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Step-based Physical Activity Metrics and Cardiometabolic Risk: NHANES 2005-06

Catrine Tudor-Locke¹, John M. Schuna Jr.², Ho Han¹, Elroy J. Aguiar¹, Michael A. Green¹, Michael A. Busa¹, Sandra Larrivee³, and William D. Johnson³

¹Department of Kinesiology, University of Massachusetts Amherst, Amherst, MA

²College of Public Health and Human Sciences, Oregon State University, Corvallis, OR

³Pennington Biomedical Research Center, Louisiana State University, Baton Rouge, LA

Abstract

Purpose—To catalog the relationships between step-based accelerometer metrics indicative of physical activity volume (steps/day, adjusted to a pedometer scale), intensity (mean steps/min from the highest, not necessarily consecutive, minutes in a day; peak 30-min cadence) and sedentary behavior (percent time at zero cadence relative to wear time; %TZC) and cardiometabolic risk factors.

Methods—We analyzed data from 3388 20+ year-old participants in the 2005-2006 National Health and Nutrition Examination Survey with 1 valid day of accelerometer data and at least some data on weight, BMI, waist circumference, systolic and diastolic blood pressure, glucose, insulin, HDL-cholesterol, triglycerides, and/or glycohemoglobin. Linear trends were evaluated for cardiometabolic variables, adjusted for age and race, across quintiles of steps/day, peak 30 min-cadence, and %TZC.

Results—Median steps/day ranged from 2247-12334 for men and 1755-9824 steps/day for women, and median peak 30-min cadence ranged from 48.1-96.0 for men and 40.8-96.2 steps/min for women, for the 1st and 5th quintiles, respectively. Linear trends were statistically significant (all $p < 0.001$), with increasing quintiles of steps/day and peak 30-min cadence inversely associated with waist-circumference, weight, BMI and insulin, for both men and women. Median %TZC ranged from 17.6-51.0% for men and 19.9-47.6% for women, for the 1st and 5th quintiles, respectively. Linear trends were statistically significant (all $p < 0.05$), with increasing quintiles of %TZC associated with increased waist circumference, weight and insulin for men, and insulin for women.

Conclusions—This analysis identified strong linear relationships between step-based movement/non-movement dimensions and cardiometabolic risk factors. These data offer a set of quantified access points for studying the potential dose-response effects of each of these dimensions separately or collectively in longitudinal observational or intervention study designs.

Corresponding author: Dr Catrine Tudor-Locke, Address: University of Massachusetts Amherst, 30 Eastman Lane, Amherst, MA, 01002, USA. Phone: +1 413 577 4702, Fax: +1 413 545 2906, ctudorlocke@umass.edu.

Conflicts of Interest

The authors disclose no conflicts of interest. The results of the present study do not constitute endorsement by ACSM

Keywords

physical activity; steps; intensity; sedentary time; cardiovascular; metabolic

Introduction

Steps/day, detected by either pedometers (13), or accelerometers (21, 34), or more contemporary wearable technologies (39), is a widely accepted simple metric for objectively quantifying total daily volume of ambulatory activity. Objectively measured steps/day has been related to indicators of body composition (6, 27), blood pressure (6), glucose control (28), higher HDL-cholesterol (27), and lower levels of triglycerides (27). Increasing steps/day decreases body mass index (BMI) (4, 23) and improves blood pressure (4) and insulin resistance (42). Pedometer based interventions demonstrated that increasing steps/day (by approximately 2,000 (14) to 2,500 steps/day (4, 23)) elicits modest weight loss (4, 23) and improvements in blood pressure (4). Although steps/day has been associated with time spent in objectively-determined moderate intensity physical activity ($r=0.79$) (35), a simple daily tally of steps taken has been criticized as failing to clearly capture or communicate “quality” of ambulatory activity (7).

Re-considering cadence (steps/min) as an indicator of intensity of ambulatory activity has evolved as a result of a number of controlled studies (based upon treadmill, track, or corridor walking) (1, 3, 18, 24, 38), that taken together, demonstrate the correlation between cadence and absolutely-defined intensity (measured as metabolic equivalents or METs) is $r=0.94$ (33). Notably, amidst continued disagreements about accelerometer activity count/min cut points reflective of moderate intensity thresholds (19), there has been remarkable consistency in agreement that >100 steps/min can be used as a reasonable heuristic value for the same purpose (while still acknowledging individual variation) (1, 3, 18, 24, 38). Free-living studies of cadence have also emerged (2, 32). Based on accelerometry data collected as part of the 2005-2006 National Health and Nutrition Examination Survey (NHANES), we have previously reported that American adults accumulate, ≈ 8.7 hours at 1-59 steps/min (including a range of incidental movements to more purposeful steps), ≈ 16 min/day at 60-79 steps/min (slow walking), ≈ 8 minutes at 80-99 steps/min (medium walking), ≈ 5 minutes at 100-119 steps/min (brisk walking), and ≈ 2 minutes at 120+ steps/min (considered indicative of all faster locomotor movements, for example, running, dancing, skipping, etc.) (32).

Using these same NHANES data, we have also published the descriptive epidemiology of peak 30-min cadence, a derived variable that captures the average steps/min recorded for the highest 30 minutes (not necessarily consecutive) in a day (31). As such, peak 30-min cadence reflects the highest “natural best effort” in a day. Inspiration for this variable grew out of research conducted using the StepWatch Activity Monitor that offers a similar output as one of its summary variables (21). U.S. men and women had an average peak 30-min cadence of 73.7 and 69.6 steps/min, respectively, and the variable was inversely associated with age and BMI-defined overweight and obesity categories (31).

Steps/day is a metric used to convey daily volume of ambulatory movement events and steps/min is used to communicate accumulation patterns of these ambulatory movement events indicative of intensity. In contrast, there is growing interest in tracking sedentary time as it has been positively associated with undesirable values for a number of cardiometabolic biomarkers (i.e., BMI, high and low density lipoprotein cholesterol, triglyceride, fasting plasma glucose, high sensitivity-C-reactive protein, insulin resistance, etc.), independent of physical activity (25, 29). Time spent at zero cadence has been used as an indicator of non-movement and therefore sedentary time (41). Using the NHANES data, we have previously reported that the average U.S. resident accumulates ≈ 4.8 hours/day of zero cadence during the time that the accelerometer is worn (32). Since wear time varies with protocol design and participant tolerance, expressing the amount time spent in sedentary time as a percent of time worn at zero cadence (%TZC) is a reasonable metric to facilitate comparisons between studies and individuals.

We have previously advocated that volume, intensity, and an indicator of sedentary behavior could all be inferred from step-based metrics simultaneously quantifying daily human behavior in terms of movement/non-movement dimensions (37). Building upon and extending this early concept, this analysis of the 2005-2006 NHANES accelerometer data catalogs the relationships between these three dimensions and cardiometabolic risk factors. Such an extensive catalogue is a necessary first step to illuminating multiple health-related thresholds for each of these objectively monitored movement/non-movement dimensions.

Methods

NHANES Physical Activity Monitor (PAM)

The NHANES continuously assesses the health and nutritional status of civilian U.S. children and adults using a combination of interviews and physical examinations. Databases and details of questionnaires, protocols, and accompanying documentation are located at <http://www.cdc.gov/nchs/nhanes.htm>. ActiGraph accelerometer (model 7164 manufactured by ActiGraph, of Ft. Walton Beach, FL) data were collected as part of the NHANES Physical Activity Monitor (PAM) component in 2005-2006, however, the step output was only released for the latter cycle. The PAM database includes minute-by-minute data collected from 6+ year old ambulatory participants who were instructed to wear the waist-worn accelerometer for up to 7 consecutive days, removing it only at bedtime and for water-based activities such as showering and bathing. The National Center for Health Statistics (NCHS) ethics review board approved the NHANES survey protocols, and written informed consent was obtained from all participants.

Subjects and Data Treatment

The National Cancer Institute (NCI) made a SAS macro publically available (http://riskfactor.cancer.gov/tools/nhanes_pam/) to facilitate standard PAM data analysis, and this was used to identify valid monitored days, defined as ≥ 10 hours of wearing time. The present analysis is limited to 3388 20+ year-olds with at least one valid day (30, 34) of NHANES-designated reliable accelerometer data with an average of at least 500 steps/day, complete sex (1725 men and 1663 women), age, race, weight, and BMI data, and at least

some data on any of the following cardiometabolic risk factors: waist circumference (1685 men and 1630 women), systolic and diastolic blood pressure (1662 men and 1588 women), glucose (806 men and 741 women), insulin (799 men and 721 women), HDL-cholesterol (1667 men and 1583 women), triglycerides (801 men and 728 women), C-reactive protein (1668 men and 1591 women), and glycohemoglobin (1662 men and 1599 women). HOMA-IR was calculated as fasting insulin $\{[(\mu\text{U/mL}) \times [\text{fasting glucose (mmol/L)}]]/22.5\}$ for 799 men and 720 women. Since BMI was a focus of this analysis, we also excluded 382 self-reported pregnant women and a single individual with a BMI > 100 kg/m².

Initial demographic information including sex, age and race were self-reported. Other categorical variables such as self-reported diabetic and hypertensive status as well as current medication use were collected. Anthropometric measurements including height, weight, and waist circumference and blood pressure were directly measured using standardized protocols. Fasting glucose, insulin, HDL-cholesterol, triglycerides, and glycohemoglobin levels were collected utilizing traditional venipuncture techniques and processed at various laboratories according to standardized protocols. Questionnaire and protocol details are available at http://wwwn.cdc.gov/nchs/nhanes/search/nhanes05_06.aspx. Collected data were then used to identify increased cardiometabolic risk defined as: waist circumference 102 cm (men), 88 cm (women); blood pressure 130/ 85 mm Hg, or on blood pressure medication; fasting glucose 100 mg/dL (5.55 mmol/L), or on diabetes medication; HDL-cholesterol < 40 mg/dL (1.03 mmol/L; men), < 50 mg/dL (1.3 mmol/L; women), or on medication; and triglycerides 150 mg/dL (1.7 mmol/L), or on blood lipid lowering medication (8).

We applied a previously used approach (34) to adjust the NHANES ActiGraph 7164 accelerometer-determined steps/day to a metric more consistent with expected outputs from research-grade pedometers. Specifically, we censored steps by excluding activity occurring at < 500 activity counts/min. Justification, including sensitivity analyses, for this censoring cut-point has previously been reported (35, 36). Minute-by-minute step data were summed by day and averaged across valid days to obtain steps/day. Minute-by-minute steps/day were also rank ordered (descending) for each day to identify and compute the average steps/min for the highest 30 minutes of the day. The resulting value was averaged across valid days to produce peak 30-min cadence as previously described (31). A sedentary time (non-movement) variable was constructed as a percent of time worn at zero cadence (%TZC), also averaged across valid days ($[(\text{total wear and non-wear time at zero cadence} - \text{non-wear time}) \div \text{wear-time}] \times 100$).

Statistical Analysis

Data distributions for steps/day, peak 30-min cadence, and %TZC were cut into quintiles, and each quintile was identified by its median value. Geometric means (95% confidence intervals) were computed for the cardiometabolic variables from least square means. All geometric means were covariate adjusted for age in years and race (with the exception of systolic and diastolic blood pressures) and organized by each of the identified movement/non-movement quintiles.

Descriptive statistics are presented as frequencies (sex, race) and median and mean (and 95% CI) values as appropriate. The geometric mean was used for all continuous variables except age, and systolic and diastolic blood pressures. Sex comparisons were performed on the natural log of all the response variables except age, systolic and diastolic blood pressures. Linear trends were evaluated for cardiometabolic variables organized across each of the identified movement/non-movement indicator quintiles, adjusted for age and race. Spearman rank order correlations were computed to evaluate effect size of the relationships between the cardiometabolic variables and steps/day, peak 30-min cadence, and %TZC. A semi-log scatter plot was generated to display the relationships between ln insulin (displayed values are back transformed to $\mu\text{U/L}$) and steps/day, peak 30-min cadence and %TZC. Quintile bands for each movement/non-movement variable and their respective geometric means (95% CI's) were also included on the plots to inform interpretation and observe trends. Multivariable regression was used to evaluate the independent associations of steps/day, peak 30-min cadence, and %TZC with a subset of evaluated cardiometabolic variables (BMI, systolic blood pressure, glucose, insulin, HDL-cholesterol, triglycerides, and glycohemoglobin).

Results

Estimated median, mean, and 95% CI for selected variables for the analytic sample are presented in Table 1. Racial composition was 49.6% Caucasian, 23.2% African American, 20.2% Mexican American, and 7.0% Other. Applying recommended thresholds (8), 43.6% of men (and 64.9% of women) had high waist circumferences, 48.3% (and 43.4%) had high blood pressure or were on blood pressure medication, 58.6% (and 47.2%) had fasting blood glucose consistent with metabolic syndrome and prediabetes or were on diabetes medication, 36.3% (and 35.6%) had high cholesterol or were on cholesterol medication, and 37.3% (and 24.6%) had high triglycerides or were on blood lipid lowering medication. Mean accelerometer wear time was 843 min/day and the mean number of valid days considered was 5.3.

Median censored steps/day by ascending quintile were 2247, 4745, 6762, 9001 and 12334 for men and 1755, 3682, 5284, 6766 and 9824 for women. Table 2 presents the means and 95% CI for cardiometabolic risk factors across censored steps/day quintiles. Linear trends were statistically significant across all factors besides systolic blood pressure for men.

Median peak 30-min cadences by ascending quintile were 48.1, 62.6, 72.4, 82.3 and 96.0 steps/min for men and 40.8, 57.0, 67.8, 78.3 and 96.2 steps/min for women. Table 3 presents the means and 95% CI for cardiometabolic risk factors across peak 30-min cadence quintiles. Linear trends were statistically significant across most factors with a few exceptions for men (systolic blood and diastolic blood pressure and glucose) and women (diastolic blood pressure).

Median %TZC by ascending quintiles were 17.6, 26.8, 34.1, 40.6 and 51.0 for men and 19.9, 27.1, 32.9, 39.0 and 47.6 for women. Table 4 presents the means and 95% CI for cardiometabolic risk factors across %TZC quintiles. There were statistically significant

linear trends for insulin, HOMA-IR, HDL-cholesterol and triglyceride for both sexes. There was also a significant linear trend for weight and waist circumference for men.

Table 5 presents the relationships (Spearman's ρ) between steps/day, peak 30-min cadence, %TZC and the various cardiometabolic variables. Small to moderate correlations were observed for the majority of variables. Spearman correlations between steps/day and peak 30-min cadence, steps/day and %TZC, and peak 30-min cadence and %TZC were $r_s = 0.81$, -0.61 , and -0.35 , respectively. In addition, as a single purposive example, a semi-ln scatter plot (Figure, SDC 1, scatter plot displaying linear trends for insulin) was generated to display the relationships between ln insulin (displayed values are back transformed to $\mu\text{U/L}$) and steps/day, peak 30-min cadence and %TZC, due to its strong and consistent linear relationships (Table 2, 3, 4) and correlations (Table 5) across all three movement/non-movement dimensions.

Results of multivariable regression analyses predicting cardiometabolic outcomes from continuous measures of steps/day, peak 30-min cadence, and %TZC are presented in Table 6. Significant associations were observed for steps/day with all evaluated cardiometabolic outcomes in men and fasting blood glucose only in women. Conversely, peak 30-min cadence was associated with all evaluated cardiometabolic outcomes in women and only BMI and glycohemoglobin in men. %TZC was not associated with any evaluated cardiometabolic outcomes in men but was associated with BMI, triglycerides, and glycohemoglobin in women. All variance inflation factors for the evaluated models were < 4 , indicating no serious multicollinearity problems (9).

Discussion

Although steps/day (6, 27), and more recently, peak 30-min cadence (31), have been previously linked with some cardiometabolic risk factors, we present the most extensive compilation considering a wide array of cardiometabolic risk factors and also include relationships with %TZC, an indicator of sedentary time shaped by behaviors where no stepping occurs. Strong and consistent significant linear relationships and correlations were observed for both men and women between each movement/non-movement dimension and several of the cardiometabolic risk factors, including waist circumference, weight, insulin, HOMA-IR, and C-reactive protein.

As previously mentioned, steps/day has been criticized for not capturing the quality or pattern of physical activity (7), with intensity-based physical activity and sedentary behavior measures seemingly preferred. However, in the current analyses, significant linear relationships were observed between steps/day quintile and cardiometabolic outcomes, highlighting the relevance and usefulness of steps/day (Table 2; Figure, SDC 1, scatter plot displaying linear trends for insulin). Indeed, linear trends for steps/day were statistically significant for all cardiometabolic risk factors with the exception of systolic blood pressure for men. Further, for several of the outcomes (e.g., weight, waist circumference, insulin and HOMA-IR) similar or even stronger linear relationships and Spearman correlations were observed for steps/day when compared to relationships with peak 30-min cadence and

%TZC. Thus, these analyses provide justification for the use of steps/day recommendations in national physical activity guidelines.

Consistent with our step-based approach, we included peak 30-min cadence in these analyses as a proxy measure describing physical activity intensity. This metric resonates with physical activity guidelines that recommend adults participate in a minimum of 30 min/day of at least *moderate* intensity activity (accumulated in minimum bouts of 10 minutes) on most or preferably all days per week (7, 22). In parallel to this, a series of controlled laboratory studies have consistently demonstrated that ~100 steps/min appears to be a reasonable heuristic indicator of at least *moderate* intensity (i.e., 3 metabolic equivalents [METs]) physical activity (1, 3, 18, 24, 38). Taken together then, previous guidelines have recommended that adults engage in 30 min/day of physical activity at ~100 steps/min in order to meet physical activity guidelines (7). Interestingly, in the current analysis, the natural distribution of peak 30-min cadences across quintiles indicated that only the highest quintile of participants (5th Quintile: median peak 30-min cadence ~96 steps/min for men and women) achieved a peak 30-min cadence similar to what has been considered a direct translation of enacted moderate intensity physical activity. Despite this finding, statistical testing across quintiles revealed highly statistically significant linear relationships, but perhaps more importantly, clinically meaningful associations in expected directions, for the majority of the cardiometabolic risk factors. Furthermore, it is interesting to note that the 3rd (~70 steps/min) and 4th Quintiles (~80 steps/min), despite achieving median peak 30-min cadences well below what would be considered moderate intensity, displayed clinically favorable values for many of the cardiometabolic outcomes. The same was also true for participants in the 3rd and 4th Quintiles for steps/day (Table 2; Figure, SDC 1, scatter plot displaying linear trends for insulin), who achieved less than the popularized 10,000 steps/day, but still displayed favorable values for several of the cardiometabolic risk factors. A fundamentally similar pattern was also observed in %TZC (Table 4; Figure, SDC 1, scatter plot displaying linear trends for insulin), however due the nature of variable, Quintiles 1-3 were associated with clinical favorable values, as these correspond to a lower percentage of the day spent in sedentary behavior. These findings have important implications for public health and provide additional evidence-based support for the recommendation that “some physical activity is better than none,” as stated in the 2008 Physical Activity Guidelines for Americans (40). Simply put, small increases in the volume (steps/day) and intensity (peak 30-min cadence expressed in steps/min) of physical activity across the day and decreased amount of sedentary time (%TZC) are associated with clinically favorable values for a wide range of cardiometabolic risk factors.

Within the extant literature, sedentary time has been defined by a variety of objectively-measured metrics including time spent at < 100 (20) or < 150 (16) activity counts/min and time spent at zero cadence (41). It is important to note that all of the aforementioned metrics are related to accelerometer-determined wear-time, which can be empirically demonstrated via the strong correlations apparent between each metric and accelerometer wear-time in this investigation (e.g., $r=0.577$ between time at zero cadence and wear time and $r=0.401$ between time < 100 activity counts/min and wear time). Not surprisingly, several studies have demonstrated that varying the minimum wear-time requirement while defining a “valid” day of accelerometer data can substantially impact estimates of sedentary time (11,

12). As an illustrative example using data from the 2005-2006 NHANES, Herrmann et al. (12) previously reported that decreasing the minimum accelerometer-determined wear-time requirement from 14 to 10 hr/day reduced estimates of sedentary time (defined in this case by < 100 activity counts/min) by 30%. In light of these results, time-based comparisons of sedentary time with varying definitions of a valid day (e.g., 10 vs. 14 hr/day), or with different mean values of accelerometer-determined wear-time, may lead to spurious observations of significant differences in sedentary time which are largely attributable to discrepant wear-time estimates. To address this issue, previous analyses have sought to incorporate statistical adjustments for accelerometer-determined wear-time, or to present sedentary time metrics in relative terms as a proportion of accelerometer wear time (10). These analytic strategies inherently assume that sedentary time during wear and non-wear times are similar (15). It remains unknown whether or not this is a tenable assumption; however, Herrmann et al. (12) reported that the mean proportion of daily sedentary time (relative to wear time) remained relatively stable across varying definitions of a valid day (proportion of sedentary time at 14hr – 54.9%, 13hr – 54.5%, 12hr – 54.3%, 11hr – 54.2% and 10hr – 54.0%). To be clear, absolute wear time did little to affect variability of computed proportion of sedentary time when it was considered relative to wear time. Therefore, since our volume and intensity metrics herein were step-based, and zero cadence is consistent with sedentary time (41), we selected a consistent step-based metric to capture sedentary time relative to wear time.

Although steps/day and peak 30-min cadence were highly correlated (Spearman correlation > 0.80), results herein indicated that each measure appeared to provide unique contributions when predicting cardiometabolic outcomes. Interestingly, cardiometabolic associations were strongest with steps/day among men, while peak 30-min cadence was more strongly associated with cardiometabolic outcomes in women. Previous longitudinal analyses have indicated that self-reported walking speed (a marker of physical activity intensity) was more important than walking volume in reducing risks for heart failure and metabolic syndrome (17, 26). However, comparisons of these findings with results presented here are problematic due to the discrepant physical activity assessment measures used (self-report questionnaire vs. accelerometer). %TZC appeared to be less strongly associated with cardiometabolic measures than steps/day and peak 30-min cadence when considered collectively in multivariable regression models; however, %TZC remained a significant predictor of BMI, triglycerides, and glycohemoglobin in women. Analyses among adults using metrics similar to peak 30-min cadence and %TZC, have indicated that sedentary time is independently associated with fasting insulin, 2-hour plasma glucose, HOMA-IR, HDL-cholesterol, and triglycerides after adjustment for time spent in moderate-to-vigorous physical activity (5). However, we are unaware of any other published studies which collectively examined the associations of various cardiometabolic outcomes with volume (steps/day) and intensity (peak 30-min cadence) step-based physical activity, as well as time spent in non-movement (%TZC). Further research elucidating the independent and collective relationships of these measures with longitudinal outcomes remain needed.

This study has several strengths, including the use of a large nationally representative sample (NHANES) and use of objectively measured physical activity monitoring (waist-worn accelerometer) data. This study also has some limitations to acknowledge. These are cross-

sectional data and as such the ability to make causal conclusions are limited. An obvious potential confounder in the apparent relationships between the different step-based metrics and the evaluated cardiometabolic outcomes is body mass/composition, itself a cardiometabolic risk factor. Since there are few people with high body mass/composition with also relatively high steps/day, high peak 30-min cadence, or low %TZC, it is difficult to attribute the seeming effects catalogued in Tables 2 through 5 exclusively (or at all) to these movement/non-movement dimensions.

Conclusions

Collectively, this assemblage of data adds to the body of evidence supporting the important role of physical activity for reducing cardiometabolic risk by providing a useful classification of associations organized across organic distribution parameters natural to each of the selected movement/non-movement dimensions. As such, these data also offer a set of quantified access points for researchers/ clinicians studying the potential dose-response effects of each of these dimensions separately or collectively in longitudinal observational or intervention study designs. At face value it is quite apparent that these distinct yet overlapping dimensions of movement/non movement are related in multifarious ways to an array of cardiometabolic risk factors. In addition, it is important to consider, even without an acceptable method of statistical proof, the complex and interactive effects of these small-to-moderate improvements in cardiometabolic outcomes on overall health; we should not dismiss these effects simply by a judgment of their seemingly small magnitude or non-significant p-values. Rather, it is important to consider the multiplicity of effects, which may compound on one another and act in concert to achieve minimal clinically important differences in these cardiometabolic risk factors, ultimately leading to improved health outcomes.

These findings are also pertinent to the general population, particularly users of commercial physical activity monitors. Moving forward, physical activity monitoring devices and their software developers might consider presenting these step-related movement/non-movement dimensions in an integrated way, e.g., a total movement score that encompasses the whole spectrum and pattern of movement/non-movement over 24 hours. Providing the end user with feedback on these movement/non-movement dimensions and their association with cardiometabolic risk factors, e.g., waist circumference, insulin, C-reactive protein, may also provide additional motivation to improve/maintain physical activity accordingly.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Estimated median, mean and 95% CI for selected variables for male and female 20+ years old from NHANES 2005-2006.

Item	Men				Women			
	n	Median	Mean ^a	(95% CI)	n	Median	Mean ^a	(95% CI)
Age, years	1725	44.8	46.1	(44.3,47.9)	1663	45.8	47.6	(46.2,49.0)
Waist circumference, cm	1685	100.0	100.1	(98.6,101.6)	1630	92.2	93.1	(91.7,94.5)
Weight, kg	1725	85.7	86.8	(85.2,88.5)	1663	71.7	73.2	(71.7,74.8)
BMI, kg/m ²	1725	27.7	28.0	(27.5,28.5)	1663	27.1	27.9	(27.3,28.4)
SBP, mm Hg	1670	121.2	123.8	(122.8,124.7)	1598	117.3	121.4	(119.8,122.9)
DBP, mm Hg	1662	71.3	71.9	(71.0,72.8)	1588	70.2	70.1	(69.2,70.9)
Glucose, mg/dL	806	98.9	102.2	(100.1,104.4)	741	95.4	100.2	(98.2,102.2)
Insulin, μ U/mL	799	8.6	9.0	(8.6,9.4)	721	8.0	8.1	(7.3,8.9)
HOMA	799	2.2	2.3	(2.1,2.4)	720	1.9	2.0	(1.8,2.2)
HDL-cholesterol, mg/dL	1667	45.6	47.1	(46.4,47.8)	1583	56.9	57.5	(56.2,58.7)
Triglyceride, mg/dL	801	125.1	131.2	(125.0,137.7)	728	103.2	107.5	(102.5,112.8)
C-reactive protein, mg/dL	1668	0.15	0.16	(0.15,0.17)	1591	0.22	0.21	(0.19,0.23)
Glycohemoglobin, %	1662	5.27	5.41	(5.36,5.47)	1599	5.26	5.40	(5.35,5.45)
Uncensored steps/day	1725	10299	10737	(10443,11031)	1663	8929	9113	(8832,9394)
Censored steps/day	1725	7133	7564	(7282,7847)	1663	5685	5941	(5671,6212)
Peak 30-min cadence, steps/min	1725	74.2	74.6	(72.7,76.5)	1663	70.5	71.1	(69.2,72.9)
Wearing time, min/day	1725	851.4	858.1	(850.7,865.4)	1663	830.0	833.9	(825.7,842.1)

^aMean: geometric mean for all the variables except age, SBP, DBP, uncensored, censored steps and wearing time

^bp-value: sex comparison conducted on the natural log of all the response variables except age, SBP, DBP, uncensored, censored steps and wearing time

Table 2

Means (95% confidence intervals) for selected variables with steps/day quintiles for male and female 20+ years old from NHANES 2005-2006.

	Censored steps/day Quintiles ^a					Linear
	1 st Quintile	2 nd Quintile	3 rd Quintile	4 th Quintile	5 th Quintile	
Men						
n ^c	164-345	149-345	160-345	169-345	156-345	
	Mean ^b (95% CI)					
Waist circumference, cm	104.2 (101.9,106.6)	101.3 (99.3,103.5)	98.9 (95.9,102.0)	99.3 (97.4,101.2)	95.4 (93.2,97.8)	<0.0001
Weight, kg	89.0 (85.5,92.5)	86.6 (84.1,89.1)	84.0 (80.3,87.9)	84.0 (81.7,86.3)	79.6 (76.6,82.8)	<0.0001
BMI, kg/m ²	29.4 (28.4,30.5)	28.7 (27.9,29.6)	27.9 (26.8,29.0)	27.9 (27.1,28.7)	26.8 (26.2,27.5)	<0.0001
SBP, mm Hg	125.0 (123.0,126.9)	126.1 (124.1,128.1)	126.5 (124.2,128.8)	126.3 (124.4,128.3)	122.9 (121.7,124.0)	0.0996
DBP, mm Hg	68.4 (66.0,70.9)	71.9 (69.5,74.2)	73.6 (71.8,75.4)	73.4 (71.6,75.3)	70.7 (68.9,72.5)	0.0481
Glucose, mg/dL	108.8 (103.8,114.1)	105.5 (101.4,109.7)	104.6 (101.1,108.2)	105.1 (101.9,108.4)	101.9 (97.5,106.5)	0.0464
Insulin, µU/mL	13.5 (11.0,16.6)	11.2 (9.6,13.1)	9.3 (7.9,11.0)	9.3 (7.9,10.9)	7.2 (6.4,8.1)	<0.0001
HOMA-IR ^d	3.6 (3.0,4.5)	2.9 (2.5,3.5)	2.4 (2.0,2.8)	2.4 (2.0,2.8)	1.8 (1.6,2.0)	<0.0001
HDL-cholesterol, mg/dL	43.7 (42.1,45.3)	45.1 (43.4,46.9)	47.5 (45.6,49.5)	48.6 (47.1,50.3)	50.1 (48.3,52.0)	<0.0001
Triglyceride, mg/dL	147.7 (123.6,176.6)	144.0 (128.2,161.7)	134.9 (120.8,150.6)	134.0 (118.0,152.2)	112.3 (99.8,126.2)	0.0011
C-reactive protein, mg/dL	0.28 (0.25,0.32)	0.21 (0.17,0.26)	0.16 (0.13,0.20)	0.15 (0.13,0.17)	0.14 (0.12,0.16)	<0.0001
Glycohemoglobin, %	5.79 (5.64,5.93)	5.63 (5.54,5.72)	5.59 (5.48,5.71)	5.56 (5.48,5.63)	5.52 (5.43,5.61)	0.0014
Women						
n ^c	148-333	147-333	139-332	143-333	143-332	
Waist circumference, cm	99.3 (97.0,101.6)	96.9 (94.7,99.1)	94.7 (91.7,97.8)	91.8 (89.7,93.9)	88.9 (87.5,90.2)	<0.0001
Weight, kg	75.9 (73.7,78.1)	75.7 (73.5,78.0)	73.0 (69.5,76.8)	71.5 (69.5,73.5)	67.8 (66.0,69.6)	<0.0001
BMI, kg/m ²	30.0 (29.3,30.7)	29.7 (28.8,30.5)	28.7 (27.4,30.0)	27.7 (26.9,28.6)	26.4 (25.8,27.0)	<0.0001
SBP, mm Hg	125.2 (121.9,128.5)	124.7 (122.8,126.6)	122.7 (119.5,125.9)	122.4 (119.3,125.4)	123.1 (121.3,124.9)	0.0366
DBP, mm Hg	67.2 (65.3,69.1)	70.7 (69.0,72.4)	70.3 (68.2,72.4)	70.2 (68.8,71.6)	70.6 (68.7,72.4)	0.0164
Glucose, mg/dL	107.9 (102.0,114.0)	105.4 (100.0,111.1)	103.1 (98.0,108.4)	100.2 (97.6,102.8)	102.2 (97.8,106.8)	0.0230
Insulin, µU/mL	13.9 (11.7,16.6)	10.0 (9.0,11.2)	8.6 (7.3,10.3)	7.9 (7.0,8.9)	6.0 (5.3,6.9)	<0.0001
HOMA-IR ^d	3.7 (3.1,4.5)	2.6 (2.3,2.9)	2.2 (1.8,2.7)	2.0 (1.7,2.2)	1.5 (1.3,1.8)	<0.0001
HDL-cholesterol, mg/dL	53.4 (51.1,55.9)	54.5 (51.9,57.2)	57.7 (56.1,59.2)	58.4 (56.1,60.7)	60.7 (58.4,63.0)	0.0005

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	Censored steps/day Quintiles ^a					Linear
	1 st Quintile	2 nd Quintile	3 rd Quintile	4 th Quintile	5 th Quintile	
Triglyceride, mg/dL	131.1 (114.4,150.4)	110.5 (100.8,121.1)	109.0 (99.6,119.4)	98.5 (90.9,106.7)	92.6 (81.4,105.3)	0.0006
C-reactive protein, mg/dL	0.34 (0.28,0.40)	0.25 (0.22,0.28)	0.22 (0.17,0.28)	0.21 (0.16,0.26)	0.16 (0.13,0.20)	0.0002
Glycohemoglobin, %	5.66 (5.56,5.77)	5.59 (5.50,5.69)	5.55 (5.45,5.64)	5.55 (5.50,5.61)	5.49 (5.41,5.57)	0.0216

^aMedian steps/day for male was 2247, 4745, 6762, 9001 and 12334 for 1st, 2nd, 3rd, 4th, 5th Quintile respectively. Median steps/day for females was 1755, 3682, 5284, 6766 and 9824 for 1st, 2nd, 3rd, 4th, 5th Quintile respectively

^bMean: geometric means for all the variables except SBP, DBP were covariate adjusted for age (years) and race

^cn: sample size range

^dHOMA-IR: calculated as fasting insulin {(μU/mL) × [fasting glucose (mmol/L)]/22.5}

Table 3

Means (95% confidence intervals) for selected variables with peak 30-min cadence (steps/min) quintiles for male and female 20+ years old from NHANES 2005–2006.

	Peak 30-min Quintiles ^a					Linear
	1 st Quintile	2 nd Quintile	3 rd Quintile	4 th Quintile	5 th Quintile	
Men			Mean ^b (95% CI)			
n ^c	164-345	149-345	160-345	169-345	156-345	
Waist circumference, cm	104.2 (101.6,106.9)	101.5 (99.0,104.1)	99.8 (96.9,102.7)	97.6 (95.0,100.3)	96.2 (94.0,98.5)	<0.0001
Weight, kg	88.6 (85.1,92.3)	87.1 (84.1,90.2)	84.7 (81.1,88.6)	81.9 (78.7,85.2)	81.0 (78.3,83.8)	<0.0001
BMI, kg/m ²	29.5 (28.3,30.6)	28.9 (27.9,29.9)	28.1 (27.0,29.2)	27.3 (26.4,28.2)	27.2 (26.5,27.9)	<0.0001
SBP, mm Hg	124.5 (122.4,126.6)	126.7 (124.6,128.9)	126.1 (124.7,127.4)	124.7 (122.9,126.6)	124.7 (122.7,126.8)	0.5549
DBP, mm Hg	67.8 (65.6,70.1)	72.8 (70.5,75.0)	74.0 (71.5,76.4)	72.3 (70.3,74.3)	71.3 (69.6,73.0)	0.0622
Glucose, mg/dL	109.0 (104.4,113.8)	104.5 (101.1,108.1)	103.9 (100.9,107.0)	104.5 (100.8,108.4)	104.4 (100.4,108.6)	0.2098
Insulin, µU/mL	13.0 (10.3,16.4)	10.0 (8.8,11.4)	10.1 (7.8,12.6)	8.6 (7.4,10.0)	8.7 (7.8,9.8)	0.0005
HOMA-IR ^d	3.5 (2.7,4.4)	2.6 (2.2,3.0)	2.6 (2.0,3.3)	2.2 (1.9,2.6)	2.2 (1.9,2.5)	0.0003
HDL-cholesterol, mg/dL	44.9 (43.1,46.7)	45.2 (43.1,47.5)	47.1 (45.3,48.8)	48.6 (45.8,51.5)	49.4 (47.4,51.4)	0.0001
Triglyceride, mg/dL	145.0 (120.3,174.7)	141.0 (124.3,160.0)	132.9 (118.6,149.1)	123.7 (109.6,139.6)	131.2 (114.7,150.2)	0.0321
C-reactive protein, mg/dL	0.27 (0.22,0.33)	0.24 (0.20,0.27)	0.17 (0.15,0.20)	0.15 (0.13,0.19)	0.12 (0.10,0.14)	<0.0001
Glycohemoglobin, %	5.77 (5.59,5.96)	5.62 (5.53,5.70)	5.59 (5.48,5.71)	5.59 (5.46,5.72)	5.51 (5.44,5.59)	0.0184
Women						
n ^c	148-333	147-333	139-332	143-333	143-332	
Waist circumference, cm	101.8 (99.4,104.1)	96.9 (94.1,99.8)	94.7 (92.6,96.8)	90.6 (89.0,92.2)	87.5 (85.1,90.0)	<0.0001
Weight, kg	79.1 (75.9,82.5)	75.3 (72.0,78.8)	73.7 (71.1,76.5)	69.6 (68.1,71.2)	66.2 (63.6,68.8)	<0.0001
BMI, kg/m ²	31.2 (30.0,32.4)	29.5 (28.3,30.8)	28.9 (28.1,29.8)	27.0 (26.3,27.6)	25.9 (24.8,27.0)	<0.0001
SBP, mm Hg	126.5 (122.8,130.3)	125.0 (123.4,126.7)	123.1 (120.3,126.0)	122.5 (120.4,124.5)	120.8 (118.9,122.6)	0.0005
DBP, mm Hg	69.1 (67.1,71.0)	70.1 (68.8,71.4)	70.2 (68.6,71.9)	70.7 (69.1,72.3)	68.9 (67.1,70.7)	0.9023
Glucose, mg/dL	106.9 (101.8,112.2)	105.9 (101.6,110.5)	104.6 (99.8,109.7)	99.4 (96.9,101.9)	100.8 (96.3,105.5)	0.0224
Insulin, µU/mL	14.3 (11.8,17.5)	9.7 (8.6,10.9)	9.1 (7.6,10.8)	6.5 (5.6,7.6)	6.7 (5.8,7.6)	<0.0001
HOMA-IR ^d	3.8 (3.1,4.7)	2.5 (2.2,2.9)	2.4 (2.0,2.8)	1.6 (1.4,1.9)	1.7 (1.4,1.9)	<0.0001

	Peak 30-min Quintiles ^a					Linear
	1 st Quintile	2 nd Quintile	3 rd Quintile	4 th Quintile	5 th Quintile	
HDL-cholesterol, mg/dL	52.8 (50.8,54.9)	56.0 (53.9,58.2)	56.2 (54.2,58.2)	58.5 (56.7,60.3)	61.8 (59.3,64.4)	<0.0001
Triglyceride, mg/dL	128.4 (110.1,149.7)	111.3 (100.9,122.8)	118.1 (106.1,131.5)	90.3 (82.8,98.5)	91.3 (81.0,103.0)	0.0013
C-reactive protein, mg/dL	0.32 (0.26,0.39)	0.26 (0.22,0.30)	0.26 (0.20,0.34)	0.17 (0.14,0.21)	0.15 (0.12,0.18)	<0.0001
Glycohemoglobin, %	5.66 (5.58,5.74)	5.60 (5.51,5.68)	5.61 (5.53,5.70)	5.50 (5.44,5.56)	5.47 (5.39,5.55)	0.0016

^aMedian peak 30 min cadence for males was 48.1, 62.6, 72.4, 82.3 and 96.0 for 1st, 2nd, 3rd, 4th, 5th Quintile respectively. Median peak 30 min cadence for females was 40.8, 57.0, 67.8, 78.3 and 96.2 for 1st, 2nd, 3rd, 4th, 5th Quintile respectively

^bMean: geometric means for all the variables except SBP, DBP were covariate adjusted for age (years) and race

^cn: sample size range

^dHOMA-IR: calculated as fasting insulin [(μU/mL) × [fasting glucose (mmol/L)]/22.5}

Table 4

Means (95% confidence intervals) for selected variables with percent time at zero cadence quintiles for male and female 20+ years old from NHANES 2005-2006.

	%TZC Quintiles ^a					Linear
	1 st Quintile	2 nd Quintile	3 rd Quintile	4 th Quintile	5 th Quintile	
Men			Mean ^b (95% CI)			
n ^c	164-345	149-345	160-345	169-345	156-345	
Waist circumference, cm	99.0 (96.9,101.2)	99.6 (96.6,102.6)	98.0 (95.6,100.6)	99.7 (97.1,102.4)	102.2 (100.3,104.2)	0.0307
Weight, kg	83.1 (80.1,86.2)	84.4 (80.6,88.3)	83.1 (80.2,86.1)	85.0 (81.7,88.3)	87.1 (84.2,90.2)	0.0094
BMI, kg/m ²	27.8 (27.3,28.4)	28.3 (27.2,29.5)	27.6 (26.8,28.5)	28.2 (27.1,29.3)	28.6 (27.8,29.4)	0.1373
SBP, mm Hg	125.1 (123.2,127.0)	126.4 (124.7,128.1)	125.2 (122.8,127.7)	124.9 (123.2,126.6)	125.1 (122.8,127.3)	0.6656
DBP, mm Hg	71.2 (69.5,72.9)	73.5 (71.2,75.9)	71.9 (70.1,73.6)	71.6 (69.4,73.7)	70.4 (68.6,72.2)	0.1312
Glucose, mg/dL	103.8 (100.0,107.8)	104.7 (101.5,108.0)	104.0 (100.8,107.3)	108.6 (105.0,112.3)	105.2 (101.6,109.0)	0.2013
Insulin, µU/mL	8.2 (7.2,9.3)	9.8 (8.4,11.5)	9.2 (7.8,10.9)	10.8 (8.8,13.3)	12.0 (10.1,14.1)	0.0015
HOMA-IR ^d	2.1 (1.8,2.4)	2.5 (2.1,3.0)	2.4 (2.0,2.8)	2.9 (2.3,3.6)	3.1 (2.6,3.7)	0.0010
HDL-cholesterol, mg/dL	49.4 (47.1,51.7)	47.3 (45.7,48.9)	47.8 (45.7,49.9)	45.3 (43.7,47.0)	45.3 (43.5,47.2)	0.0070
Triglyceride, mg/dL	120.7 (106.1,137.3)	126.0 (111.2,142.6)	144.3 (123.5,168.6)	136.9 (118.2,158.5)	146.4 (129.2,165.8)	0.0183
C-reactive protein, mg/dL	0.17 (0.13,0.23)	0.18 (0.15,0.21)	0.17 (0.14,0.20)	0.17 (0.15,0.19)	0.21 (0.17,0.25)	0.3222
Glycohemoglobin, %	5.62 (5.53,5.71)	5.62 (5.50,5.74)	5.56 (5.48,5.65)	5.60 (5.51,5.69)	5.66 (5.54,5.77)	0.5733
Women						
n ^c	148-333	147-333	139-332	143-333	143-332	
Waist circumference, cm	94.8 (92.6,97.1)	94.8 (92.6,97.1)	93.6 (91.4,95.8)	94.8 (92.1,97.6)	95.8 (93.5,98.1)	0.1486
Weight, kg	73.9 (71.3,76.6)	70.6 (69.0,72.2)	72.7 (70.4,75.1)	73.5 (70.5,76.7)	72.9 (70.0,75.9)	0.8251
BMI, kg/m ²	29.0 (28.1,30.0)	27.7 (27.2,28.3)	28.2 (27.5,29.0)	28.7 (27.5,29.9)	28.7 (27.8,29.6)	0.8028
SBP, mm Hg	125.7 (123.5,127.9)	122.4 (119.9,125.0)	121.0 (119.1,123.0)	124.9 (122.4,127.3)	123.6 (121.0,126.3)	0.6253
DBP, mm Hg	70.9 (68.9,72.9)	70.0 (68.5,71.5)	69.3 (67.6,70.9)	69.8 (67.9,71.7)	69.1 (67.5,70.7)	0.1356
Glucose, mg/dL	105.1 (100.1,110.3)	104.1 (99.9,108.4)	101.0 (96.5,105.8)	102.7 (99.9,105.7)	105.1 (101.4,109.1)	0.8045
Insulin, µU/mL	7.6 (6.6,8.7)	8.6 (7.1,10.4)	8.9 (7.5,10.4)	9.2 (8.0,10.7)	11.7 (9.9,13.9)	0.0028
HOMA-IR ^d	2.0 (1.7,2.3)	2.2 (1.8,2.7)	2.2 (1.9,2.6)	2.3 (2.0,2.7)	3.0 (2.5,3.6)	0.0034

	%TZC Quintiles ^a					Linear
	1 st Quintile	2 nd Quintile	3 rd Quintile	4 th Quintile	5 th Quintile	
HDL-cholesterol, mg/dL	58.5 (55.7,61.4)	57.5 (55.3,59.7)	56.7 (55.1,58.4)	56.6 (54.5,58.8)	54.9 (53.0,56.9)	0.0438
Triglyceride, mg/dL	99.4 (89.8,110.0)	108.2 (97.4,120.2)	104.3 (94.9,114.6)	104.7 (94.5,116.0)	128.3 (112.9,145.9)	0.0315
C-reactive protein, mg/dL	0.22 (0.17,0.29)	0.21 (0.16,0.27)	0.20 (0.17,0.23)	0.23 (0.20,0.27)	0.28 (0.25,0.32)	0.1201
Glycohemoglobin, %	5.60 (5.49,5.72)	5.55 (5.48,5.63)	5.56 (5.50,5.62)	5.55 (5.52,5.58)	5.57 (5.46,5.68)	0.5328

^aMedian % time at zero cadence for male was 17.6, 26.8, 34.1, 40.6 and 51.0 for 1st, 2nd, 3rd, 4th, 5th Quintile respectively. Median % time at zero cadence for females was 19.9, 27.1, 32.9, 39.0 and 47.6 for 1st, 2nd, 3rd, 4th, 5th Quintile respectively

^bMean: geometric means for all the variables except SBP, DBP were covariate adjusted for age (years) and race

^cn: sample size range

^dHOMA-IR: calculated as fasting insulin [(μU/mL) × [fasting glucose (mmol/L)]/22.5]

Table 5

Spearman's correlations between physical activity volume (steps/day), intensity (peak 30-min cadence; steps/min) and sedentary behavior (%TZC) and cardiometabolic risk factors.

		Spearman's rho (ρ)		
	n^a	Steps/day	Peak 30-minute Cadence	%TZC (%) ^b
Men				
Waist circumference, cm	1685	−0.25	−0.24	0.14
Weight, kg	1725	−0.16	−0.15	0.10
BMI, kg/m ²	1725	−0.17	−0.18	0.06
SBP, mm of Hg	1670	−0.15	−0.12	0.08
DBP, mm of Hg	1662	0.03	0.02	−0.04
Glucose, mg/dL	806	−0.20	−0.17	0.16
Insulin, μ U/mL	799	−0.22	−0.15	0.12
HOMA-IR ^b	799	−0.25	−0.18	0.14
HDL-Cholesterol, mg/dL	1667	0.13	0.11	−0.07
Triglyceride, mg/dL	801	−0.13	−0.08	0.11
C-reactive protein, mg/dL	1668	−0.24	−0.28	0.10
Glycohemoglobin, %	1662	−0.22	−0.22	0.10
Women				
Waist circumference, cm	1630	−0.28	−0.35	0.08
Weight, kg	1663	−0.16	−0.24	0.02
BMI, kg/m ²	1663	−0.21	−0.29	0.02
SBP, mm of Hg	1598	−0.21	−0.26	0.07
DBP, mm of Hg	1588	0.03	−0.02	−0.03
Glucose, mg/dL	741	−0.21	−0.26	0.04
Insulin, μ U/mL	721	−0.32	−0.34	0.17
HOMA-IR ^b	720	−0.34	−0.36	0.16
HDL-Cholesterol, mg/dL	1583	0.11	0.14	−0.03
Triglyceride, mg/dL	728	−0.29	−0.32	0.17
C-reactive protein, mg/dL	1591	−0.19	−0.22	0.08
Glycohemoglobin, %	1599	−0.23	−0.26	0.07

^a n: sample size

^b %TZC – percent time a zero cadence

^b HOMA-IR: calculated as fasting insulin {[(uU/mL) × [fasting glucose (mmol/L)] / 22.5 }.

Table 6

Multiple regression analyses for censored steps/day, peak 30-min cadence, and percent of time at zero cadence (%TZC) with each cardiometabolic outcome.

	Intercept	Censored steps/day ^a		Peak 30-min Cadence		%TZC		
	<i>B</i> ₀ (SE)	<i>B</i> ₁ (SE)	VIF	<i>B</i> ₂ (SE)	VIF	<i>B</i> ₃ (SE)	VIF	<i>b</i> _{<i>p</i>}
Men								
BMI, kg/m ²	3.48 (0.03)	-0.0080 (0.0021) *	3.29	-0.0008 (0.0004) *	2.12	-0.0009 (0.0005)	1.84	<0.001
SBP, mm Hg	131.05 (2.31)	-0.6012 (0.1742) *	3.27	-0.0225 (0.0307)	2.10	-0.0310 (0.0412)	1.84	<0.001
Glucose, mg/dL	4.72 (0.04)	-0.0085 (0.0028) *	3.12	-0.0002 (0.0005)	2.06	-0.0002 (0.0007)	1.77	<0.001
Insulin, μU/mL	2.60 (0.16)	-0.0490 (0.0114) *	3.10	0.0004 (0.0021)	2.03	-0.0017 (0.0028)	1.79	<0.001
HDL-cholesterol, mg/dL	3.75 (0.04)	0.0074 (0.0030) *	3.27	0.0005 (0.0005)	2.09	0.0002 (0.0007)	1.85	<0.001
Triglyceride, mg/dL	4.90 (0.13)	-0.0283 (0.0092) *	3.10	0.0023 (0.0017)	2.03	0.0007 (0.0022)	1.78	<0.001
Glycohemoglobin, %	1.79 (0.02)	-0.0032 (0.0015) *	3.27	-0.0010 (0.0003) *	2.11	-0.0001 (0.0004)	1.84	<0.001
Women								
BMI, kg/m ²	3.69 (0.03)	-0.0039 (0.0034)	3.60	-0.0034 (0.0004) *	2.74	-0.0028 (0.0007) *	1.57	<0.001
SBP, mm Hg	136.10 (2.93)	0.4720 (0.2907)	3.59	-0.2749 (0.0379) *	2.72	0.0604 (0.0569)	1.59	<0.001
Glucose, mg/dL	4.78 (0.04)	-0.0066 (0.0048)	3.72	-0.0014 (0.0006) *	2.87	-0.0010 (0.0009)	1.55	<0.001
Insulin, μU/mL	2.68 (0.15)	-0.0498 (0.0164) *	3.64	-0.0053 (0.0021) *	2.82	0.0022 (0.0030)	1.53	<0.001
HDL-cholesterol, mg/dL	3.87 (0.04)	0.0066 (0.0040)	3.57	0.0014 (0.0005) *	2.74	0.0012 (0.0008)	1.55	<0.001
Triglyceride, mg/dL	4.97 (0.11)	-0.0097 (0.0117)	3.62	-0.0054 (0.0015) *	2.79	0.0044 (0.0022) *	1.54	<0.001
Glycohemoglobin, %	1.80 (0.02)	-0.0033 (0.0018)	3.58	-0.0010 (0.0002) *	2.75	-0.0007 (0.0003) *	1.56	<0.001

VIF = variance inflation factor. Dependent variables in all regression models were transformed using the natural logarithm (ln) except SBP.

^a Censored steps/day were divided by 1000.

^b Significance of *F*-test associated with overall regression model.

* Significant at $p < 0.05$