heart rate was achieved. The test was terminated prior to achieving the predetermined heart rate if the participant had an abnormal heart rate or blood pressure response, requested to stop, or other criteria recommended by the American College of Sports Medicine for test termination were present. Achievement of 85% of the age-predicted maximal heart rate during the test was required for inclusion in the study. Measurements included time to test termination in seconds and oxygen consumption ($\text{VO}_2 \text{ max}$) from a Vmax® Encore metabolic cart (CareFusion, San Diego, CA) in $\text{mL/kg}\cdot\text{min}$ at the point of test termination.

For this study, moderate-to-vigorous physical activity (MVPA) was used as a covariate when analyzing associations between SED and measures of fitness or adiposity. Objectively measured MVPA was obtained from the SWA and defined as activity with an intensity of ≥ 3 METS that lasted for ≥ 10 minutes, which is consistent with current physical activity recommendations.¹⁹ Self-reported recreational MVPA was measured by the GPAQ, which has been shown to be reliable and have validity similar to other questionnaires for measuring physical activity in diverse populations.¹⁸

Statistical Analysis

All variables were checked for normality and nonparametric statistics were used where appropriate. Descriptive statistics (frequencies and percentages or medians, interquartile ranges (IQR), and ranges) summarized baseline characteristics.

Three estimates of self-reported SED (SED_Q , SED_{TV} , SED_{GPAQ}) were compared to objectively-measured SED (SED_{OBJ}). Spearman's rank correlation coefficients were used to estimate the associations between measures of SED, both amount and percentage of time, and to test whether these correlations differed from 0. The Wilcoxon signed-rank test determined whether the median difference between each SED_Q and SED_{GPAQ} vs. SED_{OBJ} was zero. Finally, agreement between self-reported and objectively-measured SED was examined with Bland-Altman plots.²⁰ Plots include horizontal lines at the line of equality, upon which all points would lie if the two measures were always the same. Because the differences between methods were not all normally distributed, the values between which 95% of the differences were observed are plotted. SED variables were also categorized into quartiles and absolute categories (<4 hours, 4 to <7 hours, 7 to <10 hours, and ≥ 10 hours), a common practice in observational studies,⁵ and agreement between quartiles and categories of SED_{OBJ} vs. self-reported SED was evaluated by calculating kappa statistics. To comment on whether wear time was related to differences between self-reported SED and SED_{OBJ} , β coefficients and adjusted R^2 were calculated from linear regression models with wear time as the independent variable and between-measure differences as the dependent variable.

Unadjusted and partial Spearman's rank correlations were used to evaluate associations between each of the three measures of self-reported SED and SED_{OBJ} with fitness (time to and oxygen consumption at test termination) and adiposity (BMI and percent body fat). Variables adjusted for when calculating partial correlations included MVPA (matched for assessment type, self-report or objective) and wear time (SED_{OBJ} only).

For comparisons between SED_{TV} vs. SED_{OBJ}, only statistics that would evaluate agreement where SED_{TV} is used as a surrogate for SED_{OBJ} were calculated (e.g. correlations and kappa statistics for quartiles were calculated, but not absolute differences or kappa statistics for absolute categories).

Analyses were conducted using SAS (version 9.3). All reported p-values are two-sided. P-values less than 0.05 are considered to be statistically significant.

RESULTS

Of 470 participants enrolled in the IDEA study, 448 (95%) had complete data for the current analysis. Participant characteristics are listed in Table 1.

Description of Objective Sedentary Time

Most participants, 80.8%, wore the SWA for 7 days, whereas 13.0% wore it for 6 days, 4.5% for 5 days and 1.8% for 4 days. Median (IQR) of average daily wear time was 13.9 (13.1, 14.5) hours/day.

Median (IQR) SED_{OBJ} was 9.1 (7.8, 10.2) hours/day, with substantial range across participants [1.0, 13.4 hours/day] (Table 2). Median (IQR) %SED_{OBJ} was 65.5% (57.6%, 72.7%) and was strongly correlated with absolute SED_{OBJ} ($r_s = 0.89$, $P < 0.001$).

Comparison of Self-reported vs. Objective Sedentary Behavior

Descriptive statistics for self-reported SED from the EARLY Trials Sedentary Behavior Questionnaire (SED_Q and SED_{TV}) and the GPAQ (SED_{GPAQ}), differences from SED_{OBJ}, and correlations with SED_{OBJ} are also reported in Table 2. Correlations were comparable when %SED_{OBJ} replaced SED_{OBJ}: %SED_{OBJ} vs. SED_Q, $r_s = 0.24$, $P < 0.001$; %SED_{OBJ} vs. SED_{GPAQ}, $r_s = 0.28$, $P < 0.001$; and %SED_{OBJ} vs. SED_{TV}, $r_s = 0.11$, $P = 0.02$. Correlations between self-reported measures of SED were as follows: SED_Q vs. SED_{TV}, $r_s = 0.41$, $p < 0.001$; SED_Q vs. SED_{GPAQ}, $r_s = 0.39$, $p < 0.001$; and SED_{GPAQ} vs. SED_{TV}, $r = 0.12$, $p = 0.01$.

Both questionnaires assessing total SED yielded significant differences from SED_{OBJ}. The eight-question SED_Q had a median difference of 1.1 hours/day, indicating that half of the participants reported 1.1 hours/day more SED as compared to SED_{OBJ}. The single-question SED_{GPAQ} had a median difference from SED_{OBJ} of -0.7 hours/day, indicating that half of the participants reported a difference of -0.7 hours of SED by the SED_{GPAQ} as compared to SED_{OBJ} (Table 2). As exhibited in the Bland-Altman plots (Figure 1, **panels A and C**), there was substantial variation in the difference between self-reported and objective measures among individuals, and the differences between which 95% of observations fell were large (-4.9, 11.9 hours/day for SED_Q and -7.8, 5.8 hours/day for SED_{GPAQ}).

Differences between self-reported and objectively-measured SED were also proportionally related to the mean of the two measures, whereby individuals with smaller average SED tended to under-report vs. SED_{OBJ} and individuals with higher average SED tended to over-report vs. SED_{OBJ} .

For SED_{TV} vs. SED_{OBJ} , the pattern of differences revealed that individuals with smaller mean (TV time and objective) SED tended to also have smaller differences between SED_{TV} and SED_{OBJ} , while larger differences were observed in individuals with larger mean SED (Figure 1, **panel B**).

SED was categorized in two ways to evaluate categorical agreement: 1) absolute amount of SED (<4 hours, 4 to <7 hours, 7 to <10 hours, and ≥10 hours) and 2) quartiles. When categorized by absolute amount, SED_{OBJ} had slight agreement with SED_Q ($\kappa=0.14$; $p=0.002$) and SED_{GPAQ} ($\kappa=0.16$; $p<0.001$). When categorized by quartiles, SED_{OBJ} had poor agreement with SED_Q ($\kappa=0.11$; $p=0.10$) but fair agreement with SED_{GPAQ} ($\kappa=0.22$, $p<0.001$). Quartiles of SED_{TV} and SED_{OBJ} had poor agreement ($\kappa=0.04$, $p=0.44$).

In regression models predicting differences between self-reported and objective measures of SED, wear time was significantly related to the differences (hr/day) between SED_{OBJ} with SED_Q ($\beta=-0.79$ hr/day; $p<0.001$) and SED_{TV} ($\beta=-0.62$ hr/day; $p<0.001$). Wear time explained little of the variation in differences across subjects for SED_{OBJ} vs. SED_Q (adjusted $R^2=3.4\%$) and slightly more for differences between SED_{OBJ} vs. SED_{TV} (adjusted $R^2=10.7\%$). Wear time was not related to differences between SED_{OBJ} and SED_{GPAQ} ($p=0.63$).

Associations among Self-reported and Objective Sedentary Behavior with Measures of Fitness and Obesity

To illustrate how methods of assessment could influence associations between SED and health outcomes, we examined relationships between measures of SED with measures of fitness and adiposity (Table 3). SED_{OBJ} was weakly correlated with time to fitness test termination time, oxygen consumption at the time of termination, BMI, and body fat (%), both with and without adjustment for device wear time and objectively-measured MVPA. SED_Q and SED_{GPAQ} were not significantly correlated with any measure of fitness or adiposity. SED_{TV} was only correlated with BMI, both with and without adjusting for total MVPA.

DISCUSSION

The intention of this study was to compare measures of self-reported SED to objectively-monitored SED in a population of overweight and obese young adults. Overall, associations were poor when comparing self-reported SED to SED_{OBJ} . Examining agreement, wide limits were required to accommodate 95% of the observed differences between objective and self-report assessment methods. Further, there was proportional bias between self-report and objective assessment methods, meaning that the differences were not consistent across values of SED. Finally, while cross-sectional analysis revealed that SED_{OBJ} was weakly associated with measures of fitness and adiposity, self-reported total SED was not correlated

with any measure of fitness or adiposity. SED_{TV} was weakly associated with BMI, but not with SED_{OBJ} or measures of fitness or percent body fat.

Consistent with our findings, other studies investigating relationships between self-reported and objective SED have found associations ranging from very weak (correlations between 0.00 – 0.20) to moderate (correlations between 0.40 – 0.70).^{13, 14, 21–24} We are not aware of another study comparing the EARLY Trials or the CARDIA Sedentary Behavior Questionnaires to objectively-measured SED. Of note, a few subjects (n=10) in this sample reported >24 hours of SED by the EARLY Trials Sedentary Behavior Questionnaire, revealing a potential limitations of this instrument. In addition, though it was not the intention of this analysis, the correlation of ~0.4 between the self-report instruments evaluated herein also highlights a potential limitation of comparing results across studies using different SED questionnaires.

We are aware of three studies comparing SED_{GPAQ} to objectively-measured SED. Within a 6-month physical activity intervention study of Latina women (n=71), Spearman's correlations between SED_{GPAQ} and SED by accelerometer were $r_s=0.28$ at baseline and $r_s=0.25$ at 6 months (both $P<0.05$); however, there was not a significant correlation ($r_s=-0.01$) between 6-month changes in SED by accelerometry vs. SED_{GPAQ}.²⁵ In the Nine Country Reliability and Validity Study, associations between SED_{GPAQ} and SED by accelerometer were comparable to our results among Chinese participants ($r_s=0.40$), but not among South African participants ($r_s=-0.02$).¹⁸ A study of Vietnamese adults found that the correlation between SED_{GPAQ} and SED by accelerometry ranged from 0.22 to 0.31, depending on season.²⁶ Though our study differed from the above studies in population (young overweight or obese American adults) and the use of a multi-sensor SWA, the strength of associations we found between SED_{GPAQ} and objectively-measured SED are consistent with the published literature.

Because many studies have found associations between TV time and cardiometabolic outcomes and mortality, and TV time has often been considered a surrogate for total SED in these studies,^{2, 15–17} we examined the agreement between SED_{TV} and SED_{OBJ}. The lack of correlation as continuous variables or quartiles and the proportional differences in measurement seen on the Bland-Altman plot argue against using TV as a surrogate for total SED in this population. Rosenberg et al. found that self-reported TV time was not related to SED measured by accelerometry in overweight men (n=354, $r=-0.001$, $p=0.99$) and weakly related in overweight women (n=200, $r=0.12$, $p=0.04$).²⁷

If SED_{TV} is a poor surrogate for total SED in other populations, a good portion of the literature linking SED to adverse outcomes could be misleading. For example, in a recent meta-analysis, more SED, as measured by TV time in 13 of 18 studies, was associated with increased risks of diabetes, cardiovascular events, cardiovascular mortality, and all-cause mortality.² It is possible that the studies finding associations between TV time and outcomes are detecting a relationship for which time spent in SED is not the primary mechanism. Relationships between SED_{TV} and cardiometabolic outcomes might result from associations between TV viewing and other unhealthy behaviors (e.g. worse dietary intake).^{15–17} Lack of adjustment or residual associations with these potential confounders could overestimate the

risk or create spurious associations with SED.^{13, 14} Overall, though often associated with outcomes, it might be that SED_{TV} is a poor surrogate for SED_{OBJ} and conclusions from studies using SED_{TV} as the exposure should be extrapolated to total SED with caution.

It is important to note that SED assessment by the SWA is not the Gold Standard. The SWA does not measure posture and we are not aware of any studies comparing the SWA to devices that specifically measure posture (e.g. inclinometers). Also, we used SenseWear Professional version 7.0 software, but later and future versions of this software could produce different results. Triaxial accelerometers are more commonly used to objectively measure SED. A recent study in 55 bariatric surgery patients comparing simultaneous SED assessment by two objective monitors, the multi-sensor SWA and a Stayhealthy RTC triaxial accelerometer, did not find a significant difference in SED minutes/day (mean difference 19 minutes, $p=0.17$) or %SED (mean difference 1%, $p=0.47$) between monitors. The association between methods for time spent in SED was moderate with $r=0.60$ ($p<0.001$).²⁸

This study has strengths including the large and unique sample of young adults, the use of a multi-sensor device able to detect monitor wear time, and multiple measures of self-reported SED that could be compared to the objective measure. This is the first report, to our knowledge, comparing the GPAQ for SED measurement with objectively-measured SED in overweight or obese American young adults.

One potential limitation of this study is that our study was conducted within a convenience sample of a contemporary cohort of overweight and obese young adults enrolled in a weight loss trial with technology components. While comparing self-reported and objectively-measured SED is important in this specific population, generalizability to other age groups, normal weight individuals, or other geographical locations could be limited. The IDEA Study did not include normal weight individuals, and this could have decreased the ability to detect associations between SED and adiposity in correlational analyses. In addition, temporal trends in behaviors, for example changes in TV and use of other devices with screens, may limit the application of these findings to studies in which SED was measured many years ago. It should also be noted that the self-report questionnaires ask for 'typical' behavior over 24 hours while the armband measures a distinct week in time and on average 13.9 hours/day; these differences could contribute to the poor agreement. Lastly, the SWA does not capture domain-specific SED, e.g. TV time, and therefore, this study was unable to directly compare objective vs. self-reported TV time. The comparisons between SED_{OBJ} and SED_{TV} should be interpreted in the context where SED_{TV} is used as a surrogate for total SED.

In summary, self-reported SED by the EARLY Trials Sedentary Behavior Questionnaire and the GPAQ had weak associations and poor agreement with SED_{OBJ} measured by the SWA in a sample of overweight or obese young adults. Self-reported TV time was not associated with total SED_{OBJ}, indicating that TV time should not be used as a measure of total sedentary time in this population. One implication of these results is that studies using self-reported SED and especially SED_{TV} from these questionnaires should be aware that these questionnaires do not appear to classify individuals based on their overall SED_{OBJ} very well. These findings underscore the need for longitudinal studies evaluating associations between

objectively-measured SED and cardiometabolic outcomes to understand the potential risks of SED.

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References

1. Sedentary Behaviour Research N. 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. Wilmut EG, Edwardson CL, Achana FA, et al. Sedentary time in adults and the association with diabetes, cardiovascular disease and death: systematic review and meta-analysis. *Diabetologia*. 2012; 55(11):2895–2905. [PubMed: 22890825]
3. 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 Prev Med*. 2011; 41(2):207–215. [PubMed: 21767729]
4. Bauman A, Chau JY, Ding D, Bennie J. Too Much Sitting and Cardio-metabolic Risk: An Update on the Epidemiologic Evidence. *Curr Cardiovasc Risk Rep*. 2013; 7:293–298.
5. Chau JY, Grunseit AC, Chey T, et al. Daily sitting time and all-cause mortality: a meta-analysis. *PLoS one*. 2013; 8(11):e80000. [PubMed: 24236168]
6. Ford ES, Caspersen CJ. Sedentary behaviour and cardiovascular disease: a review of prospective studies. *Int J Epidemiol*. 2012; 41(5):1338–1353. [PubMed: 22634869]
7. Lytle L, Svetkey L, Patrick K, et al. The EARLY trials: a consortium of studies targeting weight control in young adults. *Translational Behavioral Medicine*. 2014;1–10. [PubMed: 24653770]
8. Johannsen DL, Calabro MA, Stewart J, Franke W, Rood JC, Welk GJ. Accuracy of armband monitors for measuring daily energy expenditure in healthy adults. *Med Sci Sports Exerc*. 2010; 42(11):2134–2140. [PubMed: 20386334]
9. Koehler K, Braun H, de Marees M, Fusch G, Fusch C, Schaenzer W. Assessing energy expenditure in male endurance athletes: validity of the SenseWear Armband. *Med Sci Sports Exerc*. 2011; 43(7):1328–1333. [PubMed: 21131865]
10. Mackey DC, Manini TM, Schoeller DA, et al. Validation of an armband to measure daily energy expenditure in older adults. *J Gerontol A Biol Sci Med Sci*. 2011; 66(10):1108–1113. [PubMed: 21734231]
11. Cain, KL.; Geremia, CM. Accelerometer Data Collection and Scoring Manual. San Diego, CA: San Diego State University; 2011.
12. 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]
13. Stamatakis E, Davis M, Stathi A, Hamer M. Associations between multiple indicators of objectively-measured and self-reported sedentary behaviour and cardiometabolic risk in older adults. *Preventive medicine*. 2012; 54(1):82–87. [PubMed: 22057055]
14. Stamatakis E, Hamer M, Tilling K, Lawlor DA. Sedentary time in relation to cardio-metabolic risk factors: differential associations for self-report vs accelerometry in working age adults. *Int J Epidemiol*. 2012; 41(5):1328–1337. [PubMed: 22634868]
15. Cleland VJ, Schmidt MD, Dwyer T, Venn AJ. Television viewing and abdominal obesity in young adults: is the association mediated by food and beverage consumption during viewing time or reduced leisure-time physical activity? *Am J Clin Nutr*. 2008; 87(5):1148–1155. [PubMed: 18469233]

16. 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]
17. Lowry R, Wechsler H, Galuska DA, Fulton JE, Kann L. Television viewing and its associations with overweight, sedentary lifestyle, and insufficient consumption of fruits and vegetables among US high school students: differences by race, ethnicity, and gender. *J Sch Health*. 2002; 72(10): 413–421. [PubMed: 12617028]
18. Bull FC, Maslin TS, Armstrong T. Global physical activity questionnaire (GPAQ): nine country reliability and validity study. *Journal of physical activity & health*. 2009; 6(6):790–804. [PubMed: 20101923]
19. D H.H.S. 2008 Physical Activity Guidelines for Americans. *Journal of Cardiovascular Nursing*. 2009; 24(1):2–3.
20. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet*. 1986; 1(8476):307–310. [PubMed: 2868172]
21. 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]
22. Igelstrom H, Emtner M, Lindberg E, Asenlof P. Level of agreement between methods for measuring moderate to vigorous physical activity and sedentary time in people with obstructive sleep apnea and obesity. *Phys Ther*. 2013; 93(1):50–59. [PubMed: 22956426]
23. Bond DS, Thomas JG, Unick JL, Raynor HA, Vithiananthan S, Wing RR. Self-reported and objectively measured sedentary behavior in bariatric surgery candidates. *Surg Obes Relat Dis*. 2013; 9(1):123–128. [PubMed: 23265767]
24. Dyrstad SM, Hansen BH, Holme IM, Anderssen SA. Comparison of Self-reported versus Accelerometer-Measured Physical Activity. *Med Sci Sports Exerc*. 2014; 46(1):99–106. [PubMed: 23793232]
25. Hoos T, Espinoza N, Marshall S, Arredondo EM. Validity of the Global Physical Activity Questionnaire (GPAQ) in adult Latinas. *Journal of physical activity & health*. 2012; 9(5):698–705. [PubMed: 22733873]
26. Trinh OT, Nguyen ND, van der Ploeg HP, Dibley MJ, Bauman A. Test-retest repeatability and relative validity of the Global Physical Activity Questionnaire in a developing country context. *Journal of physical activity & health*. 2009; 6(Suppl 1):S46–53. [PubMed: 19998849]
27. Rosenberg DE, Norman GJ, Wagner N, Patrick K, Calfas KJ, Sallis JF. Reliability and validity of the Sedentary Behavior Questionnaire (SBQ) for adults. *Journal of physical activity & health*. 2010; 7(6):697–705. [PubMed: 21088299]
28. Unick JL, Bond DS, Jakicic JM, et al. Comparison of two objective monitors for assessing physical activity and sedentary behaviors in bariatric surgery patients. *Obes Surg*. 2012; 22(3):347–352. [PubMed: 21814865]

FIGURE 1.

The difference between self-reported [(A) the Sedentary Behavior Questionnaire, (B) television (TV) time from the Sedentary Behavior Questionnaire, and (C) the Global Physical Activity Questionnaire (GPAQ)] and objectively-measured sedentary hours/day is plotted against the average of objectively-measured and self-reported sedentary hours/day. Horizontal lines are plotted at the line of equality (0), representing no difference between methods, and at the limits which include 95% of the observed data.

Table 1**Participant Characteristics (n=448)**

Sex, n(%)	
Female	315 (70.3)
Male	133 (29.7)
Age, years	
median (IQR)	30.9 (27.8–33.7)
Range	18.4 – 35.9
Race, n(%)	
White *	351 (78.3)
Non-white *	97 (21.7)
Education, n(%)	
High school graduate or GED	107 (23.9)
College graduate	187 (41.7)
Masters or Doctoral Degree	154 (34.4)
Household income, n(%)	
less than \$50,000	179 (40.0)
\$50,000–<\$75,000	97 (21.7)
\$75,000 or more	172 (38.4)
Fitness test: termination time, seconds	
median (IQR)	620 (500–760)
Range	140 – 1420
Fitness test: Submax V_O2, ml/kg·min	
median (IQR)	26 (22.9–30.0)
Range	14.4 – 50.1
Body mass index, kg/m²	
median (IQR)	31.2 (28.5–34.3)
Range	24.4 – 39.9
Body fat, %	
median (IQR)	40.8 (36.7–45.1)
Range	18.0 – 56.0

Submax V_O2 =Submaximal oxygen consumption at 85% of age-predicted maximal heart rate IQR=Interquartile range

*
13 white and 5 non-white participants are Hispanic ethnicity.

Distribution and Comparison of Objective vs. Self-reported Sedentary Time in Overweight and Obese Young Adults (n=448)

Table 2

	Sedentary hours/day			Correlation with SED _{OBJ}		
	median	(IQR)	[range]	P*	r _s	P
SenseWear Armband (SED_{OBJ})	9.1	(7.8–10.2)	[1.0–13.4]			
Sedentary Questionnaire: Total (SED_Q)	10.0	(8.1–12.9)	[1.4–24.0**]		0.21	<0.001
SED _Q minus SED _{OBJ} (difference)	1.1	(–1.2–3.9)	[–7.7–16.7]	<0.001		
Global Physical Activity Questionnaire (SED_{GPAQ})	8.0	(5.0–10.0)	[0.0–22.0]		0.32	<0.001
SED _{GPAQ} minus SED _{OBJ} (difference)	–0.7	(–3.3–1.4)	[–11.2–13.4]	<0.001		
Sedentary Questionnaire: TV (SED_{TV})	2.0	(1.3–2.7)	[0.0–6.0]		0.08	0.08

* Wilcoxon signed-rank test.

** A weighted average of >24 hours/day by the SED_Q was truncated at 24 hours/day (n=10 participants).

Table 3

Simple and Partial Correlations between Self-reported and Objectives Measures of Sedentary Time with Measures of Fitness and Adiposity

Measures of Sedentary Time	Fitness Test Termination Time (seconds)	Oxygen Consumption at Fitness Test Termination Time (mL/kg•min)	Body Mass Index (kg/m ²)	Body Fat (%)
SenseWear Armband (SED_{OBJ})				
Unadjusted r_s	-0.10 [†]	-0.11 [†]	0.23 [‡]	0.11 [†]
Partial r_s^*	-0.11 [†]	-0.09 [†]	0.19 [‡]	0.16 [‡]
Sedentary Questionnaire: Total (SED_Q)				
Unadjusted r_s	0.00	0.00	0.01	0.01
Partial r_s^{**}	0.00	0.01	0.01	0.01
Sedentary Questionnaire: TV (SED_{TV})				
Unadjusted r_s	-0.08	-0.08	0.15 [‡]	0.08
Partial r_s^{**}	-0.08	-0.09	0.15 [‡]	0.08
Global Physical Activity Questionnaire (SED_{GPAQ})				
Unadjusted r_s	-0.02	0.00	0.04	0.01
Partial r_s^{**}	0.01	0.02	0.06	-0.01

Abbreviations: GPAQ, Global Physical Activity Questionnaire, MHR, maximum heart rate, SWA, SenseWear Armband.

* Adjusted for wear time and moderate-to-vigorous physical activity in 10 minute bouts from the SWA

** Adjusted for total moderate-to-vigorous physical activity from the GPAQ.

[†] $P < 0.05$;

[‡] $P < 0.01$