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Activity Patterns of Obese Adults with Type 2 Diabetes in the Look AHEAD Study

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Abstract

Purpose—This study describes baseline physical activity (PA) patterns of individuals with type 2 diabetes mellitus enrolled in the multi-center Look AHEAD Study using an objective measure of PA (accelerometry).

Methods—2,240 participants (age = 59.0±6.8 years; BMI = 36.5±6.0 kg/m²) with type 2 diabetes mellitus (T2DM) provided data for this sub-study. Participants were instructed to wear an accelerometer during waking hours over 7 days. Accelerometry data were analyzed to identify periods meeting the criteria of ≥3 METs per minute for ≥10 minutes (MVPA) and ≥6 METs per minute for ≥10 minutes (VPA). Self-reported PA was also assessed with a questionnaire. Accelerometry and self-reported PA data were compared across categories of BMI, sex, race, age, fitness, diabetes medication usage, and history of cardiovascular disease

Results—Self reported PA was lower at higher levels of BMI, was higher in males, was lowest for African-American/Black, and positively associated with fitness. Multivariate analyses for accelerometer measured MVPA and VPA showed that more PA bouts per day, minutes per bout, METs per minute, and MET-minutes were associated with higher fitness. For MVPA, bouts per day were higher in men, and METs per minute were higher in women. For VPA, bouts per day was positively associated with increasing age and differed by race/ethnicity. METs per minute were significantly lower at higher levels of BMI and in women. Diabetes medication usage and history of cardiovascular disease were not associated with patterns of physical activity examined.

Conclusions—Results provide information of factors that contribute to PA patterns in adults with T2DM when PA is assessed using both objective and subjective measures. These data may inform interventions to improve PA in adults with T2DM.

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Keywords

exercise; obesity; accelerometry

INTRODUCTION

Based on recent estimates, approximately 7.8% of the population in the United States has type 2 diabetes mellitus, with this including 17.9 million diagnosed and 5.7 undiagnosed cases (10). Moreover, when using an age criterion of ≥ 20 years or ≥ 60 years, the prevalence is estimated to be 10.7% and 23.1%, respectively (10). This creates a significant public health burden due to the direct cost of its treatment, the indirect cost associated with it, and its link to increased mortality due to cardiovascular disease (10,16,18).

The recent Physical Activity Guidelines Advisory Committee Report concluded that there is evidence that physical activity is important in the treatment of type 2 diabetes as it improves glycemic and cardiovascular risk factor control (21). For example, a meta-analysis conducted by Thomas et al. (19) concluded that repeated bouts of physical activity improve glycemic control in persons with type 2 diabetes. Observational cohort studies have associated higher levels of walking and leisure time physical activity with reduced cardiovascular disease incidence and mortality (5).

The vast majority of studies examining the influence of physical activity on diabetes treatment and related complications have been based on self-report with limited objective data on the daily patterns of physical activity. An objective measure of physical activity using accelerometry was included in the multi-center Look AHEAD Study on individuals with type 2 diabetes from 8 of the 16 clinical sites (14). The availability of these data provides an opportunity to objectively examine patterns of physical activity in this population and to determine factors that may influence participation in physical activity.

The purpose of this study is to describe the patterns and correlates of physical activity in individuals with type 2 diabetes mellitus enrolled in the multi-center Look AHEAD Study using an objective measure of physical activity (accelerometry). Specifically, we examine whether patterns of physical activity among persons with type 2 diabetes vary according to levels of BMI, sex, ethnicity/race, age, baseline fitness, diabetes medication, and presence of cardiovascular disease.

METHODS

Participants

Participants for this study are a subgroup of participants who completed baseline testing prior to being randomized into the multi-center Look AHEAD Study, which is a trial examining the effect of weight loss on the primary and secondary prevention of cardiovascular disease in obese adults with type 2 diabetes (14). The Look AHEAD Study included 5,145 participants recruited across 16 clinical sites in the United States, with 8 of the sites including 2,627 participants enrolled in a sub-study to assess physical activity using accelerometry. Descriptive data for this subgroup of participants are presented in Table 1.

All participants gave written informed consent approved by the local Institutional Review Boards prior to participation in this study. Participants completed initial eligibility assessments and provided baseline data prior to randomization, and these data are used for the analyses presented in this manuscript. These data include demographic characteristics [age, sex, race/ethnicity, cardiovascular disease history (self report of myocardial infarction, stroke, transient

ischemic event, percutaneous transluminal coronary angioplasty, or coronary artery bypass graft), use of diabetes medication], physical activity assessed using accelerometry, physical activity assessed using self-report, and cardiorespiratory fitness according to a standardized protocol as described below.

Assessment of Physical Activity

Accelerometry—The RT3 triaxial accelerometer (StayHealthy®, Monrovia, CA, USA) was used to provide an objective measure of physical activity. Based on the recommendations from the manufacturer, participants were instructed to wear the device at a location consistent with the anatomical location of the anterior iliac spine with the accelerometer placed in a vertical position. The accelerometer was worn on the belt or waistband of the clothing; however, participants were also provided with a belt they could wear to secure the accelerometer to the proper location at the waist in the event that it could not be attached properly to their clothing. Participants were also provided written instructions that included the proper placement of the accelerometer on the body, specific dates (days) that the accelerometer should be worn, procedures to follow should there be difficulty with the operation of the accelerometer, and procedures for returning the accelerometer. The data collection mode for the accelerometer was set in the 3 axis and 1 minute epoch mode.

Participants were provided the accelerometer during a visit to the research center as part of an assessment visit, and they were requested to wear the accelerometer for the remainder of that day (partial day), 6 consecutive days following the visit (6 full days), and to wear it until it was returned to the clinic on the 7th day. Thus, the protocol allowed for up to 6 full days of data collection. Participants were instructed to wear the accelerometer during all waking hours over this period, and to only remove it during periods of bathing, showering, or other water-based activities. Quality control procedures were implemented, and if data were deemed to be invalid an attempt was made to have the subject wear the accelerometer for an additional period to provide valid data.

Data for a given day were considered valid if the accelerometer was worn for ≥ 10 hours on that day, which is consistent with previously published recommendations for the use of accelerometer to measure physical activity (9). The accelerometer was determined not to have been worn for periods defined as ≥ 20 continuous minutes of no activity counts on the accelerometer, and this was subtracted from 24 hours (1440 minutes) to determine if the ≥ 10 hour per day criterion was achieved so that a day could be considered a valid one. To be included in the analyses, a subject had to provide at least 4 valid days of accelerometry data.

Total energy expenditure per minute (kcal per minute) and estimated resting energy expenditure (kcal per minute) were provided by the StayHealthy® software which accompanied the RT3 accelerometer. Using these data, metabolic equivalents (METs) per minute were computed by dividing the estimated total energy expenditure per minute by the estimated resting energy expenditure [METs = total energy expenditure per minute $\div$ estimated resting energy expenditure]. Physical activity periods that are consistent with public health recommendations were identified. The American College of Sports Medicine and the American Heart Association define moderate intensity physical activity as ≥ 3 METs per minute, and it has been recommended that bouts of activity be at ≥ 10 minutes in duration (6). Thus, accelerometry data were analyzed to identify periods that were consistent with these recommendations (≥ 3 METs per minute and ≥ 10 minutes in duration). Vigorous bouts of physical activity consistent with ≥ 6 METs per minute and ≥ 10 minutes in duration were also identified for analysis.

Self-Reported Leisure-Time Physical Activity (LTPA)—Within the Look AHEAD study LTPA was assessed on a sub-sample of approximately 50 percent of the participants at

baseline, which reflects the same subject pool as those who completed measurements using accelerometry. Self-reported LTPA was assessed using the questionnaire developed for the Harvard Alumni Study (12) as part of a structured interview. LTPA was assessed by participants reporting their activity over the past week. Activities assessed included flights of stairs (10 steps = 1 flight), number of city blocks walked (1 mile = 12 blocks), and other sport, recreational, or fitness activities. Standardized scoring procedures were used to compute energy expenditure (kcal/wk) of LTPA (12). Participants also reported the number of days per week that they participated in LTPA that was of sufficient intensity to “engage in regular activity akin to brisk walking, jogging, bicycling, etc. long enough to work up a sweat, get your heart thumping, or get out of breath,” which will be referred to as “sweat episodes”.

Additional Baseline Assessments

A questionnaire was used to assess age, sex, ethnicity, current diabetes treatment, and history of cardiovascular disease. Previously described methods were used to measure height, weight, and BMI (8). A maximal graded exercise treadmill test was used to assess cardiorespiratory fitness at baseline as previously described (22). This test was terminated at the point of volitional exhaustion or at the point where ACSM (1) test termination criteria were observed. A baseline test was considered valid if the maximal heart rate was $\geq 85\%$ of age-predicted maximal heart rate ($HR_{Max} = 220$ minus age) if the participant was not taking a beta-adrenergic blocking medication (beta-blocker). If the participant was taking a beta blocking medicine, the baseline test was considered valid if Rate of Perceived Exertion (RPE) was ≥ 18 at the point of termination. Moreover, to be eligible for participation in the Look AHEAD Study the participant needed to achieve ≥ 4 METs on the baseline graded exercise test, where 1 MET is equal to 3.5 ml/kg/min of oxygen uptake.

Statistical Analysis

All analyses were performed using SAS version 9.1 (SAS Institute, Cary, NC). Statistical significance was defined as $p \leq 0.05$. Bivariate analyses were performed to examine differences in bouts per day meeting the criteria of ≥ 10 minutes per bout and either ≥ 3 METs per minute or ≥ 6 METs per minute within categories of BMI, sex, race/ethnicity, age, fitness, diabetes medication usage, and history of cardiovascular disease. For individuals found to have at least one bout of physical activity meeting the criteria of either ≥ 10 minutes per bout and ≥ 3 METs per minute or either ≥ 10 minutes per bout and ≥ 6 METs per minute, additional bivariate analyses were performed to test for differences in minutes per bout, METs per minute, and MET-minutes for all bouts meeting the criteria. Differences in self-reported LTPA (kcal/wk and sweat episodes per week) within categories of BMI, sex, race/ethnicity, age, fitness, diabetes medication usage, and history of cardiovascular disease were examined.

Multivariate analyses were performed using PROC GLM in SAS to determine the effect of age, BMI, sex, race/ethnicity, fitness, diabetes medication, and history of cardiovascular disease (self report of myocardial infarction, stroke, transient ischemic event, percutaneous transluminal coronary angioplasty, or coronary artery bypass graft) on objective measures of physical activity using accelerometry. Analyses were performed with bouts per day, minutes per bout, METs per minute, and MET-minutes considered as the dependent measures. Separate analyses were performed for these dependent measures for bouts of activity meeting the criteria of ≥ 10 minutes per bout and either ≥ 3 METs per bout or ≥ 6 METs per bout.

Results

Of the 5145 participants randomized into the Look AHEAD Study, 2,627 were at the 8 Look AHEAD clinical sites participating in the accelerometry sub-study. Of these participants, 2,240 (85.3% of the 2,627 participants) provided accelerometry data at baseline, with reasons for

missing data including equipment failure, participant refusal, time/scheduling, and other reasons. Within the “other reasons” category, some clinics did not consider this portion of the Look AHEAD trial as part of the larger trial, and thus not all participants at these clinic sites were presented with an opportunity to consent and participate in the study, with this reason accounting for approximately 21% of the missing baseline accelerometry files. Visual inspection of individual data graphs were performed to determine the presence of activity energy expenditure as depicted by vertical lines over the course of the wear period, the presence of episodes of activity interspersed with sustained periods of zero activity indicating the unit was removed for sleeping, and weekly activity energy expenditure was within reasonable limits for this population (between 200 and 15,000 kcal). Using these criteria, 95.8% (2,145) of the data files available were valid and considered for analysis in this study. Baseline demographic data are presented in Table 1.

Separate analyses were performed using all days that achieved the minimum of ≥ 10 hours per day of wear time, along with the first 4 days, 5 days, or 6 days that achieved the minimum of ≥ 10 hours per day of wear time. The pattern of results did not change when data were analyzed using 4, 5, 6, or all days that met the ≥ 10 hours per day of wear time (data not shown), and therefore the following results are described using data from all days that met this criterion of ≥ 10 hours of wear time.

Comparison by BMI Categories

Participants were categorized based on baseline BMI as 25.0 to <27.0 , 27.0 to <30.0 , 30.0 to <35.0 , 35.0 to <40.0 , and ≥ 40 kg/m² (see Tables 2 and 3). There was a significant difference between BMI categories for bouts per day achieving the ≥ 3 METs and ≥ 10 minute duration criteria, with fewer bouts identified in those with greater BMI. For participants who had a period meeting these criteria, the duration per bout was lower at higher BMI categories. A similar pattern was shown for METs per bout, MET-minutes for bouts meeting these criteria, and bouts of activity per day. Individuals at higher categories of BMI also had fewer bouts per day, shorter duration of activity bouts, and lower METs per bout, and lower MET-minutes when the criteria of ≥ 6 METs and ≥ 10 minutes was applied to the data.

Comparison by Sex

There were significantly more bouts per day in men than in women when using the ≥ 3 METs and ≥ 10 minute duration criteria (0.83 ± 1.00 vs. 0.45 ± 0.73 bouts per day) ($p < 0.0001$) (see Table 2). Moreover, for bouts identified that met these criteria, duration per bout was significantly longer for men (20.65 ± 10.26 minutes) than women (18.63 ± 8.64 minutes) ($p < 0.0001$). METs per minute for these bouts did not differ by sex; however, total MET-minutes for all bouts meeting the criteria of ≥ 3 METs and ≥ 10 minute duration was higher in men than women ($p = 0.0005$).

When the criteria of ≥ 6 METs and ≥ 10 minutes were applied to the data, men continued to have more activity bouts that met these criteria than women (0.16 ± 0.35 vs. 0.09 ± 0.28 bouts per day) ($p < 0.0001$) (see Table 3). The duration per bout did not differ between sexes (18.61 ± 8.71 vs. 18.83 ± 9.11 minutes), but METs per minute was greater for men (8.05 ± 1.18 METs) compared to women (7.58 ± 1.04 METs) ($p < 0.0001$). However, total MET-minutes for all bouts meeting the criteria of ≥ 3 METs and ≥ 10 minute duration did not differ by sex.

Comparison by Ethnic/Racial Group

There was a significant effect of ethnic/racial group on bouts per day and minutes per bout when using the criteria of ≥ 3 METs with ≥ 10 minute duration, with individuals identified as African American/Black having the fewest bouts per day and the lowest minutes per bout (see Table 2). African American/Black individuals also had the fewest bouts per day when the

criteria of ≥ 6 METs with ≥ 10 minute duration was applied to the data (see Table 3). However, there was no significant effect of ethnicity/race for duration per bout, METs per minute, or total MET-minutes using either of these criteria.

Comparison by Age

There was no significant difference between age categories for bouts per day of participating in activity ≥ 10 minutes in duration when defined using either the ≥ 3 METs or ≥ 6 METs categories. However, METs per minute decreased with advancing age for ≥ 3 METs activities, whereas minutes per bout and total MET-minutes decreased with advancing age for ≥ 6 METs activities (see Tables 2 and 3).

Comparison by Baseline Fitness

Bouts per day for both ≥ 3 and ≥ 6 METs were positively associated with fitness. For individuals reporting participation in bouts that were ≥ 3 or ≥ 6 METs that were ≥ 10 minutes in duration, there was a significant increase in duration per bout, METs per minute, and total MET-minutes of physical activity meeting these criteria with increasing levels of fitness (see Tables 2 and 3).

Comparison by Type of Diabetes Treatment and by History of Cardiovascular Disease

There was no significant associate between type of diabetes medication and bouts per day, duration per bout, METs per minute, or total MET-minutes for either the ≥ 3 METs or ≥ 6 METs physical activity categories. When grouped according to history of cardiovascular disease, individuals who had a history of cardiovascular disease and participated in activity bouts of ≥ 3 METs that were of at least 10 minutes in duration had higher METs per minute (5.17 ± 1.01 METs) than did those without a history of cardiovascular disease (5.03 ± 0.98 METs) ($p=0.0463$). Data are presented in Tables 2 and 3.

Self-Reported Leisure-Time Physical Activity (LTPA)

Self reported LTPA was compared across categories of BMI, sex, race, age, fitness, diabetes medication usage, and history of cardiovascular disease (see Table 4). Energy expenditure in LTPA was negatively associated with BMI, was greater in men than women, was lowest in individuals classified as African-American/Black, and was positively associated with fitness. There was no effect of age, type of diabetes medication usage, or history of cardiovascular disease on energy expenditure in self-reported LTPA. A similar pattern of results was observed when data were analyzed for “sweat episodes per week.”

Multivariate Analysis

Results of the multivariate models using the criteria of ≥ 10 minutes in duration and ≥ 3 METs to examine components of physical activity are shown in Table 5. Bouts per day were significantly higher in men than women, and positively associated with fitness ($p<0.0001$). Minutes per bout were significantly higher with increasing levels of fitness ($p<0.0001$), with a trend for fewer minutes per bout with increasing BMI ($p=0.0572$). METs per minute were significantly higher in women than men ($p=0.0001$) and positively associated with fitness ($p<0.0001$), with a trend observed for increasing METs per minute with BMI ($p<0.0982$). However, total MET-minutes for bouts meeting the criteria of ≥ 10 minutes in duration and ≥ 3 METs were positively associated with fitness ($p<0.0001$), with a trend for a positive association between total MET-minutes for bouts meeting the criteria and age ($p=0.0821$).

Results of the multivariate models using the criteria of ≥ 10 minutes in duration and ≥ 6 METs to examine components of physical activity are shown in Table 6. Bouts per day was positively associated with age ($p=0.0099$) and fitness ($p<0.0001$), and was influenced by race/ethnicity

with African-American/Black and Other/Mixed/Missing having lower values than Whites. Minutes per bout were significantly higher with increasing levels of fitness ($p \leq 0.0001$). METs per minute was negatively associated with BMI ($p = 0.0327$), was lower in women than men ($p = 0.006$) and was positively associated with fitness ($p < 0.0001$), with a trend observed for increasing METs per minute with BMI ($p < 0.0982$). However, total MET-minutes for bouts meeting the criteria of ≥ 10 minutes in duration and ≥ 3 METs was positively associated with fitness ($p < 0.0001$).

DISCUSSION

The most recent physical activity guidelines for Americans has recommended at least 150 minutes per week of moderate intensity activity that is spread throughout the week (20). Adults with type 2 diabetes in the Look AHEAD Study are participating in < 1 bout per day of physical activity that meet the criteria of ≥ 3 METs and ≥ 10 minutes in duration based on accelerometry data (see Table 2), < 0.20 bouts per day of vigorous activity (≥ 6 METs) (see Table 3), and approximately ≤ 2 sweat episodes per week based on self-reported LTPA (see Table 4). Based on accelerometry, results showed that 71% of subjects had at least 1 activity bout that met the ≥ 3 METs and ≥ 10 minutes in duration criteria, with 26% meeting the ≥ 6 METs and ≥ 10 minutes in duration. For those engaged in at least one activity bout per week that meet either the moderate-to-vigorous or vigorous intensity criteria for at least 10 consecutive minutes, the duration of these bouts of activity was approximately 15 to 20 minutes (see Tables 2 and 3), suggesting that few individuals were achieving the recommended level of physical activity. Moreover, 51% of subjects reported at least 1 sweat episode per week based on self-report in this study. Nwasuruba et al. (11) reported that between 23% and 37% of adults with type 2 diabetes were meeting the recommended level of physical activity based on 2003 Behavioral Risk Factor Surveillance Survey (BRFSS) data. Thus, there appears to be a need for interventions to increase the frequency and duration of sufficient doses of physical activity in individuals with type 2 diabetes to meet the recommended physical activity guidelines for adults, and this may improve diabetes control and minimize the risk of health complications or mortality related to this condition.

The data presented in this manuscript include objectively measured physical activity using accelerometry, which also provides information of the patterns of physical activity in individuals with type 2 diabetes enrolled in the Look AHEAD Study. We conducted extensive electronic library searches to identify other studies of individuals with type 2 diabetes that have used objective measures of physical activity and found few such studies. Samuel-Hodge et al. (15) used a uniaxial accelerometer to assess baseline levels of physical activity in an intervention study and reported on the minutes per day of light, moderate, and vigorous activity. However, this provides limited information on the pattern of activity that is moderate-to-vigorous in intensity that also meets the minimum recommended duration of 10 minutes as recommended by Haskell et al. (6) and the recent Physical Activity Guidelines for Americans (20). Thus, baseline data presented here from the Look AHEAD Study define activity based on the ability of a bout to meet the ≥ 10 minute duration while also meeting moderate-to-vigorous or vigorous intensity criteria. This may provide a clearer perspective of the patterns of physical activity in individuals with type 2 diabetes that meet the criteria for physical activity bouts that are recommended by leading health organizations compared with other studies that have examined physical activity in individuals with type 2 diabetes.

Despite the advantages of using objective monitoring, the use of accelerometry is not without limitations. For example, studies have regularly demonstrated that accelerometry appears to be best suited to provide valid and reliable data for activities that have a movement pattern similar to level walking and jogging (7). Moreover, while the use of activity counts have been used to define moderate and vigorous levels of physical activity, the activity counts vary by

type of accelerometer and mode of activity. For example, the activity count thresholds for moderate and vigorous physical activity differ for the RT3 accelerometer (13) compared to other accelerometers (4,17). Rowlands et al. (13) also reported that activity count thresholds for men when treadmill walking were 400 counts less than the activity count thresholds representing a variety of moderate-to-vigorous activities. Moreover, there are no published activity count thresholds for the RT3 accelerometer to define moderate or vigorous activity in overweight and obese older adults with type 2 diabetes, which is the population group examined in this study. The activity count thresholds to define moderate and vigorous physical activity reported by Rowlands et al. (13) were developed based on 19 boys with a mean age of 9.5 ± 0.8 years and 15 men with a mean age of 20.7 ± 1.4 years. Therefore, we computed METs from the total energy expenditure and resting energy expenditure data as defined earlier to identify periods which met ≥ 3 or ≥ 6 METs, which are the criteria for moderate and vigorous levels of physical activity.

Based on data from the 2003 BRFSS, African-American/Black adults with type 2 diabetes were less likely than White adults to engage in sufficient physical activity to meet the recommendation of at least 30 minutes per day of moderate intensity activity on 5 or more days per week or 20 minutes per day of vigorous activity on 3 or more days per week (11). Based on bivariate analyses presented for moderate-to-vigorous intensity physical activity, defined as ≥ 3 METs and ≥ 10 minutes in duration, it appears that African-Americans/Blacks participate in fewer bouts per day and fewer minutes per bout than Whites with type 2 diabetes, and this may contribute to lower total MET-minutes of physical activity (see Table 2). For vigorous physical activity (≥ 6 METs and ≥ 10 minutes in duration), this study showed that African-Americans/Blacks participants engaged in the fewest bouts of this level of physical activity (see Table 3). The multivariate model appears to confirm a race/ethnicity effect for bouts per day of either moderate-to-vigorous (≥ 3 METs) or vigorous (≥ 6 METs) intensity physical activity, with African-Americans/Blacks participating in fewer bouts per day of activity when compared with Whites (see Tables 5 and 6). A similar pattern was observed when examining self-reported LTPA (see Table 4). Thus, while all individuals with type 2 diabetes should be encouraged to participate in physical activity as part of their comprehensive treatment plan, particular attention may need to be given to interventions that target African-American/Black and other racial/ethnic groups that appear to have lower levels of physical activity.

The importance of understanding patterns of physical activity in this population is highlighted by the growing evidence that physical activity may be important for reducing mortality due to cardiovascular disease or all-causes in persons with type 2 diabetes. The review by Caspersen and Fulton (2) of studies examining the effect of walking on all-cause and cardiovascular disease mortality concluded that the reduction in risk ranged from 40% to 55%. Specifically, Gregg et al. (5) reported that the relative risk of all-cause mortality was 0.61 and 0.46 with 2.0–2.9 hrs/wk and 3.0–3.9 hrs/wk of walking compared to 0 hrs/wk, respectively. The risk of cardiovascular disease was reduced by 53% with 3.0–3.9 hrs/wk of walking. Tanasescu et al. (18) also reported a significant reduction in the risk of all-cause mortality of 40% with >5.3 hrs/wk of walking in adults with type 2 diabetes. Smith et al. (16) also reported hazard ratios of 0.54 and 0.19 for all-cause and cardiovascular disease mortality, respectively, for adults with diabetes who walked ≥ 1 mile per day compared with those who did not walk. While these data consistently show the beneficial effect of physical activity on reduction in mortality in individuals with type 2 diabetes, these data are based on self-report and provide little information on the patterns of physical activity. Understanding the patterns of physical activity may inform interventions that target increases in physical activity in patients with type 2 diabetes.

Church et al. (3) reported on the importance of fitness to reduce cardiovascular disease mortality in adults with type 2 diabetes. There was 1.2 hazard ratio for cardiovascular mortality

for each 1 MET difference in fitness based on a multivariate analysis. The data presented in this current analysis from the Look AHEAD study provides information on the pattern of physical activity that may enhance fitness in individuals with type 2 diabetes. The data presented in Tables 2 and 3 show greater frequency (bouts per day), duration (minutes per bout), and intensity (METs per minute) of both moderate-to-vigorous (≥ 3 METs) and vigorous activity (≥ 6 METs) with greater levels of fitness, and this was confirmed by the multivariate analyses (see Tables 5 and 6). Moreover, a similar pattern was shown with self-reported LTPA with energy expenditure and sweat episodes per week were positively associated with fitness (see Table 4). Thus, while cross-sectional, these data suggest that individuals with type 2 diabetes can improve their level of fitness through participation in sufficient doses of physical activity, and according to Church et al. (3) this may reduce the risk of mortality. The data presented in this current study provide insight into the dose and pattern of physical activity that will elicit improvements in fitness in overweight and obese adults with type 2 diabetes.

It is recognized that the R^2 for the multivariate models are relatively low (see Tables 5 and 6). This would suggest that the demographic factors considered in this study are collectively having modest effects on the observed patterns of physical activity in this study. Therefore, there may be additional demographic, behavioral, or physiological factors that are influencing physical activity behaviors in this group of individuals with diabetes, and this will require further examination. Moreover, the Look AHEAD Study provides a unique opportunity to examine changes in physical activity patterns prospectively and to examine factors that influence observed changes in physical activity in adults with diabetes as they age. An interesting finding is that higher levels of physical activity were consistently associated with higher levels of fitness in multivariate models after controlling for other demographic characteristics. These data may suggest that while patterns of physical activity may vary by demographic characteristics, it is important to engage in physical activity to improve fitness in patients with type 2 diabetes, and this may significantly influence the risk of mortality in this population(3).

In summary, these findings represent one of the few studies that have used objective measurement to examine the patterns of physical activity in individuals with type 2 diabetes. In this sample of over 2,000 participants in the Look AHEAD Study with diabetes, it does not appear that the vast majority of individuals meet the current recommended levels of physical activity (6,20). However, the patterns of activity vary consistently by level of fitness, with higher levels of fitness characterized by a higher frequency, duration, and intensity of activity bouts that are moderate-to-vigorous or vigorous in intensity. In multivariate analyses there was little influence of age, BMI, type of diabetes medication, or history of cardiovascular disease on the patterns of physical activity. However, sex and race/ethnicity may influence the pattern in individuals with type 2 diabetes, and this should be considered when developing physical activity interventions in this population. The Look AHEAD Study provides an opportunity to examine changes in physical activity measured objectively using accelerometry resulting from a lifestyle intervention, which can provide valuable information on the effect of activity patterns on weight loss and other health-related outcomes in individuals with type 2 diabetes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Baseline Characteristics of Participants with Valid Baseline Accelerometry Data (N=2145)

Variable	Participants with Valid Accelerometry Data (N=2145)	Total Look AHEAD Study Sample (N=5145)
Age	59.0 ± 6.8	58.7 ± 6.8
Weight (kg)	102.9 ± 19.2	100.7 ± 19.3
Height (cm)	168.1 ± 9.5	167.2 ± 9.7
Body mass index (kg/m ²)	36.4 ± 6.0	35.9 ± 5.9
Waist Circumference (cm)	115.4 ± 14.5	113.9 ± 14.0
Hemoglobin A1c%	7.2 ± 1.1	7.3 ± 1.2
Fasting glucose (mg/dL)	151.7 ± 44.5	153.2 ± 45.7
Duration of diabetes (years)	6.9 ± 6.5	6.8 ± 6.5
Fitness (Maximal METs)	7.1 ± 1.9	7.2 ± 2.0
Sex (% Women)		
Women	N=1228 (57.3%)	N=3063 (59.5%)
Men	N=917 (42.7%)	N=2082 (40.5%)
Race Ethnicity		
African American / Black (not Hispanic)	N=401 (18.7%)	N=803 (15.6%)
American Indian / Native American / Alaskan Native	N=12 (0.6%)	N= 258 (5.0%)
Asian/Pacific Islander	N=13 (0.6%)	N=50 (1.0%)
White	N=1563 (73.0%)	N=3246 (63.3%)
Missing	N=0 (0.0%)	N=13 (0.3%)
Hispanic	N=107 (5.0%)	N=677 (13.2%)
Other/Mixed	N=45 (2.1%)	N=98 (1.9%)
History of Cardiovascular Disease n (%)		
Yes**	N=329 (15.3%)	N=721 (14%)
No	N=1816 (84.7%)	N=4424 (86.0%)

* data presented as (mean ± standard deviation)

** self report of myocardial infarction, stroke, transient ischemic event, percutaneous transluminal coronary angioplasty, or coronary artery bypass graft

Table 2

Accelerometry determined physical activity for bouts ≥ 3 METs per minute for ≥ 10 minutes in duration by categories of BMI, sex, race/ethnicity, age, fitness, diabetes treatment, and cardiovascular disease history (mean $\pm$ standard deviation).

Variable	Categories	Bouts per Day	Minutes per Bout*	METs per Minute*	Total MET-minutes*
BMI	25.0 to <27.0 kg/m ²	0.79 $\pm$ 1.21 (N=46)	20.74 $\pm$ 10.29 (N=35)	5.14 $\pm$ 1.11 (N=35)	113.9 $\pm$ 87.09 (N=35)
	27.0 to <30.0 kg/m ²	0.72 $\pm$ 0.79 (N=235)	22.21 $\pm$ 10.81 (N=172)	5.36 $\pm$ 1.16 (N=172)	125.3 $\pm$ 81.98 (N=172)
	30.0 to <35.0 kg/m ²	0.65 $\pm$ 0.90 (N=719)	21.09 $\pm$ 10.06 (N=522)	5.25 $\pm$ 1.00 (N=521)	115.1 $\pm$ 71.58 (N=521)
	35.0 to <40.0 kg/m ²	0.59 $\pm$ 0.78 (N=619)	18.79 $\pm$ 9.05 (N=448)	5.11 $\pm$ 1.02 (N=448)	100.0 $\pm$ 67.42 (N=448)
Sex	≥ 40 kg/m ²	0.52 $\pm$ 0.95 (N=525)	17.02 $\pm$ 7.51 (N=346)	4.95 $\pm$ 0.86 (N=346)	86.46 $\pm$ 49.00 (N=346)
	<i>p-value</i>	0.0146	$<.0001$	$<.0001$	$<.0001$
	Men	0.83 $\pm$ 1.00 (N=917)	20.65 $\pm$ 10.26 (N=729)	5.17 $\pm$ 1.03 (N=728)	111.7 $\pm$ 76.35 (N=728)
	Women	0.45 $\pm$ 0.73 (N=1228)	18.63 $\pm$ 8.64 (N=795)	5.13 $\pm$ 0.98 (N=795)	99.34 $\pm$ 60.38 (N=795)
Race/Ethnicity	<i>p-value</i>	$<.0001$	$<.0001$	0.4246	0.0005
	African American/Black	0.45 $\pm$ 0.64 (N=401)	17.94 $\pm$ 8.71 (N=264)	5.08 $\pm$ 0.99 (N=263)	94.77 $\pm$ 60.31 (N=263)
	White	0.65 $\pm$ 0.88 (N=1563)	20.03 $\pm$ 9.58 (N=1129)	5.17 $\pm$ 1.00 (N=1129)	107.7 $\pm$ 69.04 (N=1129)
	Hispanic	0.74 $\pm$ 1.39 (N=107)	18.88 $\pm$ 10.11 (N=82)	5.18 $\pm$ 1.16 (N=82)	104.9 $\pm$ 88.25 (N=82)
Age	Other/Mixed/Missing	0.55 $\pm$ 0.87 (N=74)	19.78 $\pm$ 9.98 (N=49)	5.14 $\pm$ 0.87 (N=49)	104.7 $\pm$ 63.75 (N=49)
	<i>p-value</i>	0.0002	0.0121	0.6391	0.0557
	<50 years	0.60 $\pm$ 0.94 (N=208)	19.08 $\pm$ 8.34 (N=150)	5.23 $\pm$ 1.00 (N=150)	104.2 $\pm$ 64.58 (N=150)
	50 to <60 years	0.60 $\pm$ 0.85 (N=964)	19.60 $\pm$ 9.82 (N=695)	5.21 $\pm$ 1.05 (N=694)	106.9 $\pm$ 73.88 (N=694)
Fitness	60 to <70 years	0.64 $\pm$ 0.92 (N=811)	19.77 $\pm$ 9.52 (N=574)	5.09 $\pm$ 0.96 (N=574)	104.6 $\pm$ 65.13 (N=574)
	≥ 70 years	0.52 $\pm$ 0.70 (N=162)	19.40 $\pm$ 8.91 (N=105)	4.95 $\pm$ 0.89 (N=105)	99.40 $\pm$ 58.09 (N=105)
	<i>p-value</i>	0.4202	0.8766	0.0223	0.7435
	<6 METs	0.44 $\pm$ 0.85 (N=645)	16.55 $\pm$ 7.51 (N=382)	4.67 $\pm$ 0.65 (N=382)	78.73 $\pm$ 42.87 (N=382)
Diabetes Medication	6 to <8 METs	0.57 $\pm$ 0.73 (N=881)	19.25 $\pm$ 8.87 (N=635)	5.16 $\pm$ 0.93 (N=635)	102.4 $\pm$ 61.02 (N=635)
	8 to <10 METs	0.79 $\pm$ 1.07 (N=435)	21.44 $\pm$ 10.18 (N=347)	5.39 $\pm$ 1.05 (N=346)	119.9 $\pm$ 72.42 (N=346)
	≥ 10 METs	1.02 $\pm$ 0.91 (N=181)	24.29 $\pm$ 11.74 (N=160)	5.75 $\pm$ 1.34 (N=160)	148.1 $\pm$ 102.8 (N=160)
	<i>p-value</i>	$<.0001$	$<.0001$	$<.0001$	$<.0001$
Diabetes Medication	No Glucose Lowering Medication	0.64 $\pm$ 0.89 (N=267)	20.02 $\pm$ 9.57 (N=197)	5.19 $\pm$ 1.05 (N=197)	108.0 $\pm$ 65.55 (N=197)

Variable	Categories	Bouts per Day	Minutes per Bout*	METs per Minute*	Total MET-minutes*
	Glucose Lowering Medication (Not including insulin or thiazolidinedione)	0.61 ± 0.89 (N=967)	19.81 ± 9.60 (N=688)	5.19 ± 0.98 (N=687)	107.4 ± 68.48 (N=687)
	Thiazolidinedione	0.59 ± 0.75 (N=482)	19.77 ± 9.58 (N=342)	5.09 ± 1.04 (N=342)	105.1 ± 72.68 (N=342)
	Insulin Alone	0.55 ± 0.71 (N=86)	20.13 ± 10.31 (N=56)	5.07 ± 1.02 (N=56)	106.8 ± 70.93 (N=56)
	Insulin plus glucose lowering medication (Not including thiazolidinedione)	0.63 ± 0.86 (N=153)	18.28 ± 8.24 (N=112)	5.00 ± 0.88 (N=112)	93.50 ± 51.54 (N=112)
	Insulin plus thiazolidinedione	0.68 ± 1.23 (N=157)	18.28 ± 9.64 (N=111)	5.21 ± 1.03 (N=111)	100.5 ± 79.85 (N=111)
	<i>p-value</i>	0.8631	0.3827	0.2949	0.4437
Cardiovascular Disease History	No	0.61 ± 0.99 (N=329)	19.11 ± 9.29 (N=226)	5.03 ± 0.98 (N=226)	99.70 ± 67.85 (N=226)
	Yes	0.61 ± 0.85 (N=1816)	19.68 ± 9.54 (N=1298)	5.17 ± 1.01 (N=1297)	106.2 ± 68.87 (N=1297)
	<i>p-value</i>	0.9854	0.4001	0.0463	0.1903

* Indicates that data represent participants who reported ≥1 bout during the observation period that met the criteria of ≥3 METs per minute and ≥10 minutes for that bout.

Table 3

Accelerometry determined physical activity for bouts ≥ 6 METs per minute for ≥ 10 minutes in duration by categories of BMI, sex, race/ethnicity, age, fitness, diabetes treatment, and cardiovascular disease history (mean $\pm$ standard deviation).

Variable	Categories	Bouts per Day	Minutes per Bout*	METs per Minute*	MET-minutes*
BMI	25.0 to <27.0 kg/m ²	0.13 $\pm$ 0.34 (N=46)	18.77 $\pm$ 7.83 (N=12)	8.34 $\pm$ 1.61 (N=12)	158.3 $\pm$ 82.38 (N=12)
	27.0 to <30.0 kg/m ²	0.18 $\pm$ 0.35 (N=235)	20.09 $\pm$ 9.88 (N=73)	8.06 $\pm$ 1.24 (N=73)	165.3 $\pm$ 94.85 (N=73)
	30.0 to <35.0 kg/m ²	0.15 $\pm$ 0.39 (N=719)	19.49 $\pm$ 9.85 (N=217)	8.03 $\pm$ 1.20 (N=217)	159.7 $\pm$ 93.99 (N=217)
	35.0 to <40.0 kg/m ²	0.11 $\pm$ 0.28 (N=619)	18.01 $\pm$ 7.97 (N=158)	7.72 $\pm$ 0.99 (N=158)	140.8 $\pm$ 74.29 (N=158)
Sex	≥ 40 kg/m ²	0.06 $\pm$ 0.17 (N=525)	17.08 $\pm$ 6.98 (N=97)	7.36 $\pm$ 0.92 (N=97)	127.7 $\pm$ 64.50 (N=97)
	<i>p-value</i>	<.0001	0.1051	<.0001	0.0075
	Men	0.16 $\pm$ 0.35 (N=917)	18.61 $\pm$ 8.71 (N=301)	8.05 $\pm$ 1.18 (N=301)	152.6 $\pm$ 84.02 (N=301)
	Women	0.09 $\pm$ 0.28 (N=1228)	18.83 $\pm$ 9.11 (N=256)	7.58 $\pm$ 1.04 (N=256)	145.8 $\pm$ 85.68 (N=256)
Race/Ethnicity	<i>p-value</i>	<.0001	0.7652	<.0001	0.3443
	African American/Black	0.07 $\pm$ 0.17 (N=401)	20.66 $\pm$ 10.03 (N=74)	7.65 $\pm$ 1.01 (N=74)	160.3 $\pm$ 89.73 (N=74)
	White	0.13 $\pm$ 0.31 (N=1563)	18.29 $\pm$ 8.45 (N=433)	7.85 $\pm$ 1.16 (N=433)	146.5 $\pm$ 81.35 (N=433)
	Hispanic	0.19 $\pm$ 0.63 (N=107)	20.19 $\pm$ 11.48 (N=34)	7.88 $\pm$ 1.09 (N=34)	164.9 $\pm$ 117.7 (N=34)
Age	Other/Mixed/Missing	0.12 $\pm$ 0.25 (N=74)	18.07 $\pm$ 7.97 (N=16)	8.13 $\pm$ 1.22 (N=16)	146.9 $\pm$ 69.13 (N=16)
	<i>p-value</i>	0.0005	0.1334	0.3776	0.4133
	<50 years	0.10 $\pm$ 0.20 (N=208)	20.52 $\pm$ 11.21 (N=62)	8.00 $\pm$ 1.34 (N=62)	168.1 $\pm$ 111.5 (N=62)
	50 to <60 years	0.12 $\pm$ 0.32 (N=964)	19.42 $\pm$ 8.60 (N=253)	7.89 $\pm$ 1.18 (N=253)	156.0 $\pm$ 82.88 (N=253)
Fitness	60 to <70 years	0.13 $\pm$ 0.34 (N=811)	17.41 $\pm$ 8.35 (N=212)	7.75 $\pm$ 1.03 (N=212)	137.3 $\pm$ 77.29 (N=212)
	≥ 70 years	0.08 $\pm$ 0.23 (N=162)	18.20 $\pm$ 8.75 (N=30)	7.60 $\pm$ 1.11 (N=30)	141.3 $\pm$ 78.77 (N=30)
	<i>p-value</i>	0.2060	0.0320	0.2190	0.0267
	<6 METs	0.03 $\pm$ 0.13 (N=645)	15.69 $\pm$ 5.92 (N=64)	6.58 $\pm$ 0.32 (N=64)	103.4 $\pm$ 40.02 (N=64)
Diabetes Medication	6 to <8 METs	0.11 $\pm$ 0.25 (N=881)	17.18 $\pm$ 6.79 (N=232)	7.61 $\pm$ 0.66 (N=232)	131.9 $\pm$ 57.38 (N=232)
	8 to <10 METs	0.20 $\pm$ 0.46 (N=435)	19.09 $\pm$ 9.46 (N=165)	8.18 $\pm$ 1.20 (N=165)	158.8 $\pm$ 92.70 (N=165)
	≥ 10 METs	0.30 $\pm$ 0.47 (N=181)	23.78 $\pm$ 11.59 (N=96)	8.61 $\pm$ 1.43 (N=96)	206.5 $\pm$ 111.9 (N=96)
	<i>p-value</i>	<.0001	<.0001	<.0001	<.0001
Diabetes Medication	No Glucose Lowering Medication	0.15 $\pm$ 0.32 (N=267)	17.79 $\pm$ 6.44 (N=78)	7.75 $\pm$ 1.07 (N=78)	139.1 $\pm$ 56.10 (N=78)

Variable	Categories	Bouts per Day	Minutes per Bout*	METs per Minute*	MET-minutes*
	Glucose Lowering Medication (Not including insulin or thiazolidinedione)	0.13 ± 0.36 (N=967)	18.99 ± 8.76 (N=256)	7.89 ± 1.19 (N=256)	152.9 ± 84.81 (N=256)
	Thiazolidinedione	0.10 ± 0.26 (N=482)	18.85 ± 10.54 (N=126)	7.82 ± 1.10 (N=126)	151.4 ± 99.30 (N=126)
	Insulin Alone	0.13 ± 0.29 (N=86)	18.48 ± 8.84 (N=21)	7.71 ± 1.24 (N=21)	145.1 ± 83.28 (N=21)
	Insulin plus glucose lowering medication (Not including thiazolidinedione)	0.09 ± 0.22 (N=153)	18.64 ± 8.36 (N=31)	7.76 ± 0.97 (N=31)	145.2 ± 72.21 (N=31)
	Insulin plus thiazolidinedione	0.09 ± 0.22 (N=157)	17.91 ± 8.70 (N=40)	7.75 ± 1.21 (N=40)	142.3 ± 93.78 (N=40)
	<i>p-value</i>	0.1566	0.9196	0.9027	0.8412
Cardiovascular Disease History	No	0.11 ± 0.30 (N=329)	17.51 ± 8.08 (N=75)	7.70 ± 1.02 (N=75)	138.3 ± 82.72 (N=75)
	Yes	0.12 ± 0.31 (N=1816)	18.90 ± 9.00 (N=482)	7.86 ± 1.16 (N=482)	151.2 ± 85.04 (N=482)
	<i>p-value</i>	0.4194	0.2087	0.2734	0.2189

* Indicates that data represent participants who reported ≥1 bout during the observation period that met the criteria of ≥6 METs per minute and ≥10 minutes for that bout.

Table 4

Self-reported leisure-time physical activity (LTPA) by categories of BMI, sex, race/ethnicity, age, fitness, diabetes treatment, and cardiovascular disease history.

Variable	Categories	Energy Expenditure (kcal/wk) Median (25 th , 75 th Percentiles) N	Sweat Episodes per Week Median (25 th , 75 th Percentiles) N
BMI	25.0 to <27.0 kg/m ²	686.0 (224.0, 1515) N=46	1.0 (0.0, 3.0) N=46
	27.0 to <30.0 kg/m ²	644.0 (168.0, 1500) N=235	1.0 (0.0, 4.0) N=234
	30.0 to <35.0 kg/m ²	640.5 (168.0, 1417) N=716	1.0 (0.0, 3.0) N=714
	35.0 to <40.0 kg/m ²	514.8 (112.0, 1064) N=616	1.0 (0.0, 3.0) N=615
	≥40 kg/m ²	280.0 (56.0, 784.0) N=522	0.0 (0.0, 2.5) N=520
	<i>p-value</i>	<.0001	<.0001
Sex	Men	672.0 (196.0, 1490) N=911	1.0 (0.0, 3.0) N=907
	Women	392.0 (100.0, 944.0) N=1225	0.0 (0.0, 3.0) N=1223
	<i>p-value</i>	<.0001	<.0001
Race/Ethnicity	African American/Black	392.0 (100.0, 840.0) N=401	0.0 (0.0, 3.0) N=400
	White	532.0 (140.0, 1316) N=1554	1.0 (0.0, 3.0) N=1550
	Hispanic	392.0 (84.0, 1316) N=107	1.0 (0.0, 3.0) N=106
	Other/Mixed/Missing	640.5 (112.0, 1200) N=74	0.0 (0.0, 3.0) N=74
	<i>p-value</i>	0.0004	0.0919
Age	<50 years	524.0 (112.0, 1008) N=207	1.0 (0.0, 3.0) N=207
	50 to <60 years	504.0 (140.0, 1224) N=960	1.0 (0.0, 3.0) N=958
	60 to <70 years	468.0 (112.0, 1200) N=807	1.0 (0.0, 3.0) N=803
	≥70 years	528.5 (112.0, 1359) N=162	0.0 (0.0, 3.0) N=162
	<i>p-value</i>	0.7388	0.6926
Fitness	<6 METs	226.0 (56.0, 747.5) N=644	0.0 (0.0, 2.0) N=642
	6 to <9 METs	505.5 (140.0, 1064) N=875	1.0 (0.0, 3.0) N=874
	8 to <10 METs	728.0 (196.0, 1515) N=435	1.0 (0.0, 3.0) N=433
	≥10 METs	1310 (560.0, 2263) N=180	3.0 (0.0, 4.0) N=179
	<i>p-value</i>	<.0001	<.0001
Diabetes Medication	No Glucose Lowering Medication	616.0 (168.0, 1304) N=267	1.0 (0.0, 4.0) N=267
	Glucose Lowering Medication (Not including insulin or thiazolidinedione)	476.0 (112.0, 1205) N=964	1.0 (0.0, 3.0) N=960
	Thiazolidinedione	449.0 (112.0, 1132) N=478	1.0 (0.0, 3.0) N=478
	Insulin Alone	434.5 (140.0, 1008) N=86	1.0 (0.0, 3.0) N=86
	Insulin plus glucose lowering medication (Not including thiazolidinedione)	426.0 (112.0, 1023) N=152	1.0 (0.0, 3.0) N=150
	Insulin plus thiazolidinedione	561.0 (112.0, 1393) N=156	0.0 (0.0, 3.0) N=156
	<i>p-value</i>	0.1434	0.3277
Cardiovascular Disease History	No	477.0 (112.0, 1182) N=1808	1.0 (0.0, 3.0) N=1804
	Yes	479.0 (112.0, 1344) N=328	1.0 (0.0, 3.0) N=326

Variable	Categories	Energy Expenditure (kcal/ wk) Median (25 th , 75 th Percentiles) N	Sweat Episodes per Week Median (25 th , 75 th Percentiles) N
	<i>p-value</i>	0.9086	0.1849

Table 5

Multivariate model based on accelerometry data for bouts defined as ≥ 3 METs per minute for a duration of ≥ 10 minutes.

Model	Estimate	Standard Error	F-Value	P-value	R ² for Model
Dependent Variable: Bouts per Day					0.0732
Age	0.0001	0.0032	0.00	0.9688	
BMI	0.0006	0.0037	0.03	0.8690	
Sex (Women versus Men)	-0.2999	0.0424	50.12	<0.0001	
Race/Ethnicity (White is the reference group)					
African-American/Black	-0.1075	0.0491	2.42	0.0644	
Hispanic	0.1033	0.0865			
Other/Mixed/Missing	-0.0702	0.1028			
Baseline Fitness (maximal METs)	0.0696	0.0128	29.77	<0.0001	
Diabetes Medication (No Glucose Lowering Medication is the Reference Group)			0.45	0.8108	
Glucose Lowering Medication (Not including insulin or thiazolidinedione)	-0.0138	0.0592			
Thiazolidinedione	-0.0274	0.0656			
Insulin Alone	-0.0075	0.1063			
Insulin + Glucose Lowering Medication (Not including thiazolidinedione)	0.0465	0.0872			
Insulin + Thiazolidinedione	0.0725	0.0871			
Without Baseline history of CVD	0.0511	0.0539	0.90	0.3425	
Dependent Variable: Minutes per Bout *					0.0814
Age	0.0693	0.0406	2.91	0.0883	
BMI	-0.0922	0.0485	3.62	0.0572	
Sex (Women versus Men)	-0.2286	0.5368	0.18	0.6703	
Race/Ethnicity (White is the reference group)					
African-American/Black	-1.4866	0.6439	1.88	0.1313	
Hispanic	-0.8860	1.0659			
Other/Mixed/Missing	-0.4300	1.3418			
Baseline Fitness (maximal METs)	0.8991	0.1617	53.69	<0.0001	
Diabetes Medication (No Glucose Lowering Medication is the Reference Group)			0.52	0.7594	
Glucose Lowering Medication (Not including insulin or thiazolidinedione)	0.1964	0.7466			

Model	Estimate	Standard Error	F-Value	P-value	R ² for Model
Thiazolidinedione	0.6639	0.8297			
Insulin Alone	1.4732	1.3991			
Insulin + Glucose Lowering Medication (Not including thiazolidinedione)	-0.4743	1.0970			
Insulin + Thiazolidinedione	0.0157	1.1096			
Without Baseline history of CVD	0.4176	0.6987	0.36	0.5501	
Dependent Variable: METs per Minute *					0.1325
Age	0.0047	0.0042	1.27	0.2602	
BMI	0.0082	0.0050	2.74	0.0982	
Sex (Women versus Men)	0.2109	0.0550	14.69	0.0001	
Race/Ethnicity (White is the reference group)					
African-American/Black	-0.0636	0.0661			
Hispanic	-0.0574	0.1092			
Other/Mixed/Missing	-0.0537	0.1375			
Baseline Fitness (maximal METs)	0.2105	0.0164	164.77	<0.0001	
Diabetes Medication (No Glucose Lowering Medication is the Reference Group)			1.37	0.2315	
Glucose Lowering Medication (Not including insulin or thiazolidinedione)	0.0650	0.0765			
Thiazolidinedione	0.0044	0.0850			
Insulin Alone	0.0476	0.1433			
Insulin + Glucose Lowering Medication (Not including thiazolidinedione)	-0.0460	0.1124			
Insulin + Thiazolidinedione	0.2341	0.1137			
Without Baseline history of CVD	-0.0075	0.0716	0.01	0.9171	
Dependent Variable: MET-minutes *					0.1095
Age	0.5042	0.2898	3.03	0.0821	
BMI	-0.3135	0.3455	0.82	0.3644	
Sex (Women versus Men)	3.5176	3.8293	0.84	0.3585	
Race/Ethnicity (White is the reference group)			1.29	0.2778	
African-American/Black	-8.9192	4.5984			
Hispanic	-2.7792	7.5975			
Other/Mixed/Missing	-4.4441	9.5646			

Model	Estimate	Standard Error	F-Value	P-value	R ² for Model
Baseline Fitness (maximal METs)			101.45	<0.0001	
Diabetes Medication (No Glucose Lowering Medication is the Reference Group)			0.62	0.6836	
Glucose Lowering Medication (Not including insulin or thiazolidinedione)	3.1416	5.3222			
Thiazolidinedione	4.6801	5.9138			
Insulin Alone	10.4050	9.9725			
Insulin + Glucose Lowering Medication (Not including thiazolidinedione)	-4.1663	7.8196			
Insulin + Thiazolidinedione	7.1660	7.9090			
Without Baseline history of CVD	2.0723	4.9807	0.17	0.6774	

* Indicates that data represent participants who reported ≥1 bout during the observation period that met the criteria of ≥3 METs per minute and ≥10 minutes for that bout.

Table 6

Multivariate model based on accelerometry data for bouts defined as ≥ 6 METs per minute for a duration of ≥ 10 minutes.

Model	Estimate	Standard Error	F-Value	P-value	R-Square for Model
Dependent Variable: Bouts per Day					0.0807
Age	0.0029	0.0011	6.67	0.0099	
BMI	0.0009	0.0013	0.48	0.4881	
Sex (Women versus Men)	-0.0090	0.0151	0.36	0.5501	
Race/Ethnicity (White is the reference group)			3.27	0.0204	
African-American/Black	-0.0399	0.0174			
Hispanic	0.0562	0.0307			
Other/Mixed/Missing	-0.0138	0.0365			
Baseline Fitness (maximal METs)	0.0455	0.0045	100.85	<0.0001	
Diabetes Medication (No Glucose Lowering Medication is the Reference Group)			0.72	0.6062	
Glucose Lowering Medication (Not including insulin or thiazolidinedione)	-0.0030	0.0210			
Thiazolidinedione	-0.0254	0.0233			
Insulin Alone	0.0247	0.0378			
Insulin + Glucose Lowering Medication (Not including thiazolidinedione)	-0.0266	0.0310			
Insulin + Thiazolidinedione	-0.0148	0.0309			
Without Baseline history of CVD	0.0074	0.0191	0.15	0.6993	
Dependent Variable: Minutes per Bout *					0.0985
Age	-0.0751	0.0626	1.44	0.2306	
BMI	-0.0223	0.0801	0.08	0.7805	
Sex (Women versus Men)	0.8540	0.8304	1.06	0.3042	
Race/Ethnicity (White is the reference group)			1.54	0.2038	
African-American/Black	2.1024	1.0996			
Hispanic	1.8014	1.5373			
Other/Mixed/Missing	-0.0441	2.1904			
Baseline Fitness (maximal METs)	1.2454	0.2310	29.06	<0.0001	
Diabetes Medication (No Glucose Lowering Medication is the Reference Group)			0.33	0.8929	
Glucose Lowering Medication (Not including insulin or thiazolidinedione)	1.3583	1.1174			

Model	Estimate	Standard Error	F-Value	P-value	R-Square for Model
Thiazolidinedione	1.3329	1.2465			
Insulin Alone	1.6337	2.1046			
Insulin + Glucose Lowering Medication (Not including thiazolidinedione)	1.1841	1.8220			
Insulin + Thiazolidinedione	1.3074	1.6948			
Without Baseline history of CVD	0.3069	1.1297	0.07	0.7860	
Dependent Variable: METs per Minute *					0.2538
Age	-0.0093	0.0073	1.62	0.2093	
BMI	-0.0201	0.0094	4.58	0.0327	
Sex (Women versus Men)	-0.2684	0.0972	7.62	0.0060	
Race/Ethnicity (White is the reference group)					
African-American/Black	-0.1302	0.1287	0.82	0.4853	
Hispanic	0.0929	0.1800			
Other/Mixed/Missing	0.2488	0.2565			
Baseline Fitness (maximal METs)	0.2319	0.0270	73.48	<0.0001	
Diabetes Medication (No Glucose Lowering Medication is the Reference Group)					
Glucose Lowering Medication (Not including insulin or thiazolidinedione)	0.0993	0.1308	0.23	0.9498	
Thiazolidinedione	0.0542	0.1459			
Insulin Alone	0.1068	0.2464			
Insulin + Glucose Lowering Medication (Not including thiazolidinedione)	0.1143	0.2133			
Insulin + Thiazolidinedione	0.1854	0.1984			
Without Baseline history of CVD	0.0726	0.1323	0.30	0.5832	
Dependent Variable: MET-minutes *					0.1462
Age	-0.7787	0.5823	1.79	0.1817	
BMI	-0.4582	0.7447	0.38	0.5386	
Sex (Women versus Men)	3.1983	7.246	0.17	0.6790	
Race/Ethnicity (White is the reference group)					
African-American/Black	12.5487	10.2294	0.94	0.4233	
Hispanic	18.1756	14.3007			
Other/Mixed/Missing	1.7140	20.3772			

Model	Estimate	Standard Error	F-Value	P-value	R-Square for Model
Baseline Fitness (maximal METs)	14.8832	2.1492	47.95	<0.0001	
Diabetes Medication (No Glucose Lowering Medication is the Reference Group)					
Glucose Lowering Medication (Not including insulin or thiazolidinedione)	14.3984	10.3947	0.45	0.8144	
Thiazolidinedione	14.3224	11.5961			
Insulin Alone	16.3091	19.5786			
Insulin + Glucose Lowering Medication (Not including thiazolidinedione)	10.5168	16.9496			
Insulin + Thiazolidinedione	16.4032	15.7665			
Without Baseline history of CVD	1.9710	10.5095	0.04	0.8513	

* Indicates that data represent participants who reported ≥ 1 bout during the observation period that met the criteria of ≥ 6 METs per minute and ≥ 10 minutes for that bout.