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Steps, Moderate-to-Vigorous Physical Activity, and Cardiometabolic Profiles

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Abstract

The relative benefits of meeting the current moderate-to-vigorous intensity physical activity (MVPA) and 'active' step count recommendations are unknown. Using robust linear regressions, we compared cardiometabolic marker differences (blood pressure, lipid levels, Homeostatic Model Assessment of Insulin Resistance (HOMA-IR), hemoglobin A1C, C-reactive protein (CRP), and body mass index (BMI)) across MVPA (150 minutes/week) and step (10,000 steps/day) thresholds and between step categories (low active: 5,000 to 7,499, somewhat active: 7,500 to 9,999, and active: ≥10,000 steps/day vs. inactive: <5,000 steps/day) in approximately 6,000 Canadian adults (41.5 years, SD 14.9). Differences across MVPA and step thresholds were similar but additional benefits were observed for BMI and A1C for the MVPA target (i.e., above vs. below 150 minutes/week MVPA: -1.02 kg/m^2 (95% CI -1.25 to -0.80) and -0.04 % (95% CI -0.06 to -0.02); above vs. below ≥10,000 steps/day: -0.40 kg/m^2 (95% CI -0.63 to -0.16) and 0.01% (95% CI -0.01 to 0.03)). In terms of step categories, the greatest gains were for the somewhat vs. inactive categories (e.g., 5,000 to 7,499 steps/day vs. <5,000 steps/day: -0.36 (-0.73 to 0.02) but 7,500 to 9,999 steps/day vs. <5,000 steps/day:-0.90 (-1.28 to -0.53)).Given that most benefits to markers of cardiometabolic health were at the ≥7,500 step/day threshold and that there was some additional benefit across the 150 minutes/week MVPA threshold compared to a 10,000 steps/day threshold, we suggest aiming for ≥7,500 steps/day and then advancing to a 150 minutes/MVPA goal.

Keywords

accelerometer; blood pressure; risk factors; BMI; epidemiology

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[A]The <5,000 step category has been previously labelled as 'sedentary' by Tudor-Locke and colleagues[13]. However, given that steps classifications do not directly measure sedentary behaviours (e.g., sitting time), we have relabeled the lowest step count category to 'inactive' as it more appropriately captures inactivity rather than sedentary behaviours

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Introduction

Physical inactivity has been placed alongside tobacco and obesity as critical modifiable risk factors for chronic disease worldwide[1,2]. In 2013, the global cost of physical inactivity to health care systems was INT $53.8 billion. Monitoring of physical activity (PA) patterns has demonstrated that progress on physical inactivity reductions worldwide have been modest at best[3,4].

In a hyperlinked world where work and leisure often occur on screen, PA guidelines are particularly important for goal setting at both the individual and population levels. The World Health Organization, the American College of Sports Medicine, and the Centers for Disease Control converge on a recommendation of 150 minutes of moderate-to-vigorous PA (MVPA) per week, accumulated in bouts ≥10 minutes (e.g., 30 minutes per day, 5 days per week)[5–7]. This may include a combination of PA accumulated during activities of daily living and more structured/planned PA (e.g., going to the gym). In Canada, a large proportion of adults are not meeting the recommended levels of PA. Based on objective measures of PA, 15% of Canadian adults achieve the 150 minutes of MVPA week target and 35% achieve the 10,000 step/day target[8].

In recent years, there has been strong interest in real-time PA monitoring and the application of PA tracking devices in goal setting. Accelerometers are commonly used to quantify PA intensity based on pre-defined activity count cut-points, but they may also be used to approximate step counts[9]. The advantage of step monitoring over intensity-based PA metrics is that steps are easily understood by the public[10,11] – and thus they might be more readily translated into action than intensity-based recommendations. In addition to this, step monitoring may be a more efficient intervention target in certain contexts (e.g., in low resource settings where pedometers are cheaper alternatives to accelerometers). Achieving 10,000 steps/day has been proposed as a threshold for being sufficiently active to lower cardiometabolic risk[12]. There has, however, been little study of MVPA guidelines and step-based recommendations in terms of relationships with cardiometabolic indicators of health. The objective of this study was to determine if differences in cardiometabolic profiles above and below a 150 minutes/week MVPA threshold were similar to differences across a 10,000 steps/day threshold. In a systematic review of studies that correlated steps and MVPA, achieving as few as 7,000 steps/day correlated with achieving the recommended level of weekly MVPA[12]. We therefore also examined cardiometabolic differences across previously delineated step count categories[13] (i.e., ≥10,000 (active), 7,500 to 9,999 (somewhat active), and 5,000 to 7,499 (low active) versus <5,000 (inactive)).[A]

Methods

The CHMS occurs biennially with interviews conducted in participants' homes and with follow-up medical assessments conducted in mobile health clinics. The CHMS field team travelled to each newly recruited participant's home address where they asked participants to complete a household questionnaire (developed by Health Canada and the Public Health

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Conflicts of interest: None

Agency and external experts)[14] and gave them further information about their upcoming mobile health assessment. All of the covariates of interest in our study were assessed as part of the household questionnaire and all of our PA and cardiometabolic health measures of interest were assessed as part of the mobile clinic assessment.

The Canadian Health Measures Survey (CHMS) was approved by the Health Canada Research Ethics Board. Prior to data collection, Statistics Canada obtained written informed consent from all participants. The Social Sciences and Humanities Research Council of Canada approved the present analyses (12-SSH-MCG-3081). We performed all analyses at the McGill-Concordia Quebec Inter-University Center for Social Statistics (QICSS). Data from Cycles 1 (March 2007 to February 2009; n=5,600), 2 (August 2009 to November 2011; n=6,400) and 3 (January 2012 to December 2013; n=5,800) were combined. We retained participants who were ≥18 years old and not taking glucose, blood pressure and/or lipid lowering medications. These medications alter cardiometabolic profiles and may impact associations with PA.

Physical activity

Immediately following their mobile clinic visit, ambulatory participants were requested to wear an accelerometer (Actical; Philips Respironics, Oregon, USA) on their right hip during waking hours for seven consecutive days. Participants with ≥4 valid days of data (with each valid containing ≥10 hours) were retained in the present analyses[8,14]. MVPA was counted as a bout if a minimum of eight out of ten consecutive minutes were above the MVPA of ≥1,535 counts per minute[8]. The step count and the MVPA functions of the Actical have been validated in adults[15]. Both total and bout-specific MVPA were evaluated.

Cardiometabolic profiles

Blood pressure and lipid profiles were assessed as they are well-established predictors of cardiovascular endpoints[16–19]. Hemoglobin A1C, Homeostatic Model Assessment of Insulin Resistance (HOMA-IR), and C-reactive protein (CRP) were also examined. Hemoglobin A1C is predictive of diabetes-related complications[20,21]. HOMA-IR is associated with cardiovascular disease in type 2 diabetes patients[22]. CRP is considered useful in refining risk predictions for those determined to be at intermediate risk for cardiovascular disease based on Framingham predictions[23].

The average of the last three of four systolic and diastolic blood pressure measurements were computed separately. Hemoglobin A1C, HDL cholesterol, total cholesterol, and CRP were assayed in all participants. In a subset of participants who underwent an overnight fast, insulin, plasma glucose, and LDL cholesterol (Friedwald equation) were assessed. HOMA-IR was calculated based on the fasting insulin and plasma glucose levels (fasting plasma glucose in mmol/L *x* fasting insulin in pmol/L/6)/22·5). All blood samples were sent to the Health Canada reference laboratory in Ottawa for analyses using standardized protocols and instrumentation (Vitros 5,1 FS by Ortho Clinical Diagnostics).

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Covariates

During the household visit age, sex, married/in a common-law relationship (yes/no), immigrant status, education level (dichotomized into having/not having a Bachelor degree or higher), having ever smoked, and depressed mood (defined as presence or absence of depression, bipolar disorder, mania or dysthymia) were assessed as part of the household questionnaire.

Statistical Analyses

We used robust linear regressions (m estimation with bisquare weighting) to estimate mean differences in each of the markers of cardiometabolic health for participants meeting the recommend level of 150 minutes/week of MVPA versus not meeting this threshold and differences between those meeting and not meeting a 10,000 steps/day target. The MVPA threshold was examined for cumulative and bouted MVPA. We used a similar approach to compare low active, somewhat active, and active step count categories with cardiometabolic profiles of participants in the sedentary step count category[13]. A series of models were fit, unadjusted, partially adjusted, and maximally adjusted for the covariates identified *a priori* as potential confounders and/or predictors of interest. These included age, sex, married/ common-law, immigrant status, education, ever smoker, and depressed mood. Final models were based on complete case data. All analyses were conducted using SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

Participant Characteristics

Data were collected on a total of 10,996 adults (18 to 79 years). After excluding participants taking antihyperglycemic (n=615), antihypertensive (n=2,201), and/or lipid-lowering medications (n=1,403), 8,106 participants remained. The characteristics of the study population are presented in Table 1. In brief, participants were middle-aged (41.5 years SD 14.9) and on average fell into the somewhat active category – achieving an average of 8,772 steps/day (SD 3,735), accumulated a total of 166 minutes/week of cumulative MVPA (SD 149) and 75 minutes/week of bouted MVPA (SD 115). Approximately half were women (53.6%) and the majority had partners (60.1%). On average participants were overweight (BMI 26.6 kg/m^2 SD 5.4). Average systolic and diastolic blood pressure values averaged well below even the strictest thresholds for hypertension (i.e., <140/90 mm Hg). Lipid profiles were generally within normal limits although the mean total cholesterol/HDL ratio was not optimal (i.e., >3). A1C averaged below the 6.5% threshold for diabetes diagnosis. Average HOMA-IR was in the range of what would be considered elevated (2.5 SD 3.0)[24]. Mean CRP was at the average level achieved by 12 months with statin (lipid lowering) therapy in a clinical trial that measured this biomarker (2.2 mg/L SD 2.6)[25].

Cardiometabolic Profiles Above versus Below PA Thresholds

In models adjusted for age, sex, married/common-law status, immigrant status, education, ever smoker status and depressed mood, differences above versus below the activity thresholds considered were similar for systolic blood pressure (SBP), CRP, lipid parameters, HOMA-IR, insulin, and plasma glucose (Table 2). For example, differences for SBP averaged -0.69 mm Hg (95% CI -1.32 to -0.06) above vs. below 10,000 steps/day and -0.86 mm Hg (95% CI -1.46 to -0.26) above vs. below 150 minutes/week MVPA (cumulative); the magnitude of lowering was similar but not conclusive for bouted MVPA (-0.71 mm Hg, 95% CI -1.50 to 0.08). The estimates from all of the unadjusted and partially adjusted models are available in Appendix A.

A1C differences were conclusive across the 150 minutes/week MVPA thresholds (≥*150 minutes/week of cumulative MVPA*: -0.04%, 95% CI -0.06 to -0.02; ≥*150 minutes/week of bouted MVPA*: -0.04%, 95% CI -0.06 to -0.01); but not across the 10,000 steps/day threshold (0.01%, 95% CI -0.01 to 0.03). BMI differences were conclusive across all PA thresholds but were greater in magnitude for MVPA thresholds (≥*150 minutes/week of cumulative MVPA*: -1.02 kg/m^2, 95% CI -1.25 to -0.80; ≥*150 minutes/week of bouted MVPA*: -0.86 kg/m^2, 95% CI -1.15 to -0.57) than for the step count threshold (-0.40 kg/m^2, 95% CI -0.63 to -0.16). Cardiometabolic differences above and below PA thresholds were attenuated with additional adjustment for BMI but remained conclusive for total cholesterol/HDL, HOMA-IR, and CRP. A1C lowering remained conclusively different for those achieving MVPA thresholds (Appendix B).

Cardiometabolic Profiles between Different Step Count Categories

In models adjusted for age, sex, married/common-law, immigrant status, education, ever smoker and depressed mood (Table 3), there was a graded improvement as a function of step count categories for HOMA-IR, CRP, total cholesterol/HDL, and insulin. Profiles of total cholesterol were also better for all step categories ≥5,000 steps/day compared to the inactive step group (<5,000 steps/day) – and better LDL cholesterol levels were observed for step categories ≥7,500 steps/day. Both the ‘somewhat active’ and ‘active’ step categories had lower BMI and SBP than the ‘inactive’ group and these differences were similar in magnitude. There were no conclusive differences for DBP or hemoglobin A1C. The greatest gains to cardiometabolic health were observed at the ≥7,500 step/day threshold. Beyond this threshold, benefits to cardiometabolic health were comparable. The estimates of all unadjusted and partially adjusted models are available in Appendix C. Conclusive differences were generally still apparent with adjustments for BMI across models (Appendix D).

Discussion

In this Canadian cohort not receiving medication for type 2 diabetes, hypertension, or dyslipidemia, meeting the 10,000 steps/day and 150 minutes/week of MVPA thresholds were associated with similar beneficial differences in lipid profiles, insulin resistance, and in inflammatory markers. Mean BMI and hemoglobin A1C improvements were, however, greater for achieving the recommended level of MVPA than for achieving active level step counts. For example, participants achieving the ≥150 minutes/week of MVPA threshold had an approximately one kg/m^2 lower BMI than participants not achieving this threshold, whereas participants achieving the ≥10,000 steps/day threshold had an approximately 0.40 kg/m^2 lower BMI than participants not achieving this threshold. Most of the markers of cardiometabolic health also demonstrated more optimal values with higher step count categories, with most important benefits already achieved in the somewhat active category (7,500 to 10,000 steps/day) but with some further benefit in the active category (≥10,000 steps/day).

In our cohort, SBP and A1C were well within normal limits. We excluded individuals on blood pressure, glucose, and LDL cholesterol lowering medications. Although we have previously demonstrated associations between steps and hemoglobin A1C in individuals on antihyperglycemic medications[26], we opted not to combine treated individuals with those not requiring medication in the present analyses. Our rationale was that treated and untreated individuals represent sufficiently different populations from a cardiometabolic profile perspective. If these individuals had been retained and were not taking medications, greater differences across thresholds and between step count categories may have been observed and A1C differences may have emerged. Nonetheless, in the present analyses, we did observe clear differences in HOMA-IR across both active step count and MVPA thresholds. We also observed HOMA-IR differences between the 'inactive' step count group compared to each of the three other groups (i.e., low active, somewhat active, high active). High HOMA-IR reflects insulin resistance; it is a precondition for prediabetes and type 2 diabetes.

An analysis of the American National Health and Nutrition Survey (NHANES) data examined associations of steps and step cadence with cardiometabolic profiles[27]. The latter is an alternate measure of PA intensity. The investigators demonstrated associations of both metrics with multiple markers of cardiometabolic health, consistent with our findings. Our analyses build on this work by specifically examining MVPA and juxtaposing cardiometabolic profile differences above and below MVPA and step count thresholds.

Our findings support the utility of adjusting PA targets as a function of current PA level. For those achieving <5,000 steps/day, there appear to be benefits to be gained by moving to the 5,000 to 7,500 steps/day category. Once this is achieved, further benefits may be accrued by achieving ≥7,500 steps/day. At this step count level, it may then be useful to aim for 150 minutes MVPA/week. Supporting the utility of achieving small increments in step counts, in adults with prediabetes, a 2,000 steps/day step count increase at one year was associated with an 8% lower hazard for cardiovascular mortality, stroke, or myocardial infarction over six years of follow-up[28]. Step counts appear to be attractive to less active individuals as a metric to follow. In one intervention study, step count and activity time goal setting and tracking were directly compared. While both resulted in higher PA levels, participants preferred tracking steps, feeling that they were given more 'credit' for each activity[11]. Through a randomized controlled trial, we recently demonstrated that a physician-delivered step count prescription strategy in adults with type 2 diabetes and hypertension leads to net increases in step counts and reductions in A1C and HOMA-IR[29]. Notably, participants averaged at the boundary between 'inactive' and 'low active' step count levels.

Thirty minutes/day of MVPA above usual activities correlates with approximately 7,000 to 10,000 steps/day accumulated both deliberately and incidentally throughout the day[12,30,31]. In our study, 30.8% of participants achieved ≥10,000 steps/day but the majority (58.4%) of participants achieved ≥7,500 steps/day. We suggest that accumulation of ≥7,500 steps/day is

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a reasonable ‘first level’ target, with a ‘next level’ target being to aim for ≥150 minutes/week of MVPA. Less than 20% of participants accumulated 150 minutes/week of MVPA in 10 minute bouts, but 40% did accumulate 150 minutes/week of unbouted MVPA. This suggests that, 150 minutes/week of MVPA accumulated irrespective of bout duration appears to be the more reasonable goal for a substantial proportion of adults with a comparable degree of benefit.

Strengths and Limitations

The primary strength of this study was the availability of both accelerometer-assessed PA and objectively-assessed clinical markers of cardiometabolic health on a large population-based sample of adults. While such data may be available from other population-wide samples, we are not aware of a similar approach to ours: that is, a juxtaposition of cardiometabolic profiles as a function of achieving PA thresholds. We acknowledge that stronger evidence would be provided by a longitudinal study directly comparing MVPA and step count thresholds and evaluating clinical outcomes and mortality. Although our study was based on data collected as part of a large population-based study, we caution the generalization of the findings to other populations as those people who attended the in-clinic assessments and wore their activity monitors for the minimum required time may have been different from those who did not. Nevertheless, we believe our study provides evidence for the scalable approach that we advocate. In the context of other epidemiological studies confirming the benefits of walking and the increasing popularity of step count monitoring, we believe that the inclusion of step count goal alternatives would be a timely addition to PA recommendations and should be considered by guidelines committees. Lastly, given that our primary goal was to compare different recommended thresholds of PA in relation to markers of cardiometabolic health, we did not investigate effect medication in this study. To further inform the development of future PA interventions, however, we encourage researchers to investigate if and how these associations vary by factors such as age and sex.

Conclusions

When comparing the ≥150 minutes/week of MVPA recommendation to the ≥10,000 step/day recommendation, the greatest cardiometabolic benefits are accrued above the 150 minutes/week MVPA threshold. Our study adds to this literature by suggesting that accumulating ≥150 minutes/week of unbouted MVPA will convey the similar benefits on cardiometabolic health as accumulating ≥150 minutes/week of MVPA in bouts of 10 minutes or more. Our results also demonstrate that all categories step counts ≥5,000 steps/day are associated with some benefit (e.g., insulin resistance, inflammation), suggesting that any increase in activity is valuable. We would suggest that in inactive individuals, a progressive increase in steps should be advocated. Once counts are ≥7,500 steps/day, it may be beneficial to move towards an MVPA target of ≥150 minutes MVPA. With the rise of PA monitoring tools, this is an opportune time to ensure that public health recommendations capitalize on these new technologies for the improvement of human health.

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Supplementary Material

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SH, KD and NAR conceived the study. SH was responsible for data analyses and for writing the first draft of the manuscript. All authors contributed to the interpretation of the results, reviewed the manuscript for content, and approved the final manuscript for submission. The authors wish to acknowledge the editorial contributions of Andrew Stevenson in the preparation of this manuscript and for his administrative support.

Abbreviations

MVPA	moderate-to-vigorous intensity physical activity
CRP	C-reactive protein
BMI	body mass index
CHMS	Canadian Health Measures Survey
PA	physical activity
HOMA-IR	Homeostatic Model Assessment of Insulin Resistance
SBP	systolic blood pressure

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Table 1

Study population characteristics: Participants from the Canadian Health Measures Survey (2007-2009; 2009-2011; 2012-2013).

Socio-demographic characteristics	**N**	**mean (SD)**
Age, *years*	8,106	41.5 (14.9)
		% (n)
Women	8,106	53.6 (4,342)
Married/common-law	8,102	60.1 (4,869)
Immigrant	8,104	37.2 (3,012)
Education (Bachelor degree or higher)	8,060	28.1 (2,268)
Ever smoker	8,093	47.8 (3,867)
Depressed	8,099	10.1 (816)
Anthropometric measures		**mean (SD)**
Body mass index (BMI), *kg/m²*	7,996	26.6 (5.4)
Cardiometabolic measures		**mean (SD)**
Average systolic blood pressure, *mmHg*	8,095	109.6 (14.5)
Average diastolic blood pressure, *mmHg*	8,095	70.8 (9.5)
Hemoglobin A1C, *%*	7,816	5.5 (0.5)
C-reactive protein, *mg/L*	7,745	2.2 (2.6)
HDL cholesterol, *mmol/L*	7,980	1.4 (0.4)
Total cholesterol/HDL ratio	7,978	3.8 (1.3)
Total cholesterol, *mmol/L*	7,978	5.0 (1.0)
LDL cholesterol, *mmol/L*	4,020	3.0 (0.9)
HOMA-IR[a]	3,977	2.5 (3.0)
Insulin, *pmol/L*	3,987	65.8 (51.2)
Plasma glucose, *mmol/L*	6,885	4.9 (0.8)
Physical activity	**N**	**mean (SD)**
Steps per day	6,261	8,722 (3,735)
MVPA, min/week (cumulative)	6,269	166.2 (149.1)
MVPA, min/week (in bouts ≥10 minutes)	6,269	74.8 (115.4)
Proportion of participants meeting different levels of PA	**N**	**% (n)**
<5,000 steps/day (Inactive)	6,261	14.0 (879)
5,000 to 7,499 steps/day (Low active)	6,261	27.6 (1,727)
7,500 to 9,999 steps/day (Somewhat active)	6,261	27.6 (1,727)
≥10,000 steps/day (Active)	6,261	30.8 (1,928)
≥150 minutes/week of MVPA (cumulative)	6,269	43.5 (2,725)
≥150 minutes/week of MVPA (in bouts ≥10 minutes)	6,269	16.4 (1,030)

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Table 2

Mean differences in clinical indicators of cardiometabolic health (95% CI) for those achieving ≥10,000 steps/day and ≥150 minutes per week of MVPA (cumulative and accumulated in bouts of ≥10 minutes) adjusted for age, sex, married/common-law, immigrant status, education, ever smoker and depressed mood. Participants from the Canadian Health Measures Survey (2007-2009; 2009-2011; 2012-2013).

	N	≥10,000 steps/day (*versus* <10,000 steps/day)	≥150 min/week of MVPA (*versus* <150 min/week)	
			Cumulative	Accumulated in bouts ≥10 minutes
Body mass index, *kg/m²*	6,153	**-0.40 (-0.63 to -0.16)**	**-1.02 (-1.25 to -0.80)**	**-0.86 (-1.15 to -0.57)**
Systolic blood pressure, *mmHg*	6,210	**-0.69 (-1.32 to -0.06)**	**-0.86 (-1.46 to -0.26)**	-0.71 (-1.50 to 0.08)
Diastolic blood pressure, *mmHg*	6,210	-0.39 (-0.87 to 0.09)	-0.29 (-0.74 to 0.17)	**-0.93 (-1.53 to -0.34)**
Hemoglobin A1C, *%*	6,020	0.01 (-0.01 to 0.03)	**-0.04 (-0.06 to -0.02)**	**-0.04 (-0.06 to -0.01)**
C-reactive protein, *mg/L*	5,986	**-0.19 (-0.26 to -0.12)**	**-0.28 (-0.34 to -0.21)**	**-0.23 (-0.31 to -0.14)**
HDL cholesterol, *mmol/L*	6,135	**0.07 (0.05 to 0.09)**	**0.08 (0.06 to 0.10)**	**0.08 (0.06 to 0.10)**
Total cholesterol/HDL ratio	6,133	**-0.22 (-0.28 to -0.15)**	**-0.27 (-0.33 to -0.21)**	**-0.28 (-0.35 to -0.20)**
Total cholesterol, *mmol/L*	6,133	-0.03 (-0.08 to 0.02)	**-0.09 (-0.13 to -0.04)**	**-0.08 (-0.15 to -0.02)**
LDL cholesterol, *mmol/L*	3,084	**-0.09 (-0.16 to -0.02)**	**-0.12 (-0.18 to -0.05)**	**-0.13 (-0.22 to -0.05)**
HOMA-IR	3,046	**-0.28 (-0.37 to -0.19)**	**-0.33 (-0.41 to -0.25)**	**-0.30 (-0.40 to -0.19)**
Insulin, *pmol/L*	3,055	**-7.45 (-9.67 to -5.23)**	**-8.72 (-10.85 to -6.60)**	**-7.69 (-10.41 to -4.96)**
Plasma glucose, *mmol/L*	3,217	**-0.07 (-0.10 to -0.04)**	**-0.06 (-0.10 to -0.03)**	**-0.07 (-0.11 to -0.03)**

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Table 3

Mean differences in clinical indicators of cardiometabolic health for ‘low active’, ‘somewhat active’ and ‘active’ step categories (95% CI) compared to the ‘inactive’ step category (<5,000 steps/day) adjusted for age, sex, married/common-law, immigrant status, education, ever smoker and depressed mood. Participants from the Canadian Health Measures Survey (2007-2009; 2009-2011; 2012-2013).

	N	**‘Low Active’ 5,000 to 7,499 steps/day**	**‘Somewhat Active’ 7,500 to 9,999 steps/day**	**‘Active’ ≥10,000 steps/day**
Body mass index, *kg/m²*	6,153	-0.36 (-0.73 to 0.02)	**-0.90 (-1.28 to -0.53)**	**-0.93 (-1.30 to -0.57)**
Systolic blood pressure, *mmHg*	6,210	-0.18 (-1.13 to 0.77)	**-1.87 (-2.83 to -0.92)**	**-1.54 (-2.48 to -0.59)**
Diastolic blood pressure, *mmHg*	6,210	0.27 (-0.45 to 0.99)	-0.66 (-1.39 to 0.06)	-0.55 (-1.27 to 0.16)
Hemoglobin A1C, *%*	6,020	-0.01 (-0.04 to 0.02)	-0.02 (-0.05 to 0.01)	-0.01 (-0.04 to 0.02)
C-reactive protein, *mg/L*	5,986	**-0.17 (-0.29 to -0.06)**	**-0.27 (-0.38 to -0.15)**	**-0.38 (-0.49 to -0.27)**
HDL cholesterol, *mmol/L*	6,135	0.02 (-0.01 to 0.05)	**0.06 (0.03 to 0.09)**	**0.11 (0.08 to 0.13)**
Total cholesterol/HDL ratio	6,133	**-0.14 (-0.24 to -0.05)**	**-0.27 (-0.36 to -0.18)**	**-0.39 (-0.48 to -0.29)**
Total cholesterol, *mmol/L*	6,133	**-0.10 (-0.17 to -0.02)**	**-0.18 (-0.25 to -0.10)**	**-0.14 (-0.22 to -0.07)**
LDL cholesterol, *mmol/L*	3,084	-0.07 (-0.17 to 0.04)	**-0.16 (-0.27 to -0.06)**	**-0.18 (-0.29 to -0.08)**
HOMA-IR	3,046	**-0.21 (-0.34 to -0.07)**	**-0.36 (-0.50 to -0.23)**	**-0.51 (-0.64 to -0.38)**
Insulin, *pmol/L*	3,055	**-5.17 (-8.63 to -1.71)**	**-9.71 (-13.19 to -6.23)**	**-13.54 (-16.93 to -10.14)**
Plasma glucose, *mmol/L*	3,217	-0.001 (-0.05 to 0.05)	-0.01 (-0.06 to 0.04)	**-0.08 (-0.12 to -0.03)**