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Gregory P. Butler, and Stephanie A. Prince

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# How sedentary are Canadian adults? It depends on the measure

by Rachel C. Colley, Justin J. Lang, Travis J. Saunders, Karen C. Roberts, Gregory P. Butler, and Stephanie A. Prince

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## ABSTRACT

### Introduction

The new Canadian 24-Hour Movement Guidelines for Adults aged 18-64 years and Adults aged 65 years and older recommend that adults limit daily sedentary time to eight hours or less, including three hours or less of recreational screen time. The eight-hour recommendation was centred between the evidence from research using self-reported sitting time (threshold: seven hours or less per day) and accelerometer-measured sedentary time (threshold: nine hours or less per day). The purpose of this study is to compare the percentages of Canadians meeting three different sedentary thresholds (three hours or less per day of screen time, seven hours or less per day of self-reported sitting time and nine hours or less per day of accelerometer-measured sedentary time).

### Methods

This analysis is based on 2,511 adults (aged 18 to 79 years) from Cycle 3 of the Canadian Health Measures Survey, in 2012 and 2013. Screen time and sitting time were assessed via self-report, and average daily sedentary time was assessed using a hip-worn Actical accelerometer.

### Results

Adults self-reported an average daily screen time of 3.2 hours (95% confidence interval [CI]: 3.0 to 3.5) and an average daily sitting time of 5.7 hours (95% CI: 5.4 to 6.0). According to accelerometry data, adults accumulated an average of 9.8 hours per day (95% CI: 9.7 to 9.9) of sedentary time. Adherence varied, with 57.7% meeting the self-reported recreational screen time threshold of three hours or less per day, 71.7% meeting the self-reported sitting time threshold of seven hours or less per day and 26.5% meeting the accelerometer-measured sedentary time threshold of nine hours or less per day.

### Interpretation

The percentage of Canadian adults meeting the three different sedentary behaviour thresholds varied widely. The findings in this article highlight the difference in sedentary time between what Canadians report versus what is measured by an accelerometer.

### Keywords

accelerometry, sitting, sedentary behaviour, health, screen time

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### ***What is already known on this subject?***

- According to hip-worn accelerometry data, Canadian adults spend a large proportion of their day sedentary.
- Too much sedentary time is associated with an increased risk of obesity, hypertension, depression, chronic conditions and diseases, as well as premature mortality.
- Sedentary behaviour is difficult to measure given it occurs sporadically throughout the day.
- The new Canadian 24-Hour Movement Guidelines for Adults aged 18-64 years and Adults aged 65 years and older make specific recommendations regarding sedentary behaviour: three hours or less per day of recreational screen time and eight hours or less per day of sitting time.

### ***What does this study add?***

- On average, Canadian adults self-reported 3.2 hours per day of recreational screen time and 5.7 hours per day of sitting time.
- According to hip-worn accelerometry, Canadian adults were sedentary, on average, for 9.8 hours per day.
- The percentage of Canadian adults meeting the various sedentary behaviour thresholds varies. For instance, 57.7% met the screen time threshold, 71.7% met the sitting time threshold and 26.5% met the hip-worn accelerometry threshold.
- More Canadian adults met the sedentary behaviour recommendations if they were also meeting the physical activity recommendations of 150 minutes of moderate-to-vigorous physical activity per week, compared with those not meeting the physical activity recommendations.
- The discordance between self-reported and device-measured sedentary behaviour data, coupled with a rapidly changing technology environment, poses challenges for population surveillance and warrants further examination of the development of a single threshold.

Sedentary behaviour is defined as wakeful activities of low energy expenditure (1.5 metabolic equivalents or less) while sitting, lying down or reclining, such as watching television, using a computer or engaged in passive travel.<sup>1</sup> Canadian adults spend a large proportion of their day engaged in sedentary behaviour,<sup>2</sup> which in excess is a risk factor for hypertension, obesity, depression, chronic conditions and premature mortality.<sup>3-6</sup> These deleterious associations with health make population surveillance of sedentary behaviour a high priority, as evidenced by its inclusion in the Physical Activity, Sedentary Behaviour and Sleep Indicator Framework from the Public Health Agency of Canada.<sup>7</sup> Given its ubiquity throughout the day and the wide range of activities that fall under the sedentary behaviour umbrella, measurement is a challenge.<sup>8</sup>

Canada has been collecting sedentary behaviour data since the 1980s, including answers to questions about daily sitting time and time spent in specific sedentary behaviours (e.g., television viewing, reading, passive transportation), some of which have been shown to have stronger associations with negative health outcomes than answers to questions about overall sitting.<sup>9</sup> The 1981 Canada Fitness Survey asked Canadians about their daily sitting time, and these data were used to more clearly establish the relationship between prolonged sitting and mortality risk.<sup>10</sup> Most recently, sedentary behaviour has been assessed within the Canadian Community Health Survey and the Canadian Health Measures Survey (CHMS) by asking Canadians about their

daily leisure screen time habits. A recent trend analysis of Canadian sedentary behaviour surveillance data noted limitations in the comparability of these data because of changes in how sedentary behaviour has been measured over time.<sup>2</sup> Additionally, because of improvements in the affordability of device measurement in the last decade, emerging research is now examining the association between device-measured sedentary time and health outcomes. The discordance between self-reported and device-measured sedentary behaviour data and a rapidly changing technology environment—particularly in screen-based consumption of media—pose significant challenges for surveillance.

The Canadian 24-Hour Movement Guidelines for Adults aged 18-64 years and Adults aged 65 and older were released in October 2020.<sup>11,12</sup> These guidelines recommend that adults limit daily sedentary time to eight hours or less, including 3 hours or less of recreational screen time. The surveillance recommendations contained within the 24-Hour Movement Guidelines note that the proposed target for total daily sedentary time (8 hours or less per day) can be assessed by either accelerometer-measured sedentary time or self-reported sitting time.<sup>12</sup> However, it was noted that caution should be taken when comparing sedentary time estimates derived from self-reported and accelerometer-measured data, noting explicitly that the eight-hour threshold reflects a blending of results from both methods. Specifically, the evidence used to establish the eight-hour threshold was based on evidence supporting a nine-hour

threshold for accelerometer-measured sedentary time<sup>13,14</sup> and a seven-hour threshold for self-reported sitting time.<sup>4,13</sup> There is no specific guidance on whether the eight-hour threshold should be applied for all daily sedentary behaviour constructs or the seven- and nine-hour thresholds should be used based on whether sedentary behaviours are self-reported or device-assessed.

A single surveillance recommendation for self-reported and accelerometer-measured sedentary time may lead to discordant reporting of adherence to the new guidelines given that multiple studies have reported a lack of agreement between these methods, especially when using single-item questions.<sup>2,15-17</sup> For example, a recent meta-analysis indicated that self-reported sedentary time was 1.74 hours less per day compared with accelerometer-measured sedentary time.<sup>2</sup> Further to this finding is the advent of new accelerometry devices and protocols (e.g., inclinometers, wrist-worn positioning) that require their own unique measurement considerations and thresholds. In addition to the uncertainty on how to operationalize the new Canadian sedentary behaviour recommendation, it is worth noting that the World Health Organization (WHO) and the United States opted not to establish a quantitative threshold for sedentary behaviour, citing “insufficient evidence to set quantified recommendations.”<sup>18-22</sup> The proposed thresholds for sedentary behaviour are also changing as new research emerges. A recent systematic review and meta-analysis examining the relationship between sedentary behaviour and cardiovascular disease risk points to a screen time threshold of 5 to 6 hours and a total sedentary time threshold of 10 to 11 hours per day,<sup>5</sup> thresholds that are higher than those proposed in the Canadian 24-Hour Movement Guidelines for Adults aged 18-64 years and Adults aged 65 years and older.<sup>12</sup> It is worth noting that different outcomes (e.g., mortality vs. specific conditions) may influence the thresholds proposed. Evidence of the interplay between physical activity and sedentary behaviour within a fixed 24-hour period further complicates the development of sedentary behaviour thresholds. Specifically, the associations between sitting time and all-cause mortality and cardiovascular disease are dependent on one’s level of physical activity.<sup>23-27</sup> This finding makes the establishment of a one-size-fits-all sedentary behaviour threshold challenging.

The inclusion of all three components of the sedentary behaviour recommendations (i.e., accelerometer-measured sedentary time and self-reported sitting and screen time) in Cycle 3 of the CHMS offers a unique opportunity to examine the percentage of Canadians meeting the various thresholds to better understand how they relate to one another. Specifically, this study aims to determine

1. the amount of time Canadians spend in different types of sedentary behaviour and the percentage meeting the three sedentary behaviour thresholds (i.e., three, seven and nine hours)
2. the extent to which the same respondents are meeting multiple sedentary behaviour thresholds

3. whether those meeting the physical activity recommendation are more likely to meet the sedentary behaviour thresholds.

## Methods

### Data source

The CHMS covers the population aged 3 to 79 years living in the 10 provinces. The survey’s coverage excludes people living in the three territories, people living on reserves and other Indigenous settlements in the provinces, full-time members of the Canadian Forces, the institutionalized population, and residents of certain remote regions. Together, these exclusions represent approximately 4% of the target population. Data are collected via an interviewer-administered questionnaire at home and using a mobile examination centre (MEC) that travelled to multiple sites across the country.<sup>28</sup> Ethics approval to conduct the survey was obtained from Health Canada’s Research Ethics Board, and respondents provided consent before participating.<sup>29</sup> This study uses data from respondents aged 18 to 79 years in Cycle 3 of the CHMS (2012 and 2013) because it includes accelerometer-measured and self-reported sedentary time.

### Self-reported sitting time and screen time

The International Physical Activity Questionnaire (IPAQ) was designed to provide internationally comparable self-reported surveillance data on health-related physical activity.<sup>30</sup> The long-form IPAQ was included in the household survey administered in Cycle 3 of the CHMS (2012 and 2013). Two questions assessed weekday- and weekend-specific total daily sitting time. These data were averaged using a weighted averaging approach (2\*weekend and 5\*weekday). Recreational screen time was assessed using a single open-ended question about total weekly duration. The wording of the questions is provided in the appendix.

### Accelerometer-measured sedentary time

The total sedentary time was assessed by device using the Actical accelerometer (Phillips Respironics Inc., Oregon, United States). Upon completion of their MEC visit, CHMS participants were asked to wear an Actical accelerometer over their right hip on an elasticized belt during their waking hours for seven consecutive days. This device measures and records time-stamped acceleration in all directions, thereby indicating the duration and intensity of physical activity. The digitized values are summed over a user-specified interval of one minute, resulting in a count per minute (CPM) value. A valid day was defined as 10 hours or more of wear time; respondents with four or more valid days were retained for analysis.<sup>31</sup> Wear time was defined by subtracting non-wear time from 24 hours. Non-wear time was defined as at least 60 consecutive minutes of zero counts, with allowance for 1 to 2 minutes of counts between 0 and 100. Sedentary time was composed of the sum of one-minute counts that were between 1 and 100 CPM and any zero counts captured during wear time.<sup>32</sup>

## Sedentary behaviour recommendations and thresholds

The current Canadian sedentary behaviour recommendation is to accumulate eight hours or less per day of sedentary behaviour, including three hours or less of recreational screen time. Given the eight-hour recommendation is based on a blending of seven hours for self-reported sitting time and nine hours for accelerometer-measured sedentary time, the present analysis focused on applying these thresholds rather than the eight-hour threshold. Given the seven- and nine-hour thresholds are not stated explicitly as recommendations, they are referred to herein as “thresholds.” For comparison purposes, the eight-hour threshold was applied to self-reported sitting time and accelerometer-measured sedentary time to illustrate what the overall estimates of adherence would be if that single threshold was applied to the two methods.

## Sociodemographic variables

The sedentary behaviour variables are presented by sociodemographic and health variable as well as by biological sex and age grouping. Income was adjusted for household size (total income divided by the square root of the number of people living in the household) and then split into quartiles. Respondent education was broken down into the following three groups: high school or less, postsecondary below bachelor's degree and bachelor's degree or higher. Marital status was dichotomized as married or common law and single, divorced or widowed. Indigenous identity was dichotomized as Indigenous and non-Indigenous. The observed population excludes: persons living in the three territories; persons living on reserves and other Indigenous settlements in the provinces. The term ‘racialized population’ was used to label the ‘visible minority’ concept from the Census. ‘Visible minority’ refers to whether or not a person belongs to one of the visible minority groups defined by the Employment Equity Act. The Employment Equity Act defines visible minorities as “persons, other than Indigenous peoples, who are non-Caucasian in race or non-white in colour.”

## Health variables

Respondents were classified into three body mass index (BMI) categories: underweight or normal weight ( $BMI < 25.0 \text{ kg/m}^2$ ), overweight ( $25.0 \leq BMI < 30.0 \text{ kg/m}^2$ ) and obese ( $BMI \geq 30.0 \text{ kg/m}^2$ ). The presence of self-reported chronic conditions was dichotomized into none and one or more chronic conditions. Smoking status was dichotomized into current or daily smoker and non-smoker (including former smokers and those who never smoked). Respondents who accumulated more than 150 minutes per week of continuous (non-bouted) accelerometer-measured moderate-to-vigorous intensity physical activity were classified as meeting the physical activity recommendation,<sup>11</sup> and those who accumulated below 150 minutes per week were classified as not meeting the recommendation.

## Statistical analysis

Descriptive statistics were used to present accelerometer-measured sedentary time and self-reported sitting and screen time by age group and sex. The proportion of adults meeting the three sedentary behaviour thresholds (i.e., three hours or less per day of recreational screen time, seven hours or less of daily sitting time and nine hours or less per day of hip-worn accelerometer-measured sedentary time) was estimated using weighted percentages and 95% confidence intervals (CIs). CHMS survey weights and bootstrap weights were applied in all analyses. Accelerometer-measured sedentary time and self-reported sitting time data were also presented for a range of sociodemographic and health factors. Differences in mean sedentary behaviour time estimates and percentages meeting recommendations between sexes and age groups as well as across levels of sociodemographic and health factors were assessed using independent t-tests. Comparisons between self-reported sitting time and accelerometer-measured sedentary time were made using correlation and Bland-Altman analyses. All statistical analyses were performed using SAS version 9.4 (SAS Institute, Cary, North Carolina, United States) and SUDAAN version 11.0.3, using denominator degrees of freedom set to 13 in the SUDAAN procedure statements. Statistical significance was assessed using p-values ( $< 0.05$  and  $< 0.001$ ).

## Results

Adults included in the present analysis wore the accelerometer for an average of 14.0 hours per day. Approximately half (48.6%) of the respondents in the present sample provided seven valid days of data (a valid day defined as 10 hours or more of wear time), 25.4% provided six valid days, 15.7% provided five valid days and 10.4% provided four valid days. Adults reported an average daily screen time of 3.2 hours and an average daily sitting time of 5.7 hours (Table 1). According to hip-worn accelerometry data, adults accumulated an average of 9.8 hours per day of sedentary time (Table 1). Compared with adults aged 18 to 34 years (3.3 hours per day), adults aged 35 to 49 years reported less screen time (2.8 hours per day) and adults aged 65 to 79 years reported more screen time (3.8 hours per day). Adults aged 35 to 49 years (5.4 hours per day) also reported less sitting time compared with those aged 18 to 34 years (5.9 hours per day). Females aged 65 to 79 years reported less sitting time (5.3 hours per day) than males of the same age (6.4 hours per day) and females aged 18 to 34 years (6.0 hours per day). Accelerometer-measured sedentary time was higher among adults aged 50 to 64 years (9.9 hours per day) and aged 65 to 79 years (10.2 hours per day) when compared with those aged 18 to 34 years (9.5 hours per day). Screen time was higher in the lowest income quartile (3.7 hours per day) compared with the highest quartile (2.9 hours per day) (Table 1).



**Table 1**  
Average daily screen time, sitting time and sedentary time of Canadian adults by sex, age group, and sociodemographic and health factors

	Screen time (self-reported)				Sitting time (self-reported)			Sedentary time (hip-worn accelerometry)		
	n	mean	95% Confidence interval		mean	95% Confidence interval		mean	95% Confidence interval	
			from	to		from	to		from	to
<b>Overall</b>										
<b>18 to 79 years</b>										
Both sexes	2,511	3.2	3.0	3.5	5.7	5.4	6.0	9.8	9.7	9.9
Males	1,240	3.4	3.0	3.8	5.8	5.5	6.2	9.7	9.5	10.0
Females	1,271	3.1	2.8	3.4	5.6	5.1	6.1	9.9	9.7	10.1
<b>Age groups</b>										
<b>18 to 34 years<sup>§</sup></b>										
Both sexes	518	3.3	2.8	3.8	5.9	5.4	6.4	9.5	9.2	9.9
Males	244	3.4	2.7	4.2	5.8	4.9	6.7	9.5	9.1	9.9
Females	274	3.2	2.6	3.8	6.0	5.0	6.9	9.5	9.1	9.9
<b>35 to 49 years</b>										
Both sexes	846	2.8 *	2.5	3.1	5.4 *	5.1	5.7	9.8	9.5	10.1
Males	419	2.9	2.6	3.3	5.4	5.0	5.8	9.6	9.2	10.0
Females	427	2.6	2.3	2.9	5.5	5.1	5.9	10.0	9.6	10.5
<b>50 to 64 years</b>										
Both sexes	652	3.3	2.9	3.7	5.8	5.4	6.2	9.9 *	9.7	10.1
Males	347	3.5	2.9	4.1	6.1	5.4	6.8	10.0	9.6	10.4
Females	305	3.1	2.8	3.4	5.5	4.9	6.0	9.9	9.6	10.2
<b>65 to 79 years</b>										
Both sexes	495	3.8 *	3.4	4.3	5.8	5.1	6.6	10.2 ***	10.0	10.3
Males	230	4.0	3.2	4.8	6.4	5.4	7.3	10.2 ***	9.9	10.6
Females	265	3.7 *	3.4	4.0	5.3 **	4.6	6.0	10.2 *	9.9	10.4
<b>Sociodemographic factors</b>										
<b>Income quartiles</b>										
Lowest quartile	611	3.7 *	3.1	4.4	5.5	4.9	6.2	9.9	9.7	10.1
Second quartile	641	3.2	2.8	3.7	5.5	4.9	6.0	9.7	9.4	10.0
Third quartile	627	3.2	2.8	3.6	5.6	5.0	6.1	9.8	9.5	10.0
Highest quartile <sup>§</sup>	632	2.9	2.6	3.1	6.3	5.5	7.0	9.8	9.7	10.0
<b>Education</b>										
High school or less	870	3.5	3.0	4.1	5.5 *	5.0	6.0	9.7	9.4	10.0
Some postsecondary	838	3.1	2.8	3.5	5.4 *	5.0	5.9	9.8	9.6	10.0
Bachelor's degree or higher <sup>§</sup>	771	3.0	2.8	3.2	6.2	5.7	6.8	9.9	9.8	10.1
<b>Marital status</b>										
Married or common law <sup>§</sup>	1,656	3.0	2.8	3.2	5.6	5.2	5.9	9.8	9.6	10.0
Single, divorced or widowed	854	3.7 ***	3.2	4.2	6.0	5.6	6.5	9.8	9.5	10.1
<b>Indigenous identity</b>										
Indigenous	58	4.6	2.9	6.4	5.3	4.1	6.6	9.9	9.1	10.7
Non-Indigenous <sup>§</sup>	1,827	3.2	3.0	3.5	5.8	5.4	6.2	9.7	9.6	9.9
<b>Racialized population</b>										
Designated as a racialized population	457	3.1	2.3	4.0	5.6	5.0	6.2	10.0	9.7	10.2
Not designated as a racialized population <sup>§</sup>	1,995	3.2	3.0	3.5	5.8	5.3	6.2	9.8	9.6	9.9
<b>Health and behaviour factors</b>										
<b>Obesity</b>										
Normal weight <sup>§</sup>	910	3.1	2.8	3.4	5.6	5.2	6.0	9.8	9.6	9.9
Overweight	933	3.2	2.9	3.5	5.7	5.2	6.2	9.7	9.5	10.0
Obese	645	3.5 *	3.1	3.8	5.9	5.5	6.4	9.9	9.6	10.3
<b>Chronic conditions</b>										
At least one chronic condition	1,551	3.3	3.1	3.6	5.7	5.3	6.1	9.8	9.7	9.9
No chronic conditions <sup>§</sup>	868	3.0	2.6	3.5	5.8	5.3	6.2	9.7	9.5	10.0
<b>Smoking status</b>										
Occasional or daily smoker	418	3.4	2.9	3.8	5.5	4.7	6.4	9.9	9.5	10.2
Non-smoker <sup>§</sup>	2,089	3.2	2.9	3.5	5.8	5.4	6.2	9.8	9.7	9.9
<b>Physical activity recommendation</b>										
Meets physical activity recommendation <sup>§</sup>	1,047	3.1	2.8	3.5	5.8	5.3	6.2	9.5	9.2	9.8
Does not meet physical activity recommendation	1,464	3.3	3.0	3.6	5.7	5.3	6.0	10.0 ***	9.9	10.2

\* significantly different from reference category (p < 0.05)

\*\*\* significantly different from reference category (p < 0.001)

† significantly different from males (p < 0.05)

§ reference category

**Note:** The concept of racialized population is measured with the 'visible minority' variable in this release. 'Visible minority' refers to whether or not a person belongs to one of the visible minority groups defined by the Employment Equity Act. The Employment Equity Act defines visible minorities as "persons, other than Aboriginal peoples, who are non-Caucasian in race or non-white in colour".

**Source:** Canadian Health Measures Survey, 2012-2013.

**Table 2**  
**Weighted percentage of Canadian adults meeting screen, sitting and sedentary time thresholds by sex, age group, and sociodemographic and health factors**

	Met screen time threshold (≤ 3 hours per day)			Met sitting time threshold (≤ 7 hours per day)			Met sedentary time threshold (≤ 9 hours per day)		
	%	95% Confidence interval		%	95% Confidence interval		%	95% Confidence interval	
		from	to		from	to		from	to
<b>Overall</b>									
<b>18 to 79 years</b>									
Both sexes	57.7	53.7	61.5	71.7	66.8	76.1	26.5	22.7	30.8
Males	54.4	48.2	60.4	69.0	62.9	74.5	28.2	22.2	35.1
Females	60.9	55.0	66.5	74.3	67.5	80.1	24.9	20.2	30.2
<b>Age groups</b>									
<b>18 to 34 years<sup>§</sup></b>									
Both sexes	55.2	50.3	60.1	70.0	59.8	78.6	32.3	22.1	44.4
Males	54.1	42.7	65.0	67.6	54.4	78.4	31.9	19.1	48.1
Females	56.5	44.9	67.4	72.7	52.0	86.8	32.6	20.8	47.3
<b>35 to 49 years</b>									
Both sexes	65.8 <sup>*</sup>	58.6	72.4	73.5	68.7	77.8	28.2	23.3	33.7
Males	64.4	58.2	70.0	72.0	65.2	77.8	34.1	24.6	45.2
Females	67.3	56.0	76.8	75.1	68.1	81.0	22.3	15.3	31.4
<b>50 to 64 years</b>									
Both sexes	56.7	47.5	65.4	71.1	66.0	75.7	23.8	17.6	31.4
Males	48.3	32.8	64.1	68.7	58.9	77.1	24.8	16.0	36.4
Females	64.5	56.2	71.9	73.3	63.7	81.0	22.8	14.0	35.0
<b>65 to 79 years</b>									
Both sexes	47.4	38.6	56.3	72.7	62.9	80.8	15.8 <sup>*</sup>	12.0	20.6
Males	45.8	32.8	59.4	66.5	54.3	76.9	13.0 <sup>*</sup>	6.9	22.9
Females	48.8	41.4	56.4	78.3 <sup>‡</sup>	69.5	85.1	18.4	13.1	25.3
<b>Sociodemographic factors</b>									
<b>Income quartiles</b>									
Lowest quartile	50.0 <sup>*</sup>	40.0	60.0	73.3	62.0	82.2	28.6	22.7	35.2
Second quartile	55.4	45.2	65.2	81.5 <sup>***</sup>	75.6	86.2	29.8	22.4	38.4
Third quartile	60.6	52.9	67.8	71.9 <sup>*</sup>	64.2	78.6	27.2	21.6	33.6
Highest quartile <sup>§</sup>	63.0	56.9	68.8	61.0	51.8	69.5	21.2	14.2	30.3
<b>Education</b>									
High school or less	51.3	43.0	59.5	75.4 <sup>*</sup>	68.8	81.0	30.2	21.8	40.1
Some postsecondary	61.6	56.5	66.6	73.3	68.3	77.8	25.6	19.6	32.6
Bachelor's degree or higher <sup>§</sup>	61.0	56.2	65.5	65.4	55.9	73.7	23.0	15.6	32.5
<b>Marital status</b>									
Married or common law <sup>§</sup>	61.8	57.4	66.1	73.7	67.6	79.0	26.0	21.0	31.7
Single, divorced or widowed	49.6 <sup>*</sup>	42.5	56.7	67.9	61.0	74.0	27.6	20.4	36.1
<b>Indigenous identity</b>									
Indigenous	25.8 <sup>E***</sup>	13.2	44.1	76.6	42.4	93.6	19.7	10.6	33.6
Non-Indigenous <sup>§</sup>	57.1	52.7	61.5	70.9	65.3	75.9	28.5	23.5	34.0
<b>Racialized population</b>									
Designated as a racialized population	59.9	49.8	69.3	74.7	65.6	82.1	22.6 <sup>*</sup>	19.1	26.4
Not designated as a racialized population <sup>§</sup>	57.9	53.6	62.1	70.7	64.9	76.0	27.8	23.0	33.1
<b>Health and behaviour factors</b>									
<b>Obesity</b>									
Normal weight <sup>§</sup>	64.5	58.1	70.5	72.0	65.5	77.7	27.2	22.3	32.7
Overweight	56.7	49.9	63.4	73.1	65.1	79.9	27.4	20.7	35.5
Obese	49.1 <sup>*</sup>	41.6	56.7	68.8	62.0	74.8	24.0	16.2	34.1
<b>Chronic conditions</b>									
At least one chronic condition	54.7 <sup>*</sup>	50.1	59.2	71.5	65.4	77.0	26.6	22.4	31.3
No chronic conditions <sup>§</sup>	63.7	59.4	67.8	69.9	63.6	75.6	27.4	19.5	37.1
<b>Smoking status</b>									
Occasional or daily smoker	56.9	46.7	66.5	75.7	67.8	82.2	29.7	21.9	38.9
Non-smoker <sup>§</sup>	57.9	54.2	61.5	70.5	64.3	76.0	25.6	21.6	30.1
<b>Physical activity recommendation</b>									
Meets physical activity recommendation <sup>§</sup>	59.3	55.0	63.5	68.9	61.9	75.1	34.4	27.5	42.1
Does not meet physical activity recommendation	56.3	49.6	62.9	73.8	68.5	78.6	20.4 <sup>*</sup>	16.3	25.3

<sup>E</sup> use with caution

\* significantly different from reference category (p < 0.05)

\*\*\* significantly different from reference category (p < 0.001)

<sup>‡</sup> significantly different from males (p < 0.05)

<sup>§</sup> reference category

**Note:** The concept of racialized population is measured with the 'visible minority' variable in this release. 'Visible minority' refers to whether or not a person belongs to one of the visible minority groups defined by the Employment Equity Act. The Employment Equity Act defines visible minorities as "persons, other than Aboriginal peoples, who are non-Caucasian in race or non-white in colour".

**Source:** Canadian Health Measures Survey, 2012-2013.



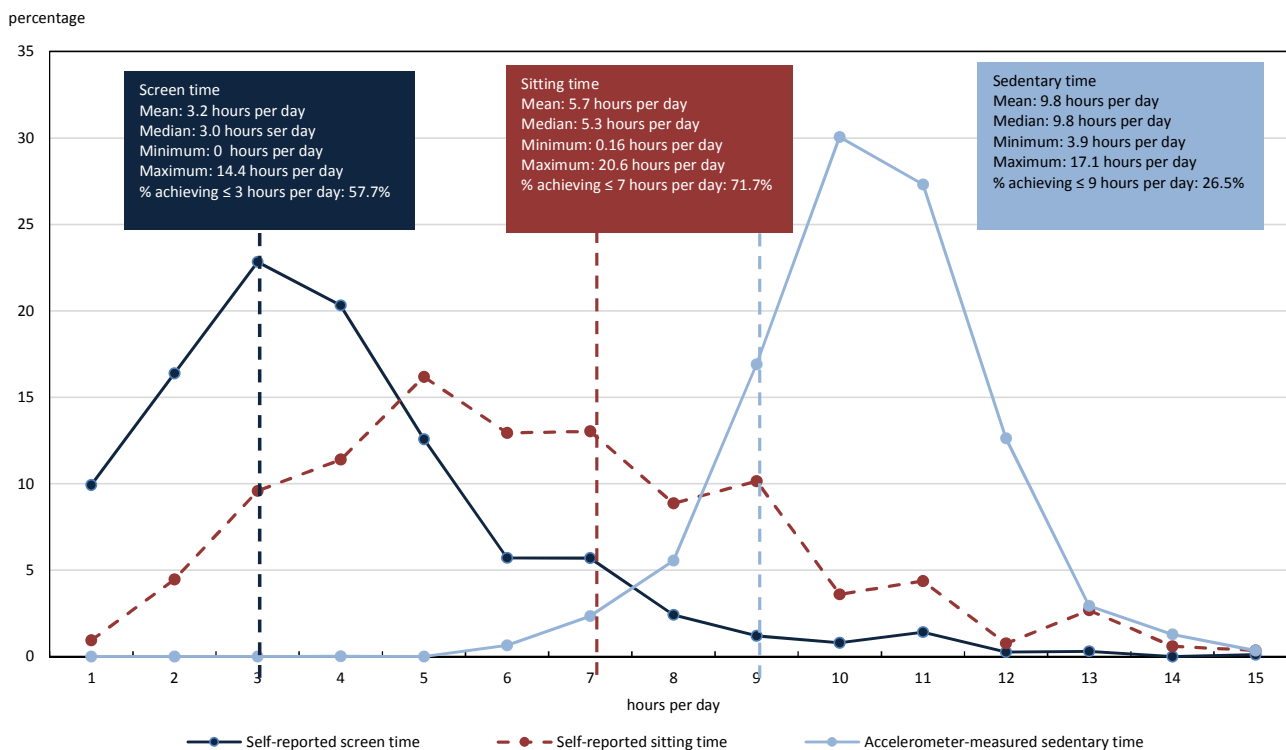
Screen time was also higher among those who were single, divorced or widowed (3.7 hours per day) compared with those who were married or common law (3.0 hours per day). Sitting time was lower in the two lower education groups (5.5 hours and 5.4 hours per day) compared with those in the highest education group (6.2 hours per day). Accelerometer-measured sedentary time was lower among those who met the physical activity threshold (9.5 hours per day) compared with those who did not (10.0 hours per day).

Adherence to the various thresholds varied, with 57.7% meeting the screen time threshold, 71.7% meeting the sitting time threshold and 26.5% meeting the sedentary time threshold (Table 2). Adults aged 35 to 49 years (65.8%) were more likely to meet the screen time threshold, compared with adults aged 18 to 34 years (55.2%). Females aged 65 to 79 years (78.3%) were more likely to meet the sitting time threshold when compared with males of the same age (66.5%). The percentage of adults aged 65 to 79 years (15.8%) meeting the sedentary time threshold was lower than that of adults aged 18 to 34 years (32.3%). Applying an eight-hour threshold to both self-reported sitting time and accelerometer-measured sedentary time (per the 24-Hour Guidelines)<sup>12</sup> resulted in a widening of the gap between the percentages adhering to the sitting time threshold (eight hours or less per day: 80.6%; 95% CI: 76.0 to 84.5) and the sedentary time threshold (eight hours or less per day: 8.6%; 95% CI: 7.1 to 10.5).

Figure 1 includes the weighted distributions of self-reported screen time and sitting time, as well as accelerometer-measured sedentary time. The means, medians, range and thresholds are noted for each. The self-reported sitting and screen time are slightly positively skewed (mean > median), while the distribution of accelerometer-measured sedentary time is symmetrical. Figure 2 shows the overlap in the weighted percentage of respondents who meet the individual thresholds and various combinations of the screen, sitting and sedentary time thresholds; 13.7% of adults met all three thresholds, while 12.3% met none. More overlap was evident between the screen and sitting time thresholds (46.1%), largely because of the relatively lower percentage meeting the sedentary time threshold. No significant differences were noted when the overlap in meeting the various thresholds was examined separately by sex and age group (data not shown).

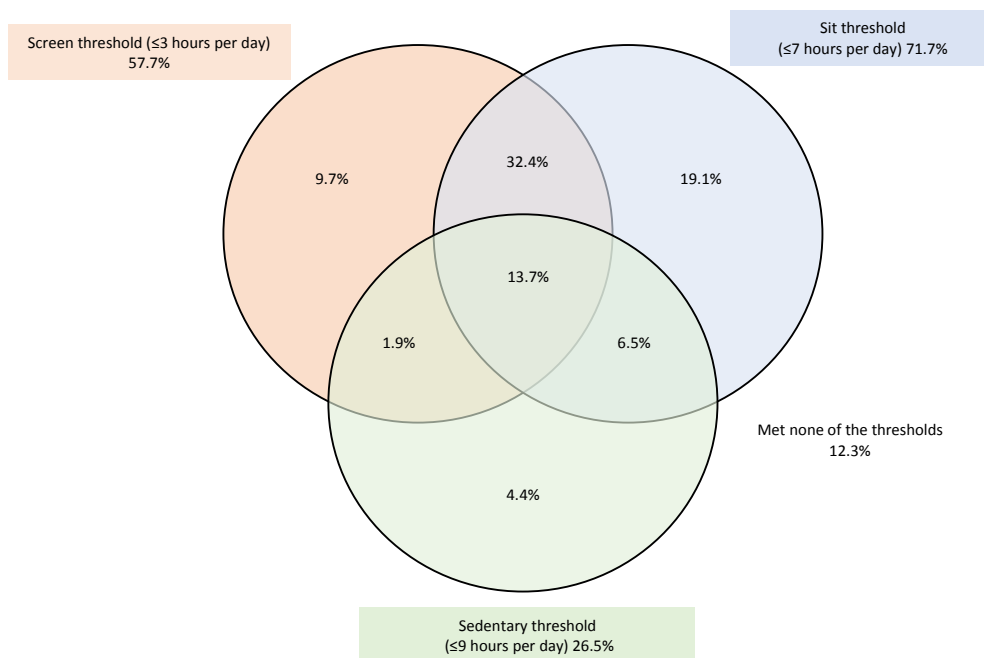
The correlations between the various sedentary behaviour concepts (i.e., screen time, sitting time and sedentary time) are shown in Table 3. Self-reported screen time and sitting time were the concepts most correlated ( $R = 0.37$ ,  $p < 0.001$ ). Correlations between either self-reported screen or sitting time and accelerometer-measured sedentary time were weak overall and across sexes and age groups. An examination of the correlation between self-reported sitting time and accelerometer-measured sedentary time for weekdays and weekends separately indicated that the correlation was higher

**Figure 1**  
Weighted distributions of screen, sitting and sedentary time in hours per day



**Note:** The dotted lines represent the sedentary behaviour thresholds for screen (3 hours per day), sitting (7 hours per day) and total sedentary time (9 hours per day).  
**Source:** Canadian Health Measures Survey, 2012-2013.

**Figure 2**  
Venn diagram depicting the weighted percentages of Canadian adults meeting individual thresholds and various combinations of the three sedentary behaviour thresholds



Source: Canadian Health Measures Survey, 2012-2013.

on weekdays ( $R = 0.19$ ,  $p < 0.001$ ) compared with weekend days ( $R = 0.10$ ,  $p < 0.001$ ) (data not shown).

Figure 3 provides a Bland–Altman plot for self-reported sitting and accelerometer-measured sedentary time. The mean bias between accelerometer-measured sedentary time and self-reported sitting time was 4.0 hours per day (95% CI: -1.6 to 9.6). The majority of respondents reported less sitting time compared with what was captured as sedentary time on the accelerometer (evidenced by the relatively larger number of data points greater than zero in Figure 3). Results of the linear regression analyses revealed significant negative bias between self-reported sitting and accelerometer-measured sedentary time. At lower levels of sedentary behaviour, respondents reported less sitting time than was captured by the accelerometer (i.e., as the mean of the methods moves towards the left side of the graph). Conversely, respondents reported more sitting time than was captured on the accelerometer at higher levels of sedentary behaviour (i.e., as the mean of the methods moves towards the right side of the graph).

Figure 4 compares the weighted percentage of adults meeting the individual sedentary thresholds, as well as all three sedentary thresholds, by adherence to the physical activity recommendation. Also noted in Table 2, adults who met the sedentary time threshold were more likely to meet the physical activity recommendation than those who did not. Similarly, adults who met all three sedentary thresholds were more likely to also meet the physical activity recommendation compared with those who did not.

## Discussion

The results of this study confirm that accelerometer-measured and self-reported sedentary behaviours are poorly correlated and quantitatively different. There was poor agreement in adherence estimates when a single sedentary behaviour threshold was applied (i.e., eight hours per day) and it was not appreciably improved when method-specific thresholds were applied (i.e., seven hours per day for self-reported sitting and nine hours per day for accelerometer-measured sedentary time). The discrepancies observed in the percentage of respondents meeting each of the proposed thresholds create a surveillance challenge. The overarching conclusion of the present study is that self-reported sitting time and accelerometer-measured total sedentary time cannot be used interchangeably. To assess adherence to the sedentary behaviour recommendation of eight hours or less per day within the new Canadian 24-Hour Movement Guidelines for Adults aged 18-64 years and Adults aged 65 years and older, using thresholds specifically aligned with the evidence for each measurement modality (i.e., seven hours or less per day of self-reported sitting and nine hours or less per day of accelerometer-measured sedentary time) is a step in the right direction. However, a rapidly evolving evidence base on what these thresholds should be creates an ongoing surveillance challenge. Variation in questionnaire design, analytical procedures (e.g., epoch length, non-wear time classification) and characteristics of accelerometer data (e.g.,

**Table 3**  
Pearson correlations between screen time, sitting time and accelerometer-measured sedentary time

Age group	Correlations		
	All	Males	Females
<b>All</b>			
Screen-sitting	0.37 <sup>††</sup>	0.39 <sup>††</sup>	0.34 <sup>††</sup>
Screen-sedentary	0.04 <sup>†</sup>	0.03	0.07 <sup>†</sup>
Sitting-sedentary	0.13 <sup>††</sup>	0.15 <sup>††</sup>	0.11 <sup>††</sup>
<b>18 to 34 years</b>			
Screen-sitting	0.35 <sup>††</sup>	0.36 <sup>††</sup>	0.34 <sup>††</sup>
Screen-sedentary	-0.04	-0.10	0.06
Sitting-sedentary	0.17 <sup>††</sup>	0.16 <sup>†</sup>	0.17 <sup>†</sup>
<b>35 to 49 years</b>			
Screen-sitting	0.28 <sup>††</sup>	0.33 <sup>††</sup>	0.23 <sup>††</sup>
Screen-sedentary	0.05	0.02	0.14 <sup>†</sup>
Sitting-sedentary	0.10 <sup>†</sup>	0.05	0.17 <sup>††</sup>
<b>50 to 64 years</b>			
Screen-sitting	0.43 <sup>††</sup>	0.47 <sup>††</sup>	0.38 <sup>††</sup>
Screen-sedentary	0.05	0.06	0.05
Sitting-sedentary	0.18 <sup>††</sup>	0.22 <sup>††</sup>	0.13 <sup>†</sup>
<b>65 to 79 years</b>			
Screen-sitting	0.45 <sup>††</sup>	0.39 <sup>††</sup>	0.52 <sup>††</sup>
Screen-sedentary	0.16 <sup>††</sup>	0.26 <sup>††</sup>	0.04
Sitting-sedentary	0.02	0.11	0.10

<sup>†</sup> significant correlation (p < 0.05)

<sup>††</sup> significant correlation (p < 0.001)

Source: Canadian Health Measures Survey, 2012-2013.

device location, model, inclusion of inclinometer) further compounds the situation.

Adding to the conceptual and measurement challenges related to sedentary behaviour is a lack of consensus on how best to approach guideline development. The thresholds denoting the inflection point of sedentary time and health risk proposed in the literature vary widely.<sup>4,5,13,14,24,33</sup> Furthermore, it is unclear whether consideration should be given to the health outcomes used in these studies. For example, is the sedentary time inflection point the same for mortality, cardiovascular disease and mental health? The WHO and the U.S. Department of Health and Human Services opted not to set specific sedentary time thresholds until further evidence was available,<sup>18,19,34</sup> and the background work supporting the Canadian recommendation noted the quality of the evidence base to inform the eight-hour threshold was very low.<sup>12</sup> However, it is worth noting that other components of the Canadian 24-Hour Movement Guidelines for Adults aged 18-64 years and Adults aged 65 years and older (resistance training and sleep consistency) were also based on a very low quality of evidence,<sup>12</sup> and some have argued for the inclusion of specific recommendations even when data are lacking.<sup>35,36</sup> Despite the decision to propose a total daily sedentary time threshold of eight hours or less per day within the Canadian 24-Hour Movement Guidelines for Adults aged 18-64 years and Adults aged 65 years and older, clarity is needed on how to operationalize it in surveillance and research.

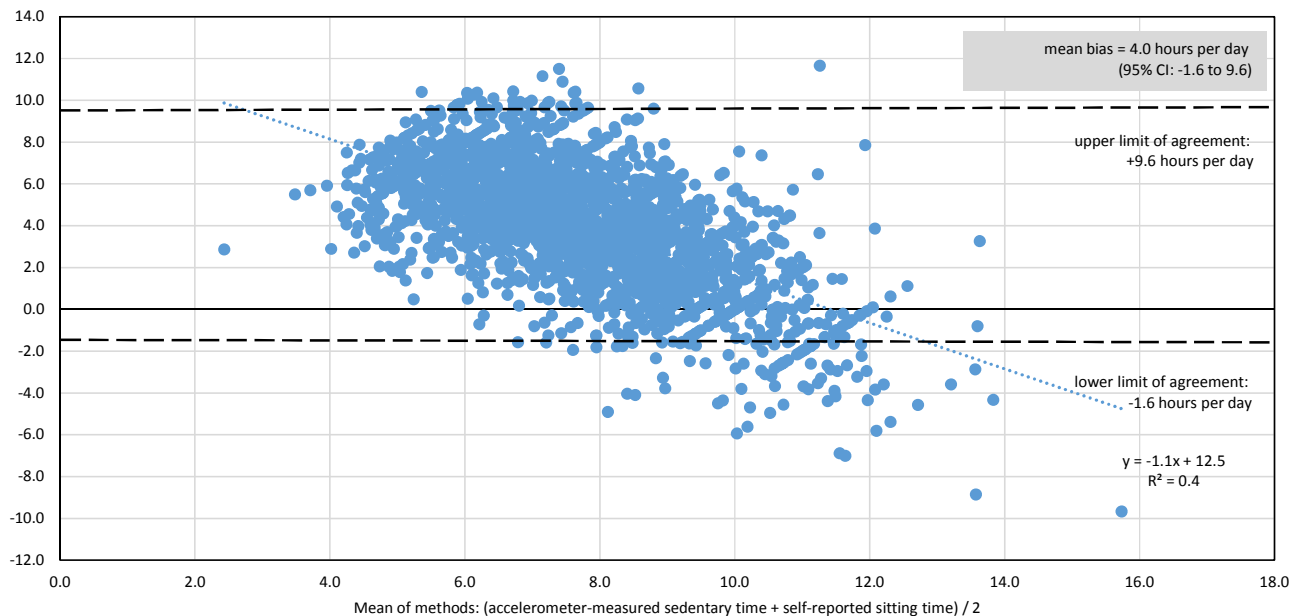
A single question about sitting time does not capture the full spectrum of sedentary behaviours throughout the day. An accelerometer captures all idle movement throughout day while standing or sitting, a breadth of time that would be near impossible for a person to recall using a single question about

total daily sitting. Other reasons for the discrepancy observed between self-reported sitting and accelerometer-measured sedentary time may include differences in the recall period (e.g., reporting “on average” over the past seven days versus actual measurement of the previous seven days via accelerometer), social desirability bias leading respondents to under-report certain activities (e.g., screen usage)<sup>37</sup>, and the inability of accelerometers to distinguish between stationary standing and sitting (thus capturing both as “sedentary time”). In comparison with inclinometers, hip-worn accelerometers have been reported to overestimate sedentary time,<sup>39-42</sup> and this is likely attributable to the misclassification of time spent standing given that accelerometers cannot distinguish between stationary sitting and standing the way that inclinometers can. On average, in the present study, accelerometers captured four more hours of sedentary time relative to what was captured in a single question focused on sitting time. According to a recent systematic review and meta-analysis, self-reported measures of sedentary time were, on average, 1.74 hours per day lower than when assessed via a device.<sup>9</sup> The Latin American Study of Nutrition and Health presented similar estimates to the present study across self-reported sitting time (3.7 hours per day), the sum of multiple self-reported sedentary activities (6.0 hours per day) and Actigraph-measured sedentary time (9.5 hours per day).<sup>38</sup> The present study is an important addition to the systematic review given that it compares the thresholds proposed for measuring adherence to the new sedentary behaviour recommendations among Canadian adults in a nationally representative sample.

While device-based measures provide an overall estimate of total sedentary time, the contextual information obtained through self-report is invaluable to understanding this

**Figure 3**  
**Bland–Altman plot of bias between accelerometer-measured sedentary time and self-reported sitting time**

Difference between methods:  
 accelerometer-measured sedentary  
 time minus self-reported sitting time



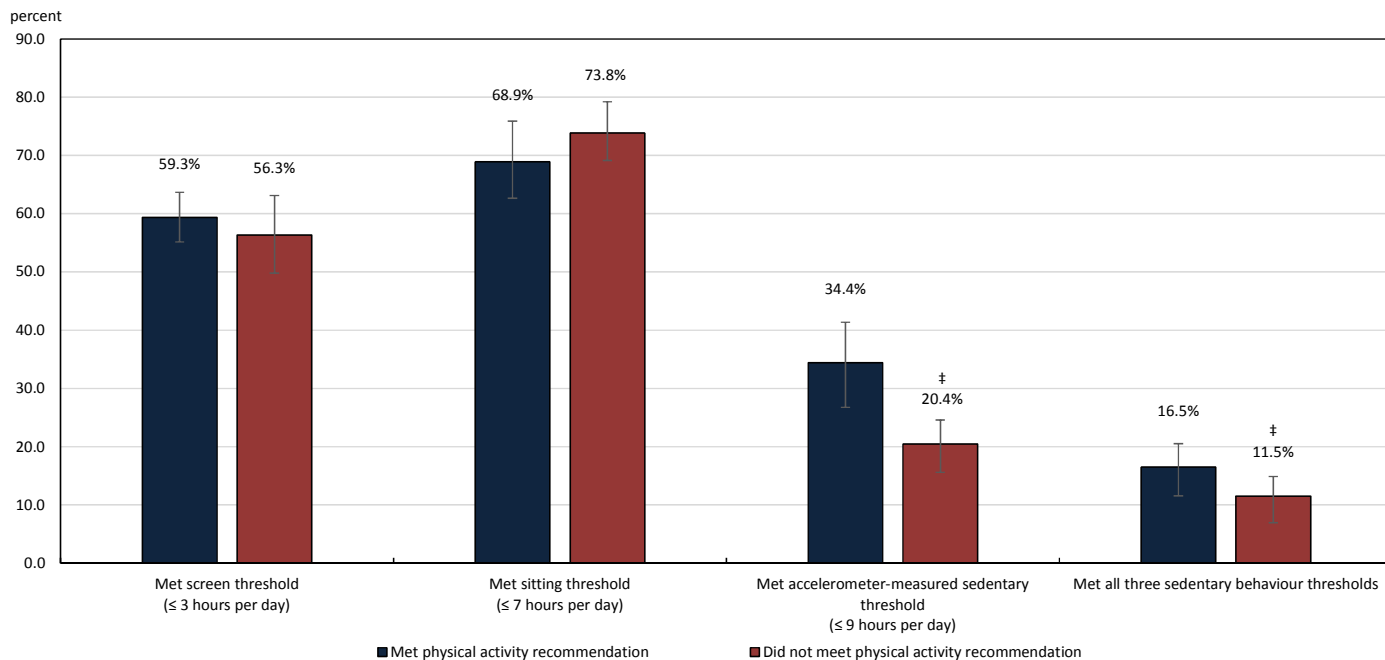
**Note:** CI = confidence interval.  
**Source:** Canadian Health Measures Survey, 2012–2013.

behaviour and identifying targets for policy and intervention. Furthermore, the magnitude of association seems to vary between measured and self-reported data, and the associations may be type-specific (i.e., there may be certain health outcomes associated with screen time in particular).<sup>9,13,15,43</sup> Researchers have suggested engaging directly with settings where actionable changes could be made (e.g., workplaces and schools) to design optimal surveillance questions.<sup>44</sup> The present study and others<sup>16</sup> have reported better agreement between measures on weekdays compared with weekends, suggesting that the higher structure of weekdays may help recall. In the present analysis, one could sum together sitting time (5.7 hours per day), screen time (3.2 hours per day) and passive travel time (0.7 [95% CI: 0.6 to 0.8] hours per day [data not shown]) to get a value (9.6 hours per day) closer to accelerometer-measured sedentary time (9.8 hours per day). The problem with this approach is that the wording of the sitting question captures screen time within it. There is no instruction to respondents to exclude (or include) screen time from their total sitting time estimation, thus imposing a risk of double-counting. Questionnaire designers are faced with a decision to rely on a single global sitting question or take a multi-item approach in hopes that the sum of the parts will be easier for respondent recall and result in more accurate estimates of total sedentary time. Including multiple specific examples of sitting behaviours in questionnaires has been suggested by others, particularly for older adults for whom sitting is interspersed throughout the day and therefore difficult to recall.<sup>16,45,46</sup> A compromise may exist somewhere in the

middle with a multi-item questionnaire focused only on targeted and common sedentary behaviours such as workplace sitting, passive commuting and screen usage.<sup>47</sup> Alternative approaches to capturing self-reported information have been developed, including past-day and past-year recall.<sup>48-51</sup> These methods show stronger alignment with Actigraph-measured sedentary time compared with traditional questionnaire approaches, and they offer the ability to capture important contextual information about how and when sedentary time is accumulated.<sup>51</sup>

It should also be noted that the issues highlighted in this study related to self-reported and device-measured sedentary behaviour are similar to those observed for physical activity,<sup>49</sup> such that data users and policy makers exercise caution when comparing results from self-reported and device-based measures. The present study observed a negative bias in how sedentary behaviour was reported relative to what was captured on an accelerometer (Figure 3). This is consistent with the findings of a similar Bland–Altman analysis in older adults<sup>16</sup> and the meta-analysis of Prince and colleagues,<sup>9</sup> which observed that half of the included studies in their systematic review found an over-reporting and the other half found an under-reporting. Reconciling self-reported and device-measured sedentary behaviour and physical activity is challenging, because the biases between methods are not systematic in a way that allows for correction factors to be applied.<sup>9,52</sup> The difference with physical activity (especially at

**Figure 4**  
**Weighted percentage of Canadian adults meeting screen, sitting and sedentary thresholds according to whether they also met the physical activity recommendation**



‡ significantly different from respondents who met the physical activity recommendation

Source: Canadian Health Measures Survey, 2012-2013.

higher intensities) is that it is often purposeful and time limited, particularly if respondents regularly engage in dedicated bouts of moderate-to-vigorous intensity physical activity such as sports or gym workouts.<sup>52</sup> In general, higher intensity movement (i.e., moderate or vigorous intensity) is easier for respondents to recall than light-intensity physical activity, which suffers from the same challenge as sedentary behaviour by being interspersed across the day in short, and perhaps less memorable, bouts.

### Strengths and limitations

The present study used data from a large sample that is representative of the Canadian population living in the 10 provinces. Cycle 3 data of the CHMS were collected over 10 years before the present analysis, but offer the only nationally representative data source with all of the required measures of sedentary behaviour. It should be noted that the estimates of how many Canadian adults are meeting the recommendations are outdated and likely very different today given the rapidly evolving landscape of screen behaviours, coupled with the impact of the COVID-19 pandemic.<sup>53</sup> At the time of writing, efforts are underway at Statistics Canada to further refine and redesign the questionnaire content related to sedentary behaviour to align with a shift towards monitoring the full 24-hour period<sup>7</sup> and to help respondents recall this behaviour. Future methodological studies will be important as questionnaire content evolves and device-based measures become more sophisticated.

### Conclusions

The present study confirms that sedentary behaviour is challenging to measure and estimates from self-report and device-based methods are not interchangeable. The percentage of Canadian adults meeting the three thresholds examined in this study varied widely. There is a growing body of literature suggesting possible thresholds for screen time, sitting time and total daily sedentary time,<sup>4,5,13,14,33</sup> but how much sedentary time is too much remains a contentious issue.<sup>21,22,35,36</sup> Further understanding of what each of the sedentary behaviour thresholds captures in terms of health risk will be important. In addition, the findings of the present analysis indicate that differences in sedentary behaviour exist by age group, sex and sociodemographic factors. These differences will have to be considered when developing population-level thresholds. The understandable wish to have simple (and singular) sedentary behaviour thresholds will have to be balanced with an acknowledgement that these thresholds must be specific for the measurement modality, with careful attention given to how questions are asked and how device-measured data are analyzed. In the context of establishing surveillance measurement standards for the new Canadian 24-Hour Movement Guidelines for Adults aged 18-64 years and Adults aged 65 years and older, the results of this study support the need for more clarity on thresholds for the various constructs that fall under the sedentary behaviour umbrella. They also suggest that we should not rely on a single threshold.

**Appendix: Sitting and screen time questions from cycle 3 of the Canadian Health Measures Survey****Sitting Time:**

This question is about the time that you spent sitting during the last 7 days. Include time at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. Do not include any time spent sitting in a motor vehicle that you have already told me about.

During the last 7 days, how much time did you usually spend sitting on a weekday?

During the last 7 days, how much time did you usually spend sitting on a weekend day?

**Notes:** Include time spent lying down while awake (e.g., reading, watching TV, insomnia). Do not include time spent lying down sleeping.

Enter number of hours: (min=0, max=24)

Enter number of minutes (min=0, max=960)

**Screen Time:**

In a typical week in the past 3 months, how much time did you usually spend on a computer, including watching videos, playing computer games, emailing or using the Internet? Include Internet use on other devices and time spent doing homework on a computer. Do not include time spent on a computer at work or at school.

Enter time to nearest half hour: (min=0, max=96)

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