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Associations between Accelerometer-derived Physical Activity and Regional Adiposity in Young Men and Women

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Abstract

Objective—Empirical evidence supports an inverse relationship between physical activity (PA) and adiposity, but studies using detailed measures of both are scarce. We described the relationship between regional adiposity and accelerometer-derived PA in men and women.

Design and Methods—Cross-sectional analysis included 253 participants from a weight loss study limited to ages 20–45 years and BMI 25–39.9 kg/m^2. PA data were collected with accelerometers and expressed as total accelerometer counts and average amount of time per day accumulated in different intensity levels (sedentary, light-, and moderate- to vigorous- intensity PA (MVPA)). Accumulation of time spent above 100 counts was expressed as total active time. Computed tomography (CT) was used to measure abdominal and adipose tissue (AT). Multivariate linear regression analyses were used to assess the relationship between regional adiposity (dependent variable) and the various PA levels (independent variable), and were executed separately for men and women, adjusting for wear time, age, race, education, and BMI.

Results—Among males light activity was inversely associated with total AT (β=−0.19; p=0.02) as well as visceral AT (VAT) (β=−0.30; p=0.03). Among females sedentary time was positively associated with VAT (β=0.11; p=0.04) and total active time was inversely associated with VAT (β=−0.12; p=0.04).

Conclusions—Findings from this study suggest that PA intensity level may influence regional adiposity differently in men and women. Additional research is needed in larger samples to clarify the difference in these associations by sex, create recommendations for the frequency, duration

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and intensity of PA needed to target fat deposits, and determine if these recommendations should differ by sex.

INTRODUCTION

Obesity(1) and obesity-related diseases(2) have reached epidemic rates in the United States. While previous studies have shown a clear inverse relationship between body weight and fat and higher physical activity (PA) levels, many of these studies rely on self-reported estimates of PA such as questionnaires, which are best able to estimate moderate- and vigorous- intensity physical activity.(3–5) Additionally, several studies suggest that higher levels of PA, particularly vigorous intensity PA, may also be associated with less visceral adipose tissue (VAT) (4, 6, 7), which additionally supports the role of intensity level, or the physiological demand of activity on obesity. However, most studies have relied on less precise estimates of VAT such as waist circumference (WC) or waist-to-hip ratio (WHR).(3, 8–11) Examining this relationship, with a measure that quantifies PA volume and time spent in various intensity levels, from sedentary to vigorous, would help clarify whether the relationship with obesity. This, in turn, will help clarify whether PA intensity or volume is necessary to maintain a healthy body weight and reduce VAT, which is associated with higher cardiometabolic risk.(12)

There is limited evidence suggesting the relationships between PA intensities and regional adiposity differ by gender.(10, 13) Li and colleagues observed that PA measured by accelerometer was associated with body fat distribution in older men but not older women.(10) McTiernan and colleagues found many similarities in the associations between PA and body fat in middle-aged men and women, however discovered that greater increases in pedometer readings were associated with less subcutaneous abdominal fat in men but not women.(13) Given that both PA behavior and regional adiposity varies by gender (14–16), it is important to understand how the relationships between the two may differ in men versus women, especially in young adults. In addition, few studies have reported the relationship between physical activity and inter-muscular adipose tissue (IMAT), which has been associated with adverse metabolic outcomes (17–19). We are not aware of existing reports that combine both accelerometer-measured estimates of physical activity with precise measurements of regional adiposity in both men and women.

The aim of the current study is to describe the cross-sectional associations between accelerometer-derived estimates of PA intensities and regional adiposity as measured by computed tomography (CT) in a group of young, overweight adults enrolled in a behavioral weight loss study. Data were collected at the baseline visit, prior to group randomization. We hypothesized that both total PA volume (total accelerometer counts) and time spent in different PA intensities (e.g., sedentary andlight-, and moderate-to vigorous- intensity PA) would be associated with regional adipose tissue, especially in the VAT and IMAT depots that have most deleterious metabolic effects.

METHODS

Study Population

This is a cross-sectional analysis of baseline data from participants in the Slow the Adverse Vascular Events of Excess Weight (SAVE) trial (NCT00366990), a randomized controlled trial assessing the impacts of weight loss, increased physical activity, and reduced sodium intake on vascular health. Moderately overweight or obese (body mass index 25–39.9 kg/m^2) men and women (n=352) 20–45 years of age were recruited from Allegheny County, Pennsylvania. Eligibility included not being regularly active, defined as exercising for <3 hours a week on average in <8 of the past 12 months. Participants were also excluded if they 1) had diabetes (fasting glucose ≥ 126 mg/dl); 2) were being treated for hypertension or had an average screening and baseline SBP of ≥140 or diastolic blood pressure (DBP) ≥ 90 mmHg; 3) were on cholesterol lowering, anti-psychotic, or vasoactive medications, or using vasoactive devices; or 4) were pregnant or breast feeding.

Participants were enrolled in SAVE from 4/2007 to 7/2009. After screening was completed, baseline data, including CT and accelerometry, were collected. The average time between CT and accelerometry data collection was 45 days (minimum=0 days, maximum=230 days, median=36 days). For the current analysis, subjects were removed due to missing accelerometer (n=99) and/or regional adiposity (n=20) data. Five individuals were missing both accelerometer and regional adiposity data, thus n=99 observations were removed for analytical purposes. Analysis was based on 253 participant observations. Age, race, gender and BMI did not vary between those included in the analytical sample and those who are not; however those who did not qualify had a significantly lower rate of completing at least bachelor’s degree than those who did qualify (56.9% vs. 74.6%, respectively; p<0.001). All subjects signed informed consent, and the study design was approved by the institutional review board of the University of Pittsburgh (Pittsburgh, PA).

Design and Procedures

All randomized participants completed screening and baseline visits that included self-reported demographic information, self- and interviewer-administered questionnaires, anthropometric measurements, fasting blood draw, 24-hour urine collection, and non-invasive tests of vascular structure and function.

Demographic and Physical Measures

Age, race, and educational status were self-reported by questionnaire at the screening visit. For the current study, race was re-coded as black vs. non-black and educational level was assessed as college or higher vs. less than college degree.

Weight was measured in kilograms using a standard balance scale. Height was measured in centimeters using a calibrated stadiometer. Body mass index (BMI) was calculated as weight in kilograms (in light clothing without shoes) divided by height in meters squared.

Regional Adiposity Measures

Single-slice CT scans of the abdomen and thigh were acquired using a C-150 Ultrafast CT Scanner (GE Imatron, San Francisco, CA). Slice thickness was set at 6 mm. Abdominal scans were transverse images between L4 and L5 obtained during suspended respiration; thigh images were transverse images 15 cm above the patellar apex.

CT images were interpreted by one of two independent readers using Slice-O-Matic software. A pixel range of −30 to −190 Hounsfield units was used to define fat in the scan circumference. Areas were calculated by multiplying the number of pixels of a given tissue type by the pixel area. Density values were determined by averaging the CT number (pixel density) values of the regions outlined on the images. For the abdominal scan, region of interest lines were drawn along fascial planes. Adipose tissue (AT) below the internal fascial plane (i.e., plane at the interior of abdominal musculature) was considered visceral adipose tissue (VAT). Total abdominal AT included both VAT and subcutaneous abdominal AT. For the leg scan, a single region of interest line was drawn around the leg muscle along a fascial plane. Fat below this line was considered intermuscular adipose tissue (IMAT). Total thigh AT included both IMAT and subcutaneous thigh AT.

Accelerometry Measures

Accelerometer data was collected using the Actigraph AM7164 accelerometer (Pensacola, FL). The Actigraph AM7164 is a small (2 × 1.5 × 0.6 inches and weighs 1.5 ounces.), uni-axial piezoelectric accelerometer that is typically worn at the waist, which measures vertical acceleration ranging in magnitude from 0.05 to 2.00 Gs with frequency response of 0.25 – 2.50 Hz. This parameter allows for the detection of normal human motion while filtering out high-frequency vibrations that occur when riding in a car or operating a lawn mower. Data output from the Actigraph accelerometer are activity counts, which quantify the amplitude and frequency of filtered accelerations. Activity counts are summed over an investigator-specified time interval (i.e., epoch). For the current study, a 60-second epoch was used. The sum of the activity counts within the 60 second interval is related to activity intensity and can be categorized based on validated activity count cut-points.(20–22) Technical specifications, as well as reliability and validity of the ActiGraph have been described previously.(20, 22–24)

SAVE study participants were provided an accelerometer and instructed to wear it on their dominant hip, during all waking hours, for seven consecutive days during all waking hours. At the end of the seven days, participants returned the monitor to study staff. Data from the accelerometers were downloaded and screened for wear time using previously reported methods reported by Troiano et al. (21). Briefly, device nonwear was defined as 60 consecutive minutes of 0 counts, with an allowance for 1–2 minutes of detected counts between 0–100. Wear time was determined by subtracting derived nonwear time from 24 hours (21). A minimum of 10 hours of wear time per day was required for data to be considered for further use in computing accelerometer-derived physical activity estimates.

Accelerometer-Derived Estimates of Physical Activity

For this analysis, accelerometer-derived estimates of physical activity included: 1) total accelerometer counts (an estimate of total PA volume), 2) average daily time spent sedentary and in light and moderate-to-vigorous PA (MVPA), and 3) total active time. Total counts (ct/min/d) were calculated using summed daily counts detected over wear periods. Time spent per day (min/d) in different intensity levels was estimated using threshold values obtained from prior calibration studies. More specifically, time (i.e., minutes) spent being sedentary was estimated as the amount of time accumulated below 100 counts per minute (cts/min) during detected periods of monitor wear (18). Time in moderate- and vigorous-intensity PA was estimated using Freedson cut-points(22). Resulting activity counts for light- (100–1951 cts/min), moderate- (1952–5724 cts/min), and vigorous- intensity (≥5725 cts/min) were computed for each day with valid wear. Finally, an estimate of total active time was computed using a threshold value of ≥100 cts/min. A minimum of 4 of 7 days with ≥10 hours (regardless of whether the days were week- or weekend- days) of wear time per day were necessary for data to be included in these analyses.(21)

Statistical Analysis

Descriptive statistics of all study data were examined, including means, medians, standard deviations, ranges, frequencies, percentiles; graphical displays were reviewed; and, assessment of normality performed. T-tests were used to assess differences between gender among normally distributed continuous variables. Variables not meeting the normality assumptions were analyzed using nonparametric procedures including Wilcoxon rank sum test. Fisher's exact test was used to compare differences between proportions of variables with dichotomous outcomes.

Multivariate linear regression analyses were used to assess the relationship between regional adiposity (dependent variable) and the various PA levels (independent variable), and were executed separately for men and women. For each specific regional adiposity measure [total abdominal AT, VAT, total thigh AT, IMAT] and PA estimate [total counts, intensity level (sedentary, light-intensity, and MVPA) and total active time] three regression models were constructed: 1) PA specific estimate and total accelerometer wear time; 2) model (1) plus covariate adjustment for age, race and education; and 3) model (2) plus covariate adjustment for BMI. We also created a set of models for each of the regional adiposity variables which simultaneously included all three PA intensity levels (sedentary, light-intensity, and MVPA) in the same model. All data manipulations and analyses were performed using SAS 9.3 running on a Windows PC. Statistical significance was considered $p<0.05$

RESULTS

Participant Characteristics

The sample (n=253) was primarily comprised of white [83.7 % (n=195)] females [78.5 % (n=183)] who had at least a college degree [74.7% (n=174)]. The average age (SD) was 38.1 (+5.8) and the mean (SD) body mass index (BMI) was 32.7 (+4.0). Among men (n=50), the average age was 37.6 (+5.8) with 6% (n=3) being black and 86% (n=43) having a bachelor's degree or higher. The average BMI among men was 33.4 (+3.8). Among women (n=183), the average age was 38.2 (+5.8), with 19.1% (n=35) being black and 71.6% (n=131) having a bachelor's degree or higher. The average BMI among women was 32.6 (+4.0). There were no demographic differences between those with a shorter (<36 days) or longer (≥36 days) time between regional adiposity and accelerometry measures.

Regional Adiposity and Accelerometry Measures in Men and Women

Levels of regional adiposity varied by gender with men having significantly higher levels of VAT [142.0 (113.6, 173.2) vs. 94.9 (69.9, 126.2); p<0.0001] and lower levels of total thigh AT 90.3 (66.5, 118.0) vs. 145.1 (117.2, 188.4); p<0.0001] than women (Table 1). Total abdominal AT, IMAT, and BMI did not vary by gender. The mean (SD) accelerometer wear time was 856.3 (67.9) or approximately 14.3 hours per day. Accelerometry measures also varied by gender. Compared to women, men spent significantly more time being sedentary [578.0 (498.8, 616.6) vs. 506.8 (448.2, 566.2); p=0.0004), less time in light-intensity PA [277.5 (247.8, 314.2) vs. 322.8 (252.0, 387.4); p=0.004], and more time in MVPA [30.4 (21.9, 40.8) and 20.3 (12.1, 35.0); p=0.0002]. Accordingly, total active time was lower in men than women [321.7 (254.7, 363.6) vs. 349.5 (275.4, 417.5); p=0.02]. Wear time and total counts did not vary by gender. There were no differences in either regional adiposity and accelerometry measures between those with a shorter (<36 days) or longer (≥36 days) time between the two measures.

Associations between Accelerometer-Derived PA Estimates and Regional Adiposity in Men and Women, adjusted for estimated accelerometer wear time

Among men, visceral AT (VAT) was negatively associated with light intensity PA (β= −0.29; p=0.046) (Model 1, Table 2B). Among men, there was also a positive association between total abdominal AT and sedentary time (β=0.40; p=0.046), and negative associations between total abdominal AT and both light intensity PA (β=−0.33; p=0.02) and total active time (β=−0.28; p=0.046) (Model 1, Table 2A). There were no significant relationships between any regional adiposity measure and MVPA in men. There also were no significant relationships between either thigh AT measure and any accelerometer estimate in men (data not shown).

Among women, VAT was negatively associated with MVPA (β=−0.15; p=0.03) (Model 1, Table 2D). There were no significant relationships between any regional adiposity measure and light intensity PA among women. There also were no significant relationships between total abdominal AT or either thigh AT measure and any accelerometer estimate in women (data not shown).

Multivariate Regression Results

Among men, after additionally adjusting for demographic variables and BMI (Model 3, Tables 2B and 2A), there was still a significant negative association between VAT and light intensity PA (β=−0.30; p=0.03), and between total abdominal AT and light intensity PA (β= −0.19; p=0.02).

Among women, after additionally adjusting for demographic variables and BMI, there was a significant positive association between VAT and sedentary time (β=0.11; p=0.04), and a significant negative association between VAT and total active time (β=−0.12; p=0.04).

There was no association between regional adiposity and total accelerometer counts in either sex (data not shown).

Multivariate Regression Results with All Three PA Intensity Levels (Sedentary, Light-intensity, and MVPA) in the Same Model

Among men, the associations of light- intensity PA with VAT and total abdominal AT were no longer statistically significant after additional adjustment for time spent sedentary and in MVPA (Table 3A). However, the relation between MVPA and total abdominal AT was statistically significant after adjustment for time spent sedentary and in light intensity PA (β=0.16; p=0.04). After additional adjustment for light intensity PA and MVPA, the association between total thigh AT and sedentary time was statistically significant (β=−0.28; p=0.03).

In women, the associations of sedentary time and total active time with VAT were no longer statistically significant after adjustment for light intensity PA and MVPA. However, after adjustment for time spent in light intensity PA and MVPA, sedentary time was inversely related to total thigh AT (β=−0.16; p=0.04).

DISCUSSION

Our findings suggest that time spent in different physical activity intensities were associated with regional adiposity, and that these associations differ by gender. In particular, the metabolically deleterious VAT was negatively associated with light intensity PA among men and positively associated with sedentary time and negatively with total active time among women. These relationships accounted for differences in device wear time, demographic variables that might impact adiposity, and BMI. However, after mutual adjustment for the other PA intensities, the unique association of different intensity levels with VAT in men and women were only of borderline significance.

There is little published literature describing the relationship between PA measured by accelerometers and regional adiposity measured by CT scans. In one such rare study, Sasai and colleges discussed results from a 12 week study that examined the impact of vigorous intensity PA on intra-abdominal fat in middle-aged overweight/obese Japanese men. Participants were categorized into a low-volume (i.e., low duration) vigorous-intensity PA (n=19) and a high-volume (n=18) vigorous-intensity PA group, based on study population-determined median time (34.4 min/week) engaged in vigorous intensity PA (>6.1 metabolic equivalents [METs]) during the program. Findings revealed that more time spent in vigorous intensity PA, regardless of low or high-volume vigorous intensity PA, was associated with greater reductions in intra-abdominal fat.(25)

In prior studies, accelerometers have been used to measure the relationship between PA and both BMI and body composition(8–11, 26–28); however, most studies have used less technologically advanced total and regional adiposity measures such as waist circumference, skin fold thickness, body mass index, fat mass index (bioimpedance measurements), and total percentage of body fat (Dual-emission X-ray absorptiometry (DXA) scans). In the majority of these descriptions abdominal adiposity is limited to waist circumference or DXA measures which provide less detailed information on fat deposits compared to CT scans. Compared to other methods of examining adiposity, CT allows us to more precisely divide adipose tissue into compartments. For example, CT can discern between total, subcutaneous and visceral abdominal adipose tissue, whereas other measures such as waist circumference or DXA would only be able to measure total abdominal or trunk adipose tissue. The studies predominately indicate that higher intensity levels of PA, particularly MVPA or vigorous intensity PA, are associated with less overall and regional adiposity.(8, 9, 26, 28) In a recent study of female breast cancer survivors MVPA was inversely associated with waist circumferences after adjusting for age, ethnicity and total energy intake.(9) In another study of middle-aged women Sternfeld et al. found that among white women vigorous intensity activity was inversely associated with less percent body fat and waist circumference.(26) Other researchers suggest that lifestyle activities may help reduce adiposity. Camhi and colleagues found that in a sample of 1371 adults (50% men) who participated the (years) NHANES accelerometer module, individuals spending more time in lifestyle activities [760–2019 counts per minute (cts/min)], independent from MVPA (>2020 cts/min), were less likely to have elevated waist circumferences.(27)

There is also published research describing this relationship using CT scans and less sophisticated measures of PA (e.g., pedometers, standardized self-reported PA questionnaires, or monitored PA exercise programs).(4, 5, 13) McTiernan and colleagues conducted a 12-month clinical randomized control trial (RCT) assessing the impact of a MVPA exercise program on body weight and composition in adult men and women. PA was measured by pedometer steps and the use of an adapted version of the Minnesota Leisure Time Physical Activity questionnaire and body composition was measured using waist and hip circumference, BMI, total percentage of body fat (DXA), and total, VAT, and subcutaneous VAT with CT scans. Participants were randomized into a control and an exercise group. Among exercisers an inverse relationship between pedometer readings and all body mass measures were found except for a non-significant finding between pedometer readings and subcutaneous fat in women.(13) In another RCT trial middle-age, obese women were randomized into a 16-week control, light-intensity exercise training (LIET) or a high-intensity exercise training (HIET) program. CT scans measured mid-thigh and abdominal fat. Participants in the HIET program showed a significant reduction in Total AT, VAT and subcutaneous fat; no significant changes were found in the control or LIET groups.(5)

Our results concur with studies reporting gender-based differences in the storage of excess body weight, indicating that men tend to more frequently store body weight in the abdominal region whereas women tend to more frequently store extra body weight in the lower (thigh) region.(15, 16) As with other study findings, ours indicates that further exploration of the relationship among gender differences, detailed measures of PA and regional adiposity are needed to determine the causality. We found that men had greater amounts of VAT and had higher levels of sedentary time than women, while women had greater amounts of total thigh fat and spent more time light intensity PA than men. In men, a negative association was found between light intensity PA and VAT, and light intensity PA and total abdominal AT, while in women an positive association was found between sedentary time and VAT, and negative associations between VAT and both total PA and total counts.

Comparison of our findings to other studies is limited due to the use of inconsistent measures of PA and regional adiposity across studies, and the age range of study participants. Although findings have not been consistent, prior research has noted some gender differences. Findings from a clinical trial among adults (ages 40–75) revealed that increasing steps per day (measured by pedometers) was associated with decreased body weight, body fat, BMI, and intra-abdominal fat among both men and women; however, increased steps per day was associated with decreased subcutaneous fat in only men.(13) In another study describing the association between PA measured by accelerometer technology, and body mass revealed an inverse relationship between levels of PA and BMI, weight circumference and body fat (%) among men but not women.(10) Since the latter study was more similar to ours in terms of PA measurement, it is not surprising to see that the PA and abdominal adiposity results are more consistent with ours.

Our study results have several limitations. First, findings are based on a cross-sectional data which cannot infer causality; therefore, we cannot conclude that increasing time spent in light intensity PA will promote reduction of abdominal or thigh adiposity. However, our significant findings warrant the need for future research in this area, specifically, longitudinal studies that can monitor the relationship of time spent in various intensity levels physical activity intensity levels with changes in regional adiposity. A relatively low number of men participated in SAVE, and this should be taken into account when comparing our study to others. In addition, because we had a fairly homogeneous sample of primarily white, well-educated participants living in Pittsburgh, it is important note that findings may not be generalizable. Our results may also reflect an enrollment bias. It has been demonstrated that individuals who volunteer for clinical trials may have higher physical activity levels than the general population (29). In order to participate in the SAVE study, participants had to have a BMI of at least 25 kg/m^2; therefore, our results represent only overweight and obese individuals. The restricted range of BMI in our population could be one possible explanation for the lack of significant associations in some of our models.

Other factors which could affect adiposity, such as energy intake and dietary composition, were not included in our adjusted analyses. While accelerometry is an accurate method of assessing PA, waist-worn, uni-axial accelerometers are less accurate when assessing non-ambulatory (i.e., cycling, weight-lifting) and water activities (i.e., swimming, water aerobics)(30). For analysis by intensity level, cut-point threshold values were applied which might increase the possibility for misclassification of the exposure variable; however, standardized values were used. Lastly, it is possible that some significant findings resulted from chance due to multiple comparisons. Because we performed an exploratory analysis of secondary data from a clinical trial, our study was not powered to adjust for the number of multiple comparisons made in our analyses.

CONCLUSION

Understanding how to reduce excess adipose tissue in high-risk areas, such as the visceral abdominal region, is important in controlling disease risk. Future investigations could help create recommendations for the frequency, duration and intensity of PA needed to target fat deposits, and determine if these recommendations should be gender-based. To our knowledge, we are among the first study to measure the relationship between PA and regional adiposity in a young adult population using accelerometer and CT scan technology. This unique data prompts further investigation into how both total counts (total volume) and intensity of PA may influence regional adiposity and weight loss among men and women.

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Table 1

Comparison of Adiposity and Accelerometer-derived estimates of physical activity (PA) by Gender

	Male (N=52)	Female (N=201)	*P*
Regional Adiposity Measures			
Total Abdominal Adipose Tissue (cm^2)	534.4 (138.7) 541.0 (430.5, 654.2)	542.4 (143.8) 538.5 (444.1, 642.8)	0.84
Visceral Adipose Tissue (VAT) (cm^2)	151.1 (61.9) 142.0 (113.6, 173.2)	104.5 (48.5) 94.9 (69.9, 126.2)	**<0.0001**
Total Thigh Adipose Tissue (cm^2)	94.7 (34.8) 90.3 (66.5, 118.0)	152.6 (46.4) 145.1 (117.2, 188.4)	**<0.0001**
Intermuscular Adipose Tissue (IMAT) (cm^2)	12.5 (4.8) 11.9 (9.1, 15.5)	12.8 (5.0) 12.4 (9.3, 16.4)	0.79
Body Mass Index (kg/m^2)	33.4 (3.8) 34.0 (30.3, 36.0)	32.6 (4.0) 32.4 (28.9, 35.7)	0.18
Accelerometry Measures			
Estimated Wear-Time (min/d)	869.8 (73.1) 882.2 (811.7, 920.8)	853.0 (66.2) 855.4 (809.2, 896.0)	0.07
Total Counts (ct/min/d; × 1000)	281.42 (82.28) 265.63 (229.97, 331.89)	284.12 (23.62) 255.97 (195.34, 334.91)	0.20
Sedentary (min/d 0–99 cts)	552.0 (84.2) 578.0 (498.8, 616.6)	504.6 (86.0) 506.8 (448.2, 566.2)	**0.0004**
Light Intensity PA (min/d 100–1951 cts)	284.2 (55.1) 277.5 (247.8, 314.2)	321.9 (84.2) 322.8 (252.0, 387.4)	**0.004**
Moderate- to-Vigorous Intensity (MV) PA (min/day ≥1952 cts)	33.6 (16.9) 30.4 (21.9, 40.8)	26.3 (28.1) 20.3 (12.1, 35.0)	**0.0002**
Total Active Time (min/day ≥100 cts)	326.4 (99.5) 321.7 (254.7, 363.6)	348.2 (88.7) 349.5 (275.4, 417.5)	**0.02**

Data are presented as mean (standard deviation) and median (25th, 75th percentile) P-values were derived from Wilcoxon Rank Sum Test.

PA = Physical Activity

Table 2A

Multivariate regressions models assessing PA specific relationship with Total Abdominal Adipose Tissue in males (n=52) showing standardized regression coefficient

	Model 1	Model 2	Model 3
Sedentary	0.39, p = 0.06 Adj R^2 = 0.03	0.30, p = 0.11 Adj R^2 = 0.24	0.20, p = 0..08 Adj R^2 = 0.66
Light	**−0.29, p = 0.046** **Adj R^2 = 0.04**	−0.23, p = 0.07 Adj R^2 = 0.25	**−0.19, p = 0.02** **Adj R^2 = 0.71**
Moderate-to-Vigorous	−0.01, p = 0.94 Adj R^2 = −0.04	0.03, p = 0.82 Adj R^2 = 0.20	0.13, p = 0.11 Adj R^2 = 0.68
Total Active Time	−0.27, p = 0.06 Adj R^2 = 0.03	−0.21, p = 0.11 Adj R^2 = 0.24	−0.14, p = 0.08 Adj R^2 = 0.69

Model 1: Adjusted for estimated Accelerometer Wear Time

Model 2: Model 1 + Age, Race/Ethnicity, Education

Model 3: Model 2 + BMI

Table 2B

Multivariate regressions models assessing PA specific relationship with Visceral Adipose Tissue in males (n=52) showing standardized regression coefficient

	Model 1	Model 2	Model 3
Sedentary	**0.40, p = 0.046** **Adj R^2 = 0.07**	0.38, p = 0.06 Adj R^2 = 0.05	0.34, p = 0.08 Adj R^2 = 0.2
Light	**−0.33, p = 0.02** **Adj R^2 = 0.10**	**−0.32, p = 0.03** **Adj R^2 = 0.08**	**−0.30, p = 0.03** **Adj R^2 = 0.15**
Moderate-to-Vigorous	0.07, p = 0.61 Adj R^2 = −0.001	0.10 p = 0.50 Adj R^2 = −0.02	0.15, p = 0.29 Adj R^2 = 0.08
Total Active Time	**−0.28, p = 0.046** **Adj R^2 = 0.07**	−0.27, p = 0.06 Adj R^2 = 0.05	−0.24, p = 0.08 Adj R^2 = 0.12

Model 1: Adjusted for estimated Accelerometer Wear Time

Model 2: Model 1 + Age, Race/Ethnicity, Education

Model 3: Model 2 + BMI

Table 2C

Multivariate regressions models assessing PA specific relationship with Total Abdominal Adipose Tissue in females (n=201) showing standardized regression coefficient

	Model 1	**Model 2**	**Model 3**
Sedentary	0.03, $p = 0.67$ Adj $R^2 = 0.006$	0.03, $p = 0.66$ Adj $R^2 = -0.01$	−0.01, $p = 0.76$ Adj $R^2 = 0.68$
Light	−0.002, $p = 0.97$ Adj $R^2 = -0.0003$	−0.01, $p = 0.90$ Adj $R^2 = -0.01$	0.004, $p = 0.93$ Adj $R^2 = 0.68$
Moderate-to-Vigorous	−0.08, $p = 0.26$ Adj $R^2 = 0.01$	−0.07, $p = 0.34$ Adj $R^2 = -0.003$	0.03, $p = 0.53$ Adj $R^2 = 0.68$
Total Physical Activity	−0.03, $p = 0.67$ Adj $R^2 = 0.0006$	−0.04, $p = 0.66$ Adj $R^2 = -0.01$	0.01, $p = 0.76$ Adj $R^2 = 0.68$

Model 1: Adjusted for estimated Accelerometer Wear Time

Model 2: Model 1 + Age, Race/Ethnicity, Education

Model 3: Model 2 + BMI

Table 2D

Multivariate regressions models assessing PA specific relationship with Visceral Adipose Tissue in females (n=201) showing standardized regression coefficient

	Model 1	Model 2	Model 3
Sedentary	0.09, $p = 0.22$ Adj $R^2 = 0.01$	**0.14, $p = 0.04$ Adj $R^2 = 0.16$**	**0.11, $p = 0.04$ Adj $R^2 = 0.47$**
Light	−0.04, $p = 0.62$ Adj $R^2 = -0.0002$	−0.09, $p = 0.19$ Adj $R^2 = 0.15$	−0.09, $p = 0.14$ Adj $R^2 = 0.47$
Moderate-to-Vigorous	**−0.15, $p = 0.03$ Adj $R^2 = 0.02$**	**−0.15, $p = 0.02$ Adj $R^2 = 0.16$**	−0.09, $p = 0.09$ Adj $R^2 = 0.47$
Total Physical Activity	−0.10, $p = 0.22$ Adj $R^2 = 0.01$	**−0.15, $p = 0.04$ Adj $R^2 = 0.16$**	**−0.12, $p = 0.04$ Adj $R^2 = 0.47$**

Model 1: Adjusted for estimated Accelerometer Wear Time

Model 2: Model 1 + Age, Race/Ethnicity, Education

Model 3: Model 2 + BMI

Table 3A

Multivariate regressions models simultaneously assessing PA specific relationship with Regional Adiposity in men (n=52)

	Total Abdominal	VAT	Total Thigh	IMAT
Sedentary	0.09, p = 0.31	0.30, p = 0.06	**−0.28, p = 0.03**	−0.01, p = 0.94
Light	−0.14, p = 0.10	−0.12, p = 0.42	−0.20, p = 0.09	−0.06, p = 0.65
Moderate-to-Vigorous	**0.16, p = 0.04**	0.10, p = 0.23	0.02, p = 0.88	0.10, p = 0.39
Adjusted R^2	0.72	0.17	0.49	0.35

Models adjusted for: Sedentary Time, Light PA, MVPA, Age, Race/Ethnicity, Education, BMI

Table 3B

Multivariate regressions models simultaneously assessing PA specific relationship with Regional Adiposity in women (n=201)

	Total Abdominal	**VAT**	**Total Thigh**	**IMAT**
Sedentary	−0.05, p = 0.35	−0.01, p = 0.85	**−0.16, p = 0.04**	0.09, p = 0.30
Light	−0.05, p = 0.40	−0.10, p = 0.15	−0.09, p = 0.22	0.10, p = 0.25
Moderate-to-Vigorous	0.008, p = 0.85	−0.10, p=0.07	−0.03, p = 0.57	0.03, p= 0.56
Adjusted R^2	0.68	0.47	0.43	0.22

Models adjusted for: Sedentary Time, Light PA, MVPA, Age, Race/Ethnicity, Education, BMI