Patterns of Sedentary Time and Cardiometabolic Risk among Canadian Adults

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Abstract

Objective: To examine the associations of total sedentary time and patterns of sedentary time with cardiometabolic biomarkers in a large representative sample of Canadian adults.

Methods: The study is based on 4,935 adults aged 20-79 years, from the 2007/09 and 2009/11 Canadian Health Measures Survey. Total sedentary time, patterns of sedentary time (≥20 minute prolonged sedentary bouts, number of sedentary breaks), and moderate- to vigorous-intensity physical activity (MVPA) were accelerometer-derived. Waist circumference, systolic and diastolic blood pressure, high-density lipoprotein (HDL) cholesterol, and C-reactive protein were measured. Triglycerides, low-density lipoprotein (LDL) cholesterol, insulin, and glucose were also measured in a fasting sub-sample (n=2120).

Results: Total sedentary time and time in ≥20 minute prolonged sedentary bouts were associated with higher insulin and lower diastolic blood pressure levels (P<0.05). On average, each additional 10 breaks/day was associated with 0.83 (95%CI: 1.35, 0.31) cm lower waist circumference, 0.32 (0.62, 0.02) mmHg lower systolic blood pressure, 0.01 (0.00, 0.02) mmol/l higher HDL-cholesterol, 3.72 (1.34, 6.13) % lower triglycerides, 0.57 (0.23, 0.92) % lower glucose, and 4.19 (1.80, 6.63) % lower insulin.

Conclusion: These findings in a large representative sample of Canadian adults indicate breaking up sedentary time may be particularly important for cardiometabolic health.

Keywords: Sedentary Lifestyle, Cardiovascular Diseases, Insulin Resistance, Adult

Introduction

Cardiovascular disease is a leading cause of mortality in Canadian adults accounting for 26% of all deaths (Statistics Canada, 2009). Cardiometabolic biomarkers (e.g., obesity, high blood cholesterol) are strong predictors of cardiovascular disease (Heart & Stroke Foundation of Canada, 2012), with moderate- to vigorous-intensity physical activity (MVPA) an established determinant of these biomarkers (Warburton et al., 2010). Growing evidence from epidemiologic observational studies indicates that sedentary behaviour, defined as any waking behaviour characterized by a low energy expenditure (i.e., ≤1.5 resting metabolic equivalents) while in a sitting or reclining posture (Sedentary Behaviour Research Network, 2012), may also be an important determinant, independent of MVPA (Ekelund et al., 2007; Healy et al., 2007; Healy et al., 2011; Healy et al., 2008b; Helmerhorst et al., 2009; Henson et al., 2013). Understanding the impact of sedentary behaviour on cardiometabolic health has important public health implications because sedentary behaviours occupy the majority of waking hours (Colley et al., 2011). Therefore, in comparison to MVPA, which only makes up a small portion of waking hours even among highly active adults, there are substantial opportunities to reduce sedentary behaviours to improve cardiometabolic health (Colley et al., 2011; Tremblay et al., 2007).

The use of activity-based monitors, such as accelerometers, within population-based studies has led to the observation of detrimental associations between total sedentary time and cardiometabolic biomarkers (Healy et al., 2007; Healy et al., 2011; Healy et al., 2008b). The date and time stamped intensity information collected from accelerometers also facilitates the analysis of the patterns of sedentary time or how total sedentary time is accumulated. Sedentary breaks, considered in terms of how frequently sedentary bouts are interrupted, has been associated with health outcomes even after taking into account total sedentary time and MVPA. For example, in

a large, representative, population-based US sample, the number of breaks in sedentary time was inversely associated with waist circumference and C-reactive protein (Healy et al., 2011). The potential health benefits of more breaks in sedentary time have also been observed in Australian adults (Healy et al., 2008a), and adults at risk for type 2 diabetes (Henson et al., 2013).

Patterns of sedentary time can also be considered in terms of the duration of sedentary bouts, with evidence from experimental studies suggesting prolonged, unbroken sedentary time is particularly harmful (Bergouignan et al., 2011; Dunstan et al., 2012; Hamilton et al., 2007; Saunders et al., 2012). To date, no population-based research in adults has examined the health impact of prolonged sedentary bouts. Such information may provide further insight on the health implications of patterns of sedentary time and inform intervention strategies. The purpose of this study was to examine the associations of total sedentary time and patterns of sedentary time with cardiometabolic biomarkers in a large representative sample of Canadian adults (aged $\geq$ 20 years).

Methods

Data Source

Data are from the first (2007-2009) and second (2009-2011) cycles of the Canadian Health Measures Survey (CHMS) (Statistics Canada, 2014), an ongoing cross-sectional survey designed to provide comprehensive direct health measures on a nationally representative sample. Ethics approval to conduct the survey was obtained from Health Canada's Research Ethics Board. All respondents provided written informed consent.

The survey consisted of a questionnaire administered in the respondent's home, followed by a visit to a mobile examination centre where physical measures were performed. Participation was voluntary; respondents could opt out or refuse any part of the survey at any time. The overall

combined response rate for cycles 1 and 2 was 53.5%. Detailed information about the CHMS is available elsewhere (Statistics Canada, 2011, Statistics Canada, 2013a). A total of 7,069 CHMS participants aged 20-79 years were eligible for this study.

Sedentary Time and Physical Activity

Sedentary time and physical activity variables were derived from the valid and reliable Actical accelerometer (Phillips- Respironics, Oregon, USA) (Esliger et al., 2007; Esliger and Tremblay, 2006). Upon completion of their mobile examination center visit, ambulatory participants were asked to wear the accelerometer (Phillips – Respironics, Oregon, USA) over their right hip on an elasticized belt during waking hours for seven consecutive days. Data were collected in one minute epochs. Nonwear time was defined as ≥60 minutes of consecutive minutes of zero counts, with allowance for 1 to 2 minutes of counts between 0 and 100 (Colley et al., 2010). A valid day was defined ≥10 hours of wear time and only respondents with four or more valid days including one weekend day were retained for analyses (Colley et al., 2010). Sedentary time was defined as <100 counts per minute (cpm) (Wong et al., 2011), a validated Actical cut-point for adults (Colley et al., 2010). MVPA was defined as ≥1,535 cpm .

Total sedentary time, time in prolonged sedentary bouts (≥20 minutes), number of sedentary breaks, and minutes of MVPA were calculated each day then averaged on valid days. A bout was defined as any continuous, uninterrupted period of sedentary time (<100 cpm). The 20 minute cut-points for prolonged sedentary bouts were chosen based on laboratory-based research and sedentary behavior intervention messages (Dunstan et al., 2012; Dunstan et al., 2013). Each interruption of a sedentary bout by ≥1 minute of light activity or MVPA (≥100 cpm) was considered a break. Consistent with previous studies (Carson et al., 2013; Healy et al., 2011), total sedentary time, prolonged bouts, and MVPA were adjusted for wear time by

standardizing the variables using the residuals obtained with regressing the variables on the corresponding wear time variable (Willett and Stampfer, 1986).

Cardiometabolic Biomarkers

Waist circumference, systolic and diastolic blood pressure, high-density lipoprotein (HDL) cholesterol, and C-reactive protein were measured in the full sample. Additionally, triglycerides, low-density lipoprotein (LDL) cholesterol, glucose, and insulin were measured in a sub-sample of participants who provided fasting blood measures (minimum 10 hours fast). These biomarkers were selected because they capture different aspects of cardiometabolic risk. See Appendix A and CHMS user guides for further details (Statistics Canada, 2011, Statistics Canada, 2013a).

Covariates

Data were collected by self-report in the household interviews on a range of potential covariates identified from the literature (Healy et al., 2007; Healy et al., 2011; Healy et al., 2008b; Henson et al., 2013). Specifically, these were age, sex, total household income (classified into five categories based on total household income and number of people living in the household) (Statistics Canada, 2012), education (no high school, high school, some post-secondary, post-secondary degree/diploma) smoking status (smoke daily/occasionally/not at all), alcohol use (>2 drinks/day for women and >3 drinks/day for men) (Butt et al., 2011), currently taking blood pressure medication (yes/no), medical history of type 2 diabetes (yes/no), heart disease (yes/no), and cancer (yes/no). Survey cycle was also included as a covariate.

Statistical Analysis

All statistical analyses were performed using SAS version 9.2 (SAS Institute, Cary, NC) and SUDAAN version 10.0 (RTI International, Research Triangle Park, NC), and were based on weighted data for combined cycles to be representative of the Canadian population and account

for non-response bias. An additional adjustment was made in the full sample to account for respondents with <4 valid days of accelerometer data. The activity monitor survey weights were used for the full sample and fasted survey weights were used for the fasted sub-sample. C-reactive protein, triglycerides, glucose, and insulin required log-transformation to meet the assumption of normality in the regression models. Descriptive data were calculated, followed by separate multiple linear regression models to examine the association of each exposure with each cardiometabolic biomarker. Results for the regression models are expressed as the effect on the mean levels of each biomarker (or relative rates, for log-transformed outcomes) for each additional hour/day of total sedentary time, time in ≥20 minute prolonged sedentary bouts, or MVPA and for each additional 10 breaks/day. Minimum differences of interest were 2 cm waist circumference, 5/3 mmHg systolic/diastolic blood pressure, 5% cholesterol, 10% triglycerides, glucose, insulin and C-reactive protein for a moderate dose of each (2 hours for total and prolonged sedentary time, 20 breaks, 30 minutes of MVPA).

Model 1 adjusted for the potential confounders (i.e., age, sex, income, smoking, alcohol use, blood pressure medication, and medical history of type 2 diabetes, heart disease, cancer) that were significant predictors (P<.10) of at least one outcome and survey cycle. Sedentary breaks models were also adjusted for total sedentary time. Model 2 adjusted for all the variables in model 1 and MVPA for sedentary time models and sedentary time for MVPA models. Models showed no evidence of collinearity (i.e., all variance inflation factors <1.4). Finally, age and sex interactions with sedentary time and physical activity variables were tested. To account for survey design effects of the CHMS, standard errors, coefficients of variation, and 95% confidence intervals were estimated using the bootstrap technique (Rao et al., 1992; Rust and Rao, 1996). The number of degrees of freedom was specified as 24 (for cycles 1 and 2

combined) to account for the CHMS sample design (Statistics Canada, 2013b). Given the 24 degrees of freedom available for variance estimation, Satterthwaite-adjusted statistics were used to test the significance of each regression model's coefficients. Statistical significance was set at $P<0.05$ for main effects and at a stricter $P<0.001$ for interactions to minimize type 1 error, given the number of interaction tests.

Results

Of the 7,069 eligible participants, 1,371 were excluded due to incomplete accelerometer data and an additional 763 were excluded due to incomplete information on outcome and/or covariate measures. In total, 4,935 were included in the full analyses and 2,551 in the fasting analyses. The participant characteristics, weighted to represent the Canadian population, are shown in Table 1. For the full sample, the average age was 46 years and approximately half of the sample was male. The average daily time (± SD) spent in total sedentary time was 10.8 hours (±2.0) with 5.5 (±2.1) hours of this time in sedentary bouts of ≥20 minutes (Table 2).

Associations of sedentary time variables and MVPA with cardiometabolic biomarkers in the full sample are shown in Table 3. In the fully adjusted model (model 2), small inverse associations with diastolic blood pressure were observed for total sedentary time (-0.34 [95%CI: -0.63,-0.05]) and time in ≥20 minute prolonged sedentary bouts (-0.34 [95%CI: -0.60, -0.080]). Each additional 10 breaks/day was associated with 0.83 (95%CI: 1.35, 0.31) cm lower waist circumference and 0.32 (95%CI: 0.62, 0.02) mmHg lower systolic blood pressure. Beneficial associations of MVPA with waist circumference, HDL-cholesterol, and C-reactive protein were also observed in the fully adjusted model, respectively equating to average benefits per hour/day of approximately 7.31 cm, 0.13 mmol/L, and an approximately 50% reduction (RR [95% CI] =

0.66[0.55, 0.79]) when back transforming from the log-scale. Interactions with age and sex were not significant (*P*>0.001).

Associations of sedentary time variables and MVPA with cardiometabolic biomarkers in the fasting sub-sample are shown in Table 4. After back transforming from the log scale (RR [95% CI]), mean insulin was higher by 3% for each additional hour per day of total sedentary time (1.03[1.00, 1.05]) and time in ≥20 minute sedentary bouts (1.03[1.00, 1.05]) in the fully adjusted model (model 2). Additionally, after back transforming from the log scale (RR [95% CI]), each additional 10 breaks/day was associated with approximately 4% lower triglycerides (0.96 [0.94-0.99]), 0.6% lower glucose (0.99 [0.99, 1.00]), and 4% lower insulin (0.96 [0.94, 0.98]). Beneficial associations of MVPA with triglycerides, LDL cholesterol and insulin were also observed in the fully adjusted model, respectively equating to benefits per hour/day of approximately 18% (0.84 [0.78, 0.91]), 24% (0.81 [0.68, 0.96]), and 33% (0.75 [0.68, 0.83]) reduction when back transforming from the log-scale. No significant interactions by age or sex were observed (*P*>0.001).

Discussion

This study was the first to examine the relationship of accelerometer-derived total sedentary time and patterns of sedentary time with cardiometabolic biomarkers in a large, representative sample of Canadian adults. Independent of confounders and MVPA, small, significant, linear associations were observed between total sedentary time and time in ≥20 minute prolonged sedentary bouts with insulin and diastolic blood pressure. Independent of confounders, total sedentary time and MVPA, sedentary breaks had significant, beneficial linear associations with waist circumference, systolic blood pressure, HDL cholesterol, triglycerides,

glucose, and insulin. However, the effect sizes were small for systolic blood pressure, HDL-cholesterol and glucose.

Detrimental associations between objectively measured total sedentary time and cardiometabolic biomarkers have been previously reported among adults (Ekelund et al., 2007; Healy et al., 2007; Healy et al., 2011; Healy et al., 2008b; Helmerhorst et al., 2009; Henson et al., 2013). For example, in a large, representative, population-based sample of US adults significant associations were reported of total sedentary time with insulin, waist circumference, HDL-cholesterol, C-reactive protein, triglycerides, HOMA-%B, and HOMA%S (Healy et al., 2011). Unlike previous studies (Ekelund et al., 2007; Healy et al., 2011; Healy et al., 2008b), an inverse association of sedentary time with diastolic blood pressure was observed in this study. However, an inverse association has previously been observed with systolic blood pressure in another cross-sectional study (Buman et al., 2013). It is difficult to tease out the associations between sedentary time and blood pressure in a cross-sectional study as the acute and long term effects of sedentary behavior may be different. For instance, acutely sitting lowers blood pressure. Overall, the specific risk factors associated with total sedentary time appear to vary across studies, which is likely due to differences in populations studied, methodology used (including accelerometer type and data reduction) (Ekelund et al., 2007; Healy et al., 2007; Healy et al., 2011; Healy et al., 2008b; Helmerhorst et al., 2009; Henson et al., 2013). In addition, various studies including ours may have missed associations due to insufficient power. Collectively, observational studies tend to support detrimental associations between total sedentary time and markers of insulin resistance (Ekelund et al., 2007; Healy et al., 2007; Healy et al., 2011; Helmerhorst et al., 2009; Henson et al., 2013).

The present study largely confirmed previous findings on patterns of sedentary time by observing beneficial associations of sedentary breaks with a variety of cardiometabolic risk factors, independent of MVPA and total sedentary time (Healy et al., 2008a; Healy et al., 2011; Henson et al., 2013). Sedentary breaks also had independent beneficial associations with waist circumference and C-reactive protein in a large, representative, population-based sample of US adults (Healy et al., 2011). The present study extended previous research on patterns of sedentary time by looking beyond number of breaks to the health impact of time spent in prolonged sedentary bouts. A recent experimental study found restricting sedentary time to 20 minute bouts, interrupted by light or moderate breaks, was beneficially associated with insulin and glucose in an overweight/obese sample (Dunstan et al., 2012). Here, results were very similar for prolonged sedentary time as for total sedentary time, despite the breaks findings. To inform public health recommendations regarding breaking up sedentary time, further experimental studies are needed to better understand which patterns of sedentary time are necessary for health benefits, including elements not examined here, such as intensity and duration of breaks.

Strengths of this study include the large representative sample of adults, the objective measurement of sedentary time and MVPA variables, and the examination of a variety of cardiometabolic risk factors. One main limitation is the cross-sectional design, precluding casual inferences about the relationships. In addition, residual confounding may have occurred from confounders that were not measured (e.g., diet, medications for cholesterol/diabetes) or due to included confounders that had measurement error (e.g., alcohol use, income), meaning associations could be either underestimated or overestimated in this study. Finally, while accelerometers have several advantages over other measures of sedentary behavior and physical activity, and validation work indicates 100 cpm is the most appropriate Actical cut-point for

sedentary behaviour in adults (Wong et al., 2011), all accelerometers entail some measurement error, in part from data reduction procedures (e.g., non-wear time, cut-points). Further, measurement error is likely greater for sedentary time and patterns of sedentary time than MVPA (Winkler et al., 2012), especially as wear algorithms have not been validated for the Actical. Power was unlikely to have impacted most null findings, as the 95% CIs mostly included only small effect sizes. However, meaningful associations of sedentary time and patterns of sedentary time with C-reactive protein could not be ruled out as unlikely.

Conclusion

These are the first findings in a large representative sample of Canadian adults to show the benefits of breaking up sedentary time in addition to participating in regular MVPA for cardiometabolic health. To inform specific public health recommendations regarding sedentary behaviour, further research, including more experimental studies, are needed to better understand which patterns of sedentary time are important for health.

Conflict of Interest

GNH presented at an OERC (Office Ergonomics Research Committee) meeting in San Diego, US in 2013. OERC covered travel and accommodation expenses and also provided an honorarium. Healy presented at the 'Juststand Wellness Summit', a conference organized by Ergotron, in 2013 in the US. Ergotron covered travel and accommodation expenses. No further honoraria or imbursements were received. The funding bodies had no influence on the conduct or the findings of the study. There are no competing interests to declare from the other authors.

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Table 1. Weighted participant characteristics of the 2007/09 and 2009/11 CHMS

Variables	**Full sample** (N=4,935)	**Fasting sub-sample** (N=2,551)
Age (years)	45.9 (15.1)	46.4 (15.3)
Sex (%)		
Male	49.9	47.6
Female	50.1	52.4
Total Household Income (%)		
Low	1.5 [E]	F
Lower middle	3.2	2.5
Middle	14.2	13.2
Upper middle	30.1	31.6
High	51.3	51.7
Smoking (%)		
Non-smoker	81.0	82.6
Smoker	19.0	17.4
Alcohol Use (%)		
Normal	96.4	97.5
High	3.6	2.5
Blood Pressure Medication (%)		
Yes	15.7	15.7
No	84.3	84.4
Medical History for Type 2 Diabetes (%)		
Yes	5.0	5.0
No	95.1	95.0
Medical History for Heart Disease (%)		
Yes	4.0	4.4
No	96.0	95.6
Medical History for Cancer (%)		
Yes	1.5	1.7[E]
No	98.5	98.3
Waist Circumference (cm)	90.9 (14.9)	90.5 (15.5)
Systolic Blood Pressure (mmHg)	112.9 (15.5)	111.6 (15.1)
Diastolic Blood Pressure (mmHg)	72.1 (9.6)	71.1 (9.4)
HDL Cholesterol (mmol/L)	1.4 (0.4)	1.4 (0.4)
C-reactive Protein (mg/L)	2.2 (2.6)	2.2 (2.2)
Triglycerides (mmol/L)	-	1.3 (0.8)
LDL Cholesterol (mmol/L)	-	3.0 (1.0)
Plasma Glucose (mmol/L)	-	5.1 (0.7)
Insulin (pmol/L)	-	69.3 (82.1)

HDL = High-density lipoprotein cholesterol; LDL = Low-density lipoprotein cholesterol
Data presented as mean (standard deviation) for continuous variations and percentage for categorical variables
E = interpret with caution (coefficient of variation 16.6% to 33.3%)
F = coefficient of variation was too high (>33.3%) to reliably report the estimate

Table 2. Weighted descriptive characteristics of accelerometer-derived variables in the 2007/09 and 2009/11 CHMS

Variables	**Full sample** (N =4,935)	**Fasting sub-sample** (N=2,551)
Total wear Time (min/day)	883.8 (89.2)	880.6 (93.0)
Sedentary Time (min/day)†	645.3 (121.5)	649.3 (133.1)
≥20 Minute Prolonged Sedentary Bouts (min/day)†	331.6 (126.5)	339.5 (134.4)
Sedentary breaks (#/day)	83.2 (18.3)	82.3 (19.6)
MVPA (min/day)	22.0 (21.0)	21.2 (21.6)

Data presented as mean (standard deviation).
†Corrected for wear time using the residuals method.

Table 3. Weighted associations of sedentary time variables with cardiometabolic biomarkers in the full sample (n = 4,935) of the 2007/09 and 2009/11 CHMS

Variables		**WC (cm)**	**SBP (mmHg)**	**DBP (mmHg)**	**HDL (mmol/L)**	**CRP(mg/L)‡**
		β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Total Sedentary Time (hr/day)†						
	Model 1	0.338 (-0.154, 0.834)	-0.164 (-0.592, 0.264)	**-0.330 (-0.624, 0.037)***	-0.003 (-0.014, 0.008)	0.033 (-0.012, 0.078)
	Model 2	0.264 (-0.187, 0.714)	-0.163 (-0.587, 0.260)	**-0.338 (-0.629, 0.046)***	-0.002 (-0.012, 0.009)	0.028 (-0.015, 0.072)
≥20 Minute Bouts prolonged sedentary bouts (hr/day)†						
	Model 1	0.448 (0.049, 0.945) §	-0.156 (-0.534, 0.222)	**-0.339 (-0.603, 0.075)***	-0.003 (-0.015, 0.009)	0.026 (-0.015, 0.067)
	Model 2	0.374(-0.086, 0.835)	-0.155 (-0.531, 0.220)	**-0.346 (-0.609, 0.084)***	-0.002 (-0.014, 0.010)	0.022 (-0.018, 0.061)
Sedentary Breaks (10/day)						
	Model 1	**-0.516 (-0.999, -0.033)***	**-0.313 (-0.592, -0.033)***	-0.002 (-0.237, 0.232)	0.005 (-0.005, 0.014)	-0.015 (-0.052, 0.023)
	Model 2	**-0.830 (-1.351, -0.309)***	**-0.321 (-0.623, -0.018)***	-0.030 (-0.273, 0.212)§	**0.010 (-0.000, 0.020)***	-0.032 (-0.070, 0.005) §
MVPA (hr/day)†						
	Model 1	**-7.404 (-8.813, -5.994)***	0.131 (-2.261, 2.523)	-0.575 (-1.981, 0.831)	**0.130 (0.077, 0.184)***	**-0.427 (-0.610, -0.245)***
	Model 2	**-7.309 (-8.722, -5.895)***	-0.072 (-2.294, 2.437)	-0.697 (-2.067, 0.673)	**0.130 (0.075, 0.185)***	**-0.417 (-0.595, -0.239)***

WC = waist circumference; SBP = Systolic Blood Pressure; DBP = Diastolic Blood Pressure; HDL = High-density lipoprotein cholesterol; CRP = C-Reactive Protein; MVPA = moderate- to vigorous-intensity physical activity; ***P* <0.05**; § *P*<0.10; ‡Log transformed; β (95% CI) = unstandardized regression coefficients and 95% confidence intervals. Model 1 is adjusted for age, sex, income, smoking, alcohol use, blood pressure medication, and medical history of type 2 diabetes, heart disease, cancer, and survey cycle. Model 2 is adjusted for all the variables in model 1 and MVPA (except for the MVPA model, which is adjusted for total sedentary time). Models 1 and 2 for sedentary breaks are also adjusted for total sedentary time. †Corrected for wear time using the residuals method.

Table 4. Weighted associations of sedentary time variables with cardiometabolic biomarkers in the fasting sample (n =2,551) of the 2007/09 and 2009/11 CHMS

Variables		**Triglycerides (mmol/L)‡**	**LDL (mmol/L)**	**Glucose (mmol/L)‡**	**Insulin (pmol/L)‡**
		β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Total Sedentary Time (hr/day)†					
	Model 1	0.015 (-0.003, 0.033)	-0.025 (-0.054, 0.004)§	0.002 (-0.001, 0.006)	**0.024 (0.003, 0.045)***
	Model 2	0.014 (-0.004, 0.031)	-0.027 (-0.055, 0.001)§	0.002 (-0.002, 0.005)	**0.022 (0.003, 0.042)***
≥20 Minute Bouts prolonged sedentary bouts (hr/day)†					
	Model 1	0.017 (-0.001, 0.036)§	-0.025 (-0.060, 0.009)	0.002 (-0.001, 0.006)	**0.026 (0.003, 0.050)***
	Model 2	0.016 (-0.002, 0.034)§	-0.027 (-0.061, 0.007)	0.002 (-0.001, 0.006)	**0.025 (0.002, 0.047)***
Sedentary Breaks (10/day)					
	Model 1	**-0.027 (-0.050, -0.003)***	0.024 (-0.034, 0.081)	**-0.005 (-0.008, -0.001)***	**-0.025 (-0.049, 0.000)***
	Model 2	**-0.037 (-0.060, -0.014)***	0.014 (-0.044, 0.072)	**-0.006 (-0.009, -0.002)***	**-0.041 (-0.064, -0.018)***
MVPA (hr/day)†					
	Model 1	**-0.176 (-0.251, -0.100)***	**-0.207 (-0.375, 0.040)***	-0.013 (-0.028, 0.002)§	**-0.292 (-0.381, -0.202)***
	Model 2	**-0.172 (-0.249, -0.095)***	**-0.214 (-0.382, 0.046)***	-0.013 (-0.028, 0.002)§	**-0.286 (-0.381, -0.190)***

LDL = Low-density lipoprotein cholesterol; MVPA = moderate- to vigorous-intensity physical activity; ***P* <0.05**; § *P*<0.10; ‡**Log transformed; β (95% CI) = unstandardized regression coefficients and 95% confidence intervals**. Model 1 is adjusted for age, sex, income, smoking, alcohol use, blood pressure medication, and medical history of type 2 diabetes, heart disease, cancer, and survey cycle. Model 2 is adjusted for all the variables in model 1 and MVPA (except for the MVPA model, which is adjusted for total sedentary time). Models 1 and 2 for sedentary breaks are also adjusted for total sedentary time. †Corrected for wear time using the residuals method.