

Health Reports

Accelerometer-measured moderate-to-vigorous physical activity of Canadian adults, 2007 to 2017

by Janine Clarke, Rachel Colley, Ian Janssen and Mark S. Tremblay

Release date: August 21, 2019



Statistics
Canada

Statistique
Canada

Canada

How to obtain more information

For information about this product or the wide range of services and data available from Statistics Canada, visit our website, www.statcan.gc.ca.

You can also contact us by

email at STATCAN.infostats-infostats.STATCAN@canada.ca

telephone, from Monday to Friday, 8:30 a.m. to 4:30 p.m., at the following numbers:

- | | |
|---|----------------|
| • Statistical Information Service | 1-800-263-1136 |
| • National telecommunications device for the hearing impaired | 1-800-363-7629 |
| • Fax line | 1-514-283-9350 |

Depository Services Program

- | | |
|------------------|----------------|
| • Inquiries line | 1-800-635-7943 |
| • Fax line | 1-800-565-7757 |

Standards of service to the public

Statistics Canada is committed to serving its clients in a prompt, reliable and courteous manner. To this end, Statistics Canada has developed standards of service that its employees observe. To obtain a copy of these service standards, please contact Statistics Canada toll-free at 1-800-263-1136. The service standards are also published on www.statcan.gc.ca under “Contact us” > [“Standards of service to the public.”](#)

Note of appreciation

Canada owes the success of its statistical system to a long-standing partnership between Statistics Canada, the citizens of Canada, its businesses, governments and other institutions. Accurate and timely statistical information could not be produced without their continued co-operation and goodwill.

Published by authority of the Minister responsible for Statistics Canada

© Her Majesty the Queen in Right of Canada as represented by the Minister of Industry, 2019

All rights reserved. Use of this publication is governed by the Statistics Canada [Open Licence Agreement](#).

An [HTML version](#) is also available.

Cette publication est aussi disponible en français.

Accelerometer-measured moderate-to-vigorous physical activity of Canadian adults, 2007 to 2017

by Janine Clarke, Rachel Colley, Ian Janssen and Mark S. Tremblay

Abstract

Background: Surveillance of physical activity among Canadian adults has typically relied on questionnaire-based data, which have many limitations. The Canadian Health Measures Survey (CHMS) has been collecting objective, accelerometer-based physical activity data on a nationally representative sample of Canadian adults since 2007.

Methods: Data are from Cycle 1 (2007 to 2009), Cycle 2 (2009 to 2011), Cycle 3 (2012 to 2013), Cycle 4 (2014 to 2015) and Cycle 5 (2016 to 2017) of the CHMS. The study sample included adults aged 18 to 79 years (Cycle 1: n = 2,952; Cycle 2: n = 2,959; Cycle 3: n = 2,517; Cycle 4: n = 2,390; Cycle 5: n = 2,355). Average daily minutes of moderate physical activity (MPA), vigorous physical activity (VPA) and moderate-to-vigorous physical activity (MVPA_{ALL}) were derived from minute-by-minute accelerometer data captured over seven consecutive days. MVPA accumulated in bouts of at least 10 minutes (MVPA_{BOUTS}) were also calculated, and adherence to the Canadian Physical Activity Guidelines was assessed.

Results: No significant linear trend was observed in accelerometer-measured MVPA from 2007 to 2017. According to the most recent cycle of CHMS data (2016 and 2017), Canadian adults accumulated an average of 26 minutes of MVPA_{ALL} per day, less than half of which (12 minutes per day, on average) was accumulated in bouts of at least 10 minutes. Average daily VPA was less than five minutes. About 3% of Canadian adults accumulated no MVPA at all, while approximately 36% did not accumulate any MVPA in bouts of at least 10 minutes; 16% of Canadian adults met the current physical activity guidelines of 150 minutes of MVPA per week in bouts of at least 10 minutes.

Interpretation: These results may be important to governments and other organizations for initiatives geared toward increasing physical activity levels in Canadian adults.

Keywords: physical activity; accelerometry; guidelines; surveillance

DOI: <https://www.doi.org/10.25318/82-003-x201900800001-eng>

Physical inactivity is associated with an increased risk of several chronic diseases and premature mortality.^{1,2} It is estimated that physical inactivity is responsible for 3.7% of total direct and indirect health care costs in Canada (\$6.8 billion/year).³ The current Canadian Physical Activity Guidelines recommend that adults accumulate at least 150 minutes of moderate-to-vigorous physical activity (MVPA) per week in bouts of at least 10 minutes, in addition to engaging in muscle and bone strengthening activities at least twice a week.^{4,6} Before accelerometers were adopted for use in the Canadian Health Measures Survey (CHMS) in 2007, physical activity prevalence and trend data in Canada were assessed using self-reported and pedometer-measured data only.

From 2007 to 2009, the first nationally representative accelerometer-measured physical activity data were collected as part of the CHMS. Results showed that 15% of adults were getting enough MVPA to meet physical activity guidelines.⁷ This was significantly lower than previous national estimates based on self-reported data, which indicated that nearly two-thirds of Canadian adults were meeting physical activity guidelines in 2007.⁸ That same study reported that physical activity in Canada had increased between 1994 and 2007.⁸ An increase in physical activity in Canadian adults between 2003 and 2013 was also reported by the Canadian Fitness and Lifestyle Research Institute,⁹ although a more recent report suggests that physical

activity levels have stabilized in recent years.¹⁰ Now that additional cycles of CHMS data (2009 to 2017) are available, it is possible to examine whether the trend over time using accelerometer-measured data provides clarity on the inconsistent trends observed using self-reported data.

Canadian guidelines recommend that Canadians accumulate MVPA in bouts of at least 10 minutes.^{5,6} The stipulation for 10-minute bouts was added to the most recent guidelines because there was insufficient evidence to indicate substantial health benefits from physical activity accumulated in periods < 10 minutes.^{2,4} More recent evidence suggests that MVPA does not need to be accumulated in 10-minute bouts and that sporadic physical activity (i.e., accumulated in bouts of less than 10 minutes) is also associated with health benefits.¹¹⁻¹⁴ This type of sporadic or incidental activity is difficult to capture through questionnaires and represents one of the key advantages of accelerometry.^{4,15} The minute-by-minute resolution of the CHMS accelerometer data allows for the quantification of MVPA accumulated in bouts of any duration.

The purpose of this paper is to present an overview of the accelerometer-measured MVPA levels of Canadian adults by age and sex, and adherence to physical activity guidelines from 2007 through 2017. A secondary purpose is to examine how the 10-minute bout stipulation affects levels of MVPA and adherence to the current physical activity guidelines.

Authors: Janine Clarke (janine.clarke@canada.ca) is with the Centre for Population Health Data and Rachel Colley is with the Health Analysis Division at Statistics Canada, Ottawa, Ontario. Ian Janssen is with the School of Kinesiology and Health Studies and the Department of Public Health Sciences at Queen's University in Kingston, Ontario. Mark S. Tremblay is with the Healthy Active Living and Obesity Research Group at the Children's Hospital of Eastern Ontario Research Institute in Ottawa.

Methods

Data source

Data are from the CHMS, a nationally representative repeated cross-sectional survey at Statistics Canada that collects self-reported and directly measured health information from the Canadian population aged 3 to 79 living in private dwellings. Approximately 96% of the Canadian population is represented in each cycle. Residents of Aboriginal reserves or Crown lands, institutions and certain remote regions, as well as full-time members of the Canadian Forces, are excluded. Data were collected from March 2007 to February 2009 (Cycle 1), August 2009 to November 2011 (Cycle 2), January 2012 to December 2013 (Cycle 3), January 2014 to December 2015 (Cycle 4) and January 2016 to December 2017 (Cycle 5). Data collection in each cycle occurred in two parts. First, a questionnaire on sociodemographic characteristics and health behaviours was administered at the respondent's home. This was followed by an appointment at a mobile examination centre, where a series of physical measurements (e.g., height, weight, blood pressure) were administered and the accelerometers were provided to participants. Ethics approval for the CHMS was obtained from Health Canada's Research Ethics Board.¹⁶⁻²¹ More information about the CHMS is available elsewhere.¹⁷⁻²²

The study sample included respondents aged 18 to 79 from all survey cycles with valid accelerometer data (Cycle 1: $n = 2,952$; Cycle 2: $n = 2,959$; Cycle 3: $n = 2,517$; Cycle 4: $n = 2,390$; Cycle 5: $n = 2,355$).

Measurement of physical activity

All ambulatory respondents were provided with an Actical accelerometer (Philips Respironics, Oregon, United States) to wear on an elasticized belt over the right hip during their waking hours for seven consecutive days. The Actical accelerometer measures acceleration of movement in all directions. Movement was captured and recorded as a digitized value that was summed over

one-minute intervals, resulting in 10,080 measures (activity counts per minute [cpm]) per person across seven days. Published guidelines were followed to identify and remove invalid data during accelerometer data reduction.²³ Total daily accelerometer wear time was determined by identifying non-wear time and subtracting it from 24 hours. Non-wear time was defined as periods of at least 60 consecutive minutes of zero counts, with an allowance for one or two minutes of counts between 0 and 100 cpm.²³ A valid day was defined as having at least 10 hours of wear time, and only participants with at least four valid days of data were included in this analysis.²³

Total measured time on each valid day (bouts + sporadic) spent in moderate physical activity (MPA_{ALL}), vigorous physical activity (VPA_{ALL}) and moderate-to-vigorous physical activity ($MVPA_{ALL}$) was determined based on the following intensity cut points: moderate (1,535 to 3,961 cpm) and vigorous ($\geq 3,962$ cpm).^{24,25} The daily average times spent in MPA , VPA and $MVPA_{ALL}$ were calculated as the total number of minutes for all valid days, divided by the number of valid days. For $MVPA$, this was also calculated for minutes accumulated in bouts of at least 10 minutes ($MVPA_{BOUITS}$), where a bout was defined analytically as a period of at least 10 consecutive minutes above the moderate intensity cut point. To count as a 10-minute bout, 80% of the minutes within a 10-minute block (i.e., 8 out of 10 minutes) had to be above the moderate intensity cut point.²⁶ This is consistent with previous accelerometer analyses of the CHMS and other datasets.^{7,11-13,26}

Adherence to the Canadian Physical Activity Guidelines was assessed based on respondents with a weekly sum of at least 150 minutes of $MVPA$ accumulated in bouts of at least 10 minutes ($MVPA_{BOUITS}$).^{4,6} If respondents had fewer than seven valid days of accelerometer data, then their average daily $MVPA_{BOUITS}$ was multiplied by seven to obtain a weekly sum. The same approach was taken to assess the proportion of adults with a weekly sum of at least 150 minutes of $MVPA_{ALL}$.

Statistical analysis

Descriptive statistics were used to calculate means or proportions and 95% confidence intervals overall and by age group and sex. Pairwise contrasts were used to compare results by age group and sex. Significance was set at $p < 0.05$.

A trend analysis was performed on average daily minutes of $MVPA_{ALL}$, allowing for linear, square and cubic effects of time (survey cycle). Linear regression analysis was performed on average daily minutes of $MVPA_{ALL}$, controlling for several covariates, including age, sex, body mass index, quintiles of household income adjusted for household size, highest level of education in the household (postsecondary graduate: yes/no), season of data collection, and time (survey cycle).

Activity monitor subsample weights for each individual cycle were used for analyses to present individual cycle estimates.¹⁷⁻²¹ The activity monitor subsample data from CHMS cycles 1 to 4 were also stacked and weighted using combined activity monitor subsample weights generated by Statistics Canada to present combined cycle estimates.²⁷ Detailed information on creating the activity monitor subsample and associated survey weights is available elsewhere. Briefly, the subsample included only respondents with a sufficient amount of data over the seven days. In adults, this included those who wore the accelerometer for a minimum of 10 hours on at least four days.^{16-21,23} Approximately 40% of CHMS respondents in each cycle had sufficient accelerometer data to be included in the analysis.²¹

All analyses were completed using SAS 9.3 (SAS Institute, North Carolina, United States) and SUDAAN 11.0, using the appropriate number of degrees of freedom for combined²⁷ or individual cycle analysis.¹⁶⁻²¹ Survey and bootstrap weights were used in the variance estimations and in the confidence interval calculations to account for survey design and to adjust for non-response.

Results

From 2016 to 2017, Canadian adults accumulated an average of 26 minutes of MVPA_{ALL} per day (Table 1, Figure 1). Less than half of the daily MVPA_{ALL} accumulated was performed in bouts of at least 10 minutes (MVPA_{BOUTS}: 12 minutes per day, on average) (Figure 1). Average daily VPA was less than

five minutes, which indicates that the majority of MVPA accumulated was at a moderate intensity (Figure 2). About 3% of Canadian adults accumulated no MVPA at all, while nearly 36% did not accumulate any MVPA in bouts of at least 10 minutes (Figure 3).

MVPA_{ALL} was higher among men compared with women, and among

younger adults compared with older adults. Average daily MVPA_{BOUTS} was not significantly different by age group or sex ($p > 0.05$). VPA_{ALL} was slightly higher among younger adults (four minutes) compared with older adults (two minutes), and among men (four minutes) compared with women (two minutes).

Table 1

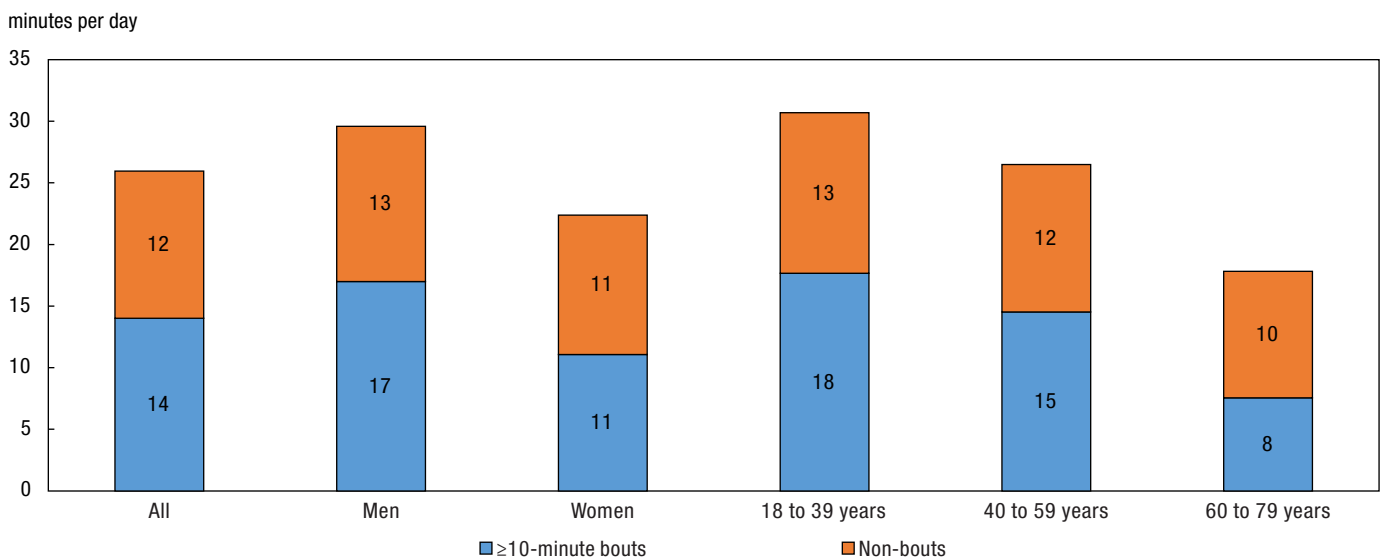
Average minutes per day of moderate-to-vigorous physical activity (MVPA_{ALL}), by Canadian Health Measures Survey cycle, sex and age group, household population aged 18 to 79 years, Canada, 2007 to 2017

	2007 to 2009			2009 to 2011			2012 to 2013			2014 to 2015			2016 to 2017		
	Cycle 1 (n = 2,952)			Cycle 2 (n = 2,959)			Cycle 3 (n = 2,517)			Cycle 4 (n = 2,390)			Cycle 5 (n = 2,355)		
	Average minutes per day	95% confidence interval		Average minutes per day	95% confidence interval		Average minutes per day	95% confidence interval		Average minutes per day	95% confidence interval		Average minutes per day	95% confidence interval	
	from	to	from	to	from	to	from	to	from	to	from	to	from	to	
Both sexes (18 to 79 years)	24	21	27	21	18	23	25	22	28	24	21	27	26	23	29
18 to 39	30	26	33	26	22	30	34	28	39	29	25	33	31	26	36
40 to 59	24	20	28	20	18	22	23	19	27	24	20	28	26	22	31
60 to 79	15	11	18	13	11	15	14	12	16	16	14	19	18	15	20
Men (18 to 79 years)	27	23	31	24	21	27	27	23	31	27	22	32	30	25	34
18 to 39	33	29	37	30	24	36	35	31	39	32	26	38	37	30	44
40 to 59	26	22	31	23	19	26	26	19	33	27	20	34	29	23	36
60 to 79	17	11	23	15	12	19	16	12	19	18	15	21	18	15	20
Women (18 to 79 years)	21	18	24	17	15	20	23	19	27	21	18	24	22	20	25
18 to 39	26	21	30	21	18	24	33	24	41	26	21	32	24	19	29
40 to 59	21	18	25	17	14	21	20	17	23	21	16	25	24	19	28
60 to 79	12	10	15	11	8	13	13	10	15	14	11	18	18	13	22

Source: Statistics Canada, Canadian Health Measures Survey, Cycle 1 (2007 to 2009), Cycle 2 (2009 to 2011), Cycle 3 (2012 to 2013), Cycle 4 (2014 to 2015) and Cycle 5 (2016 to 2017).

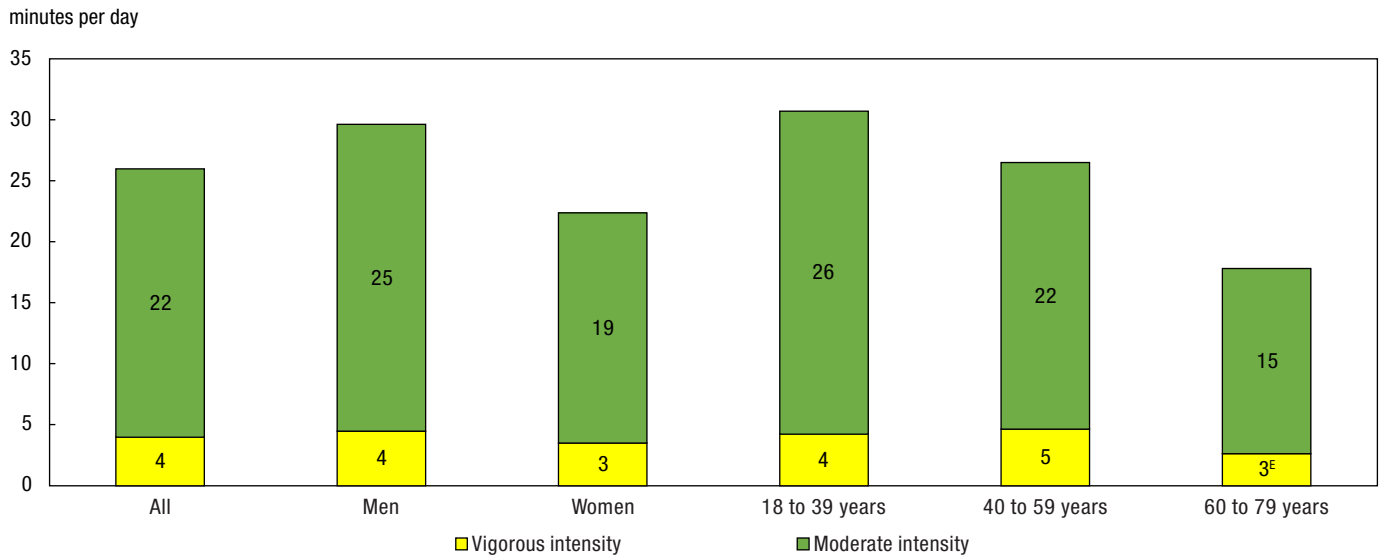
Figure 1

Average daily moderate-to-vigorous physical activity in bouts and non-bouts, by sex and age group, household population aged 18 to 79 years, Canada, 2016 to 2017



Source: Statistics Canada, Canadian Health Measures Survey, Cycle 5 (2016 to 2017).

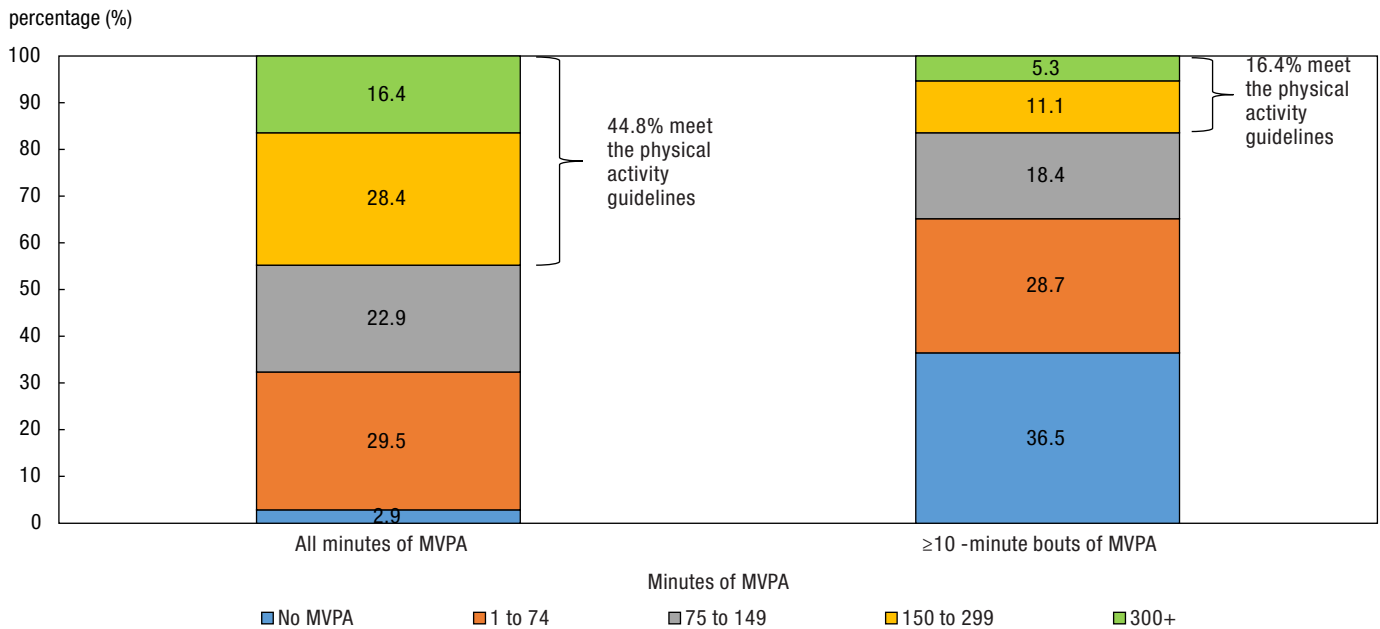
Figure 2
Average daily moderate and vigorous intensity physical activity (minutes), by sex and age group, household population aged 18 to 79 years, Canada, 2016 to 2017



^E use with caution

Source: Statistics Canada, Canadian Health Measures Survey, Cycle 5 (2016 to 2017).

Figure 3
Distribution of weekly moderate-to-vigorous physical activity (MVPA), all minutes compared with ≥ 10 -minute bouts, household population aged 18 to 79 years, Canada, combined 2016 to 2017



Source: Statistics Canada, Canadian Health Measures Survey, Cycle 5 (2016 to 2017).

Accelerometer-measured moderate-to-vigorous physical activity of Canadian adults, 2007 to 2017 • Research Article

In 2016 and 2017, 16% of Canadian adults met the Canadian Physical Activity Guidelines of 150 minutes of MVPA_{BOUTS} per week (Figure 3). Nearly triple the percentage of Canadian adults met the guideline when MVPA_{ALL} was used instead of MVPA_{BOUTS} (45% versus 16%).

Trends over time

No significant linear trend in average daily minutes of MVPA_{ALL} was evident across CHMS cycles (Table 1). The same trend was observed for MVPA_{BOUTS} (Table 2). Finally, the percentage of adults who meet the guidelines has not changed significantly since the first cycle (2007 to 2009) of the CHMS (Table 3).

In a linear regression model that controlled for season, age, sex, body mass index, household income and education, there was no significant effect of time (survey cycle) or season (data not shown).

Table 2
Average minutes per day of moderate-to-vigorous physical activity accumulated in ≥10-minute bouts (MVPA_{BOUTS}), by Canadian Health Measures Survey cycle, sex and age group, household population aged 18 to 79 years, Canada, 2007 to 2017

	2007 to 2009			2009 to 2011			2012 to 2013			2014 to 2015			2016 to 2017		
	Cycle 1 (n = 2,952)			Cycle 2 (n = 2,959)			Cycle 3 (n = 2,517)			Cycle 4 (n = 2,390)			Cycle 5 (n = 2,355)		
	Average minutes per day	95% confidence interval		Average minutes per day	95% confidence interval		Average minutes per day	95% confidence interval		Average minutes per day	95% confidence interval		Average minutes per day	95% confidence interval	
from		to	from		to	from		to	from		to	from		to	
Both sexes (18 to 79 years)	11	9	13	9	7	10	12	10	14	11	9	13	12	10	14
18 to 39	12	10	15	10	8	12	15	12	19	12	9	16	13	10	16
40 to 59	11	8	13	8	7	10	10	7	13	11	9	13	12	10	14
60 to 79	8	6	11	7	5	9	8	6	9	9	7	10	10	9	12
Men (18 to 79 years)	12	9	15	9	7	11	12	8	15	12	9	15	13	10	15
18 to 39	13	10	17	11	8	14	15	11	19	13 ^E	8	18	15	11	19
40 to 59	11 ^E	7	15	8	6	11	10 ^E	5	15	12	9	16	12	8	16
60 to 79	10 ^E	5	14	8	6	11	8	6	11	9	7	12	10	7	12
Women (18 to 79 years)	10	9	12	8	7	10	12	9	15	10	8	12	11	9	13
18 to 39	12	9	14	9	7	11	15	11	20	12	8	15	11 ^E	7	15
40 to 59	10	8	13	8	6	10	11	8	14	10	7	13	12	10	14
60 to 79	8	6	9	6	4	8	7	5	10	8	6	10	11	8	14

^E use with caution

Source: Statistics Canada, Canadian Health Measures Survey, Cycle 1 (2007 to 2009), Cycle 2 (2009 to 2011), Cycle 3 (2012 to 2013), Cycle 4 (2014 to 2015) and Cycle 5 (2016 to 2017).

Table 3
Percentage of adults meeting the Canadian Physical Activity Guidelines (≥150 minutes per week of MVPA_{BOUTS}), by Canadian Health Measures Survey cycle, sex and age group, household population aged 18 to 79 years, Canada, 2007 to 2017

	2007 to 2009			2009 to 2011			2012 to 2013			2014 to 2015			2016 to 2017		
	Cycle 1			Cycle 2			Cycle 3			Cycle 4			Cycle 5		
	%	95% confidence interval		%	95% confidence interval		%	95% confidence interval		%	95% confidence interval		%	95% confidence interval	
from		to	from		to	from		to	from		to	from		to	
Both sexes (18 to 79 years)	16.4	12.2	21.6	13.7	10.6	17.5	22.3	16.9	28.7	17.6	13.7	22.4	16.4	12.8	20.8
18 to 39	19.7	13.9	27.2	17.8	12.3	25.1	32.5	23.9	42.5	21.3 ^E	13.9	31.0	15.7 ^E	9.6	24.7
40 to 59	14.6	10.1	20.7	11.6	8.8	15.1	17.9 ^F	11.5	26.7	16.8	12.2	22.6	16.8	13.5	20.6
60 to 79	13.3	9.6	18.1	10.0 ^E	6.4	15.4	12.1	9.8	14.9	13.0	9.9	16.9	16.9	12.6	22.4
Men (18 to 79 years)	18.2	12.9	25.0	15.5	11.6	20.4	23.6 ^E	14.3	36.2	18.2 ^E	12.1	26.3	17.8	12.7	24.3
18 to 39	23.3 ^F	14.9	34.5	21.8 ^E	14.2	31.9	35.2 ^E	22.2	50.8	21.0 ^E	11.5	35.0	18.4 ^E	11.1	28.9
40 to 59	15.1 ^E	9.2	23.9	10.6	7.5	14.8	F*	18.4 ^E	9.9	31.8	17.0	11.9	23.6
60 to 79	14.0 ^E	9.2	20.7	12.8 ^E	8.0	19.9	13.0 ^E	8.6	19.1	13.1 ^E	8.7	19.2	18.1 ^E	11.0	28.4
Women (18 to 79 years)	14.5	11.2	18.7	11.8	8.8	15.6	21.0	16.1	26.9	17.1	12.9	22.3	15.0	10.8	20.5
18 to 39	16.0	10.9	22.9	13.7 ^E	9.0	20.3	29.7 ^E	19.9	41.8	21.6 ^E	12.9	33.8	F*
40 to 59	14.1	9.8	19.9	12.5 ^E	7.5	20.1	18.2 ^E	12.2	26.2	15.1	10.7	21.0	16.6	12.0	22.5
60 to 79	12.6	8.9	17.6	7.5 ^E	4.1	13.2	11.3 ^E	6.8	18.4	12.9	10.2	16.3	15.7	11.2	21.7

... not applicable

^E use with caution

F too unreliable to be published

* coefficient of variation >33.3%

MVPA_{BOUTS}: moderate-to-vigorous physical activity accumulated in bouts of at least 10 minutes

Source: Statistics Canada, Canadian Health Measures Survey, Cycle 1 (2007 to 2009), Cycle 2 (2009 to 2011), Cycle 3 (2012 to 2013), Cycle 4 (2014 to 2015) and Cycle 5 (2016 to 2017).

What is already known on this subject?

- Recent reports based on self-reported data suggested that nearly two-thirds of Canadian adults were meeting the Canadian Physical Activity Guidelines; by contrast, accelerometer-based data from 2007 to 2009 indicated that less than one-fifth of Canadian adults were meeting the guidelines.
- When based on self-reported data, assessments of trends in physical activity levels over time have been inconsistent; some have suggested that physical activity has increased, while others have suggested that it has remained stable in recent decades.
- Self-reported questionnaire data are limited since they do not typically capture information on physical activity accumulated in shorter periods (sporadic or incidental activity); recent evidence suggests that physical activity accumulated in shorter periods can have an equivalent health benefit to physical activity accumulated in longer periods (or bouts).
- The availability of several cycles of accelerometer-based data from the Canadian Health Measures Survey (2007 to 2017) provides an opportunity to assess recent physical activity trends and to evaluate physical activity accumulated in both shorter and longer bouts.

What does this study add?

- Physical activity in Canadian adults, as measured by an accelerometer, has remained low and stable between 2007 and 2017.
- Canadian adults accumulate the majority of their moderate-to-vigorous physical activity at a moderate intensity and in bouts of less than 10 minutes at a time.
- These results may be important to governments and other organizations for initiatives geared toward increasing physical activity levels in Canadian adults.

Discussion

This study provides an overview of MVPA among Canadian adults across five CHMS cycles spanning the years 2007 to 2017. There were no significant temporal trends observed over the five cycles. The most recent results (2016 and 2017) indicate that Canadian adults accumulated a daily average of 26 minutes of $MVPA_{ALL}$, less than half of which was accumulated in bouts of at least 10 minutes. Less than one in five Canadian adults met the current Canadian Physical Activity Guidelines, which recommend a minimum of 150 minutes of MVPA per week, accumulated in bouts of 10 minutes or more.⁴⁻⁶

This is the first study to assess physical activity trends in a nationally representative sample of Canadian adults by using accelerometer-measured physical activity data. The results contradict previous reports based on self-reported physical activity in Canada, which suggested that physical activity levels in Canadian adults had increased in recent decades.^{8,9,28-30} However, caution is recommended in using self-reported and accelerometer-measured physical activity data interchangeably since these data capture different aspects of the same behaviour: perceived time spent active versus actual movement above a set intensity threshold.³¹

Adherence to the Canadian Physical Activity Guidelines is based on MVPA accumulated in bouts of at least 10 minutes. In the current analysis, about one in five Canadian adults met this recommendation, in part because MVPA accumulated in bouts (12 minutes on average per day from 2016 to 2017) represented less than half of total accumulated MVPA (26 minutes on average per day from 2016 to 2017). However, certain research has shown that, for an equivalent volume, there is no significant difference in health benefits between MVPA accumulated in any time increment compared with MVPA accumulated in bouts.^{11-13,32} Further, based on this and other recent evidence, the *2018 Physical Activity Guidelines Advisory Committee Scientific Report* in the United States concluded that MVPA of any duration contributes to the health

benefits associated with the accumulated weekly volume of MVPA.¹⁴ As a result, the recently updated Physical Activity Guidelines for Americans no longer stipulate that MVPA should be accumulated in bouts.¹⁴ Results from the CHMS suggest that, if the guidelines did not stipulate the 10-minute bout requirement, the percentage of Canadian adults meeting physical activity guidelines would almost triple to 45%. Results also showed that over half of Canadian adults not meeting the guidelines are getting at least some $MVPA_{ALL}$ per week (i.e., between 1 and 149 minutes per week), including one-quarter of adults who are getting between 75 and 149 minutes. This latter group is important for public health messaging because these people are close to meeting the guideline, and a small shift in the distribution could have a meaningful impact on the percentage of the population surpassing the target of 150 minutes per week. Furthermore, it is well established that any physical activity is better than none and, in fact, the greatest health benefits occur when physical activity is increased at the lowest end of the physical activity scale (i.e., going from none to some, or from some to a bit more).^{1,2,14}

The results demonstrated that Canadian adults accumulate the vast majority of their $MVPA_{ALL}$ as MPA_{ALL} . In fact, of the average 26 minutes per day of $MVPA_{ALL}$, only four minutes were of a vigorous intensity. Although the current Canadian guidelines do not specifically prescribe VPA, other international guidelines stipulate that adults can accumulate either 150 minutes of MPA or 75 minutes of VPA, or some equivalent combination of the two (e.g., 100 minutes of MPA and 25 minutes of VPA).^{14,33-37} Although this differentiation was made as a way for people to accumulate a healthy dose of physical activity in less time, at least one study found that objectively measured VPA had a greater influence on cardiometabolic risk factors than an equivalent energy expenditure dose of MPA.³⁸ Furthermore, it is well established that VPA leads to greater improvements in cardiorespiratory fitness,³⁹ which in turn is associated with improvements in many health outcomes and a decreased risk for premature death.^{40,41}

Strengths and limitations

The examination of MVPA_{BOUTS} as stipulated in physical activity guidelines, and MVPA_{ALL} is a strength of this analysis. This examination provides information about physical activity levels for the entire population, not just the percentage who meet the guidelines. This information may be useful to governments and other organizations in improving physical activity in Canada—physical inactivity and sedentary living have been identified as critical issues in Canada and internationally. For example, *A Common Vision for Increasing Physical Activity and Reducing Sedentary Living in Canada: Let's Get Moving* is a policy in Canada that strives for “a Canada where all Canadians move more and sit less, more often.”⁴² Internationally, the World Health Organization’s global action plan on physical activity calls for a 15% relative reduction in the global prevalence of physical inactivity in adults and adolescents by 2030.⁴¹

With CHMS accelerometer data (the only nationally representative Canadian dataset with direct measures of physical activity), it is possible to track changes in physical activity over time. Accelerometers yield objective information about movement intensity and, thus, overcome some of the limitations associated with self-reporting. However, accelerometers may underestimate MVPA since they do not accurately measure the intensity of movement from activities such as swimming or cycling, and they do not take into account the additional energy expenditure from any load-bearing movement. Furthermore, using one set of cut points to determine the intensity of physical activity in adults may overestimate or underestimate physical activity levels in certain subpopulations. For example, at a given accelerometer count-per-minute value, energy expenditure may be higher for those who are obese compared with those at a normal weight.⁴³

Finally, the overall response rate to the accelerometer measurement across the five CHMS cycles was about 40%. Despite adjustments to the sampling weights to compensate, estimates may be biased by systematic differences between respondents and non-respondents.

Conclusion

Results from the 2016 to 2017 CHMS showed that less than one in five Canadian adults met the Canadian Physical Activity Guidelines. Results also showed that Canadian adults accumulated the majority of their MVPA in periods < 10 minutes in duration and at a moderate intensity. This information may be important to governments and other organizations to increase physical activity levels in Canadian adults, which, according to accelerometer data, have not changed between 2007 and 2017. ■

References

- Warburton DER, Bredin SSD. Health benefits of physical activity: a systematic review of current systematic reviews. *Current Opinion in Cardiology* 2017; 32(5):541-556.
- Warburton DER, Charlesworth S, Ivey A, et al. A systematic review of the evidence for Canada’s Physical Activity Guidelines for Adults. *International Journal of Behavioral Nutrition and Physical Activity* 2010;7(1): 39.
- Janssen I. Health care costs of physical inactivity in Canadian adults. *Applied Physiology Nutrition and Metabolism* 2012; 37: 803-806.
- Tremblay MS, Warburton DER, Janssen I, et al. New Canadian Physical Activity Guidelines. *Applied Physiology Nutrition and Metabolism* 2011; 36(1): 36-46.
- Canadian Society for Exercise Physiology. *Canadian Physical Activity Guidelines for Adults 18-64 years 2011*. Available at: www.csep.ca/view.asp?ccid=580
- Canadian Society for Exercise Physiology. *Canadian Physical Activity Guidelines for Older Adults 65 years and older 2011*. Available at: www.csep.ca/view.asp?ccid=580
- Colley RC, Garriguet D, Janssen I et al., Physical activity of Canadian adults: Accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health Reports* 2011; 22(1):7-14.
- Bryan S, Katzmarzyk PT. Are Canadians meeting the guidelines for moderate and vigorous leisure-time physical activity? *Applied Physiology, Nutrition and Metabolism* 2009; 34(4):707-715.
- Canadian Fitness & Lifestyle Research Institute. *Bulletin 1: Physical Activity Levels of Canadians*. 2014. Available at: https://www.cflri.ca/sites/default/files/node/1374/files/CFLRI_Bulletin%201_PAM%202014-2015.pdf
- Statistics Canada. “Physical activity during leisure time, 2014.” *Health Fact Sheet*, Statistics Canada Catalogue no. 82-625, Ottawa: Statistics Canada. Available at: http://www.statcan.gc.ca/pub/82-625-x/2015001/article/14189-eng.htm
- Clarke J and Janssen I. Sporadic and bouted physical activity and the metabolic syndrome in adults. *Medicine & Science in Sports & Exercise* 2013; 46(1): 76-83.
- Glazer NL, Lyass A, Esliger DW, et al. Sustained and shorter bouts of physical activity are related to cardiovascular health. *Medicine & Science in Sports & Exercise* 2013; 45(1): 109–15.
- Strath SJ, Holleman RG, Ronis DL, et al. Objective physical activity accumulation in bouts and nonbouts and relation to markers of obesity in US adults. *Preventing Chronic Disease* 2008; 5(4): 1–11.
- Physical Activity Guidelines Advisory Committee. *2018 Physical Activity Guidelines Advisory Committee Scientific Report*. Washington, DC: U.S. Department of Health and Human Services, 2018.
- Katzmarzyk P and Tremblay MS. Limitations of Canada’s physical activity data: implications for monitoring trends. *Applied Physiology, Nutrition and Metabolism*. 2007; 32: S185-S194.
- Day B, Langlois R, Tremblay MS and B-M Knoppers. Canadian Health Measures Survey: Ethical, legal and social issues. *Health Reports* 2007; 18: 37-51.
- Statistics Canada. *Canadian Health Measures Survey (CHMS) Data User Guide: Cycle 1 April 2011*. Available at: http://www23.statcan.gc.ca/imdb-bmdi/document/5071_D4_T9_V2-eng.htm
- Statistics Canada. *Canadian Health Measures Survey (CHMS) Data User Guide: Cycle 2 November 2012*. Available at: http://www23.statcan.gc.ca/imdb-bmdi/document/5071_D4_T9_V2-eng.htm
- Statistics Canada. *Canadian Health Measures Survey (CHMS) Data User Guide: Cycle 3 November 2014*. Available at: http://www23.statcan.gc.ca/imdb-bmdi/document/5071_D4_T9_V2-eng.htm

20. Statistics Canada. [Canadian Health Measures Survey \(CHMS\) Data User Guide: Cycle 4 October 2017](http://www23.statcan.gc.ca/imdb-bmdi/document/5071_D4_T9_V2-eng.htm). Available at: http://www23.statcan.gc.ca/imdb-bmdi/document/5071_D4_T9_V2-eng.htm
21. Statistics Canada. [Canadian Health Measures Survey \(CHMS\) Data User Guide: Cycle 5 April 2019](http://www23.statcan.gc.ca/imdb-bmdi/document/5071_D4_T9_V2-eng.htm). Available at: http://www23.statcan.gc.ca/imdb-bmdi/document/5071_D4_T9_V2-eng.htm
22. Tremblay MS, Wolfson M and Connor Gorber S. Canadian Health Measures Survey: background, rationale and overview. *Health Reports* 2007; 18(Suppl): 7-20.
23. Colley RC, Connor Gorber S, Tremblay MS. Quality control and data reduction procedures for accelerometry-derived measures of physical activity. *Health Reports* 2010; 21(1):63-69.
24. Colley RC, Tremblay MS. Moderate and vigorous physical activity cut-points for the Actical accelerometer. *Journal of Sports Sciences* 2011; 29(8): 783-789.
25. Wong S, Colley RC, Connor Gorber S, Tremblay MS. Sedentary activity Actical accelerometer thresholds for adults. *Journal of Physical Activity and Health* 2011; 8: 587-591.
26. Troiano RP, Berrigan D, Dodd KW, et al. Physical activity in the United States measured by accelerometer. *Medicine & Science in Sports & Exercise* 2008; 40(1): 181-188.
27. Statistics Canada. [Instructions for Combining Multiple Cycles of Canadian Health Measures Survey \(CHMS\) Data August 2017](http://www23.statcan.gc.ca/imdb-bmdi/document/5071_D4_T9_V2-eng.htm). 2017. Available at: http://www23.statcan.gc.ca/imdb-bmdi/document/5071_D4_T9_V2-eng.htm
28. Bruce MJ and Katzmarzyk PT. Canadian population trends in leisure-time physical activity levels, 1981-1998. *Canadian Journal of Applied Physiology* 2002; 27(6): 681-690.
29. Cameron C, Craig CL, Bull FC and Bauman A. Canada's physical activity guides: has their release had an impact? *Applied Physiology, Nutrition and Metabolism* 2007; 32(Supplement 2E): S161-S169.
30. Craig C Russell SJ, Cameron C, Bauman A. Twenty-year trends in physical activity among Canadian adults. *Canadian Journal of Public Health* 2004; 95(1): 59-63.
31. Colley RC, Butler G, Garriguet D, et al. Comparison of self-reported and accelerometer-measured physical activity in Canadian adults. *Health Reports* 2018; 29(12): 3-15.
32. Saint-Maurice PF, Troiano RP, Matthews CE, Kraus WE. Moderate-to-vigorous physical activity and all-cause mortality: Do bouts matter? *Journal of the American Health Association* 2018; 7(6): e007678.
33. US Department of Health And Human Services. [2008 Physical Activity Guidelines for Americans](https://health.gov/paguidelines/2008/). Washington, DC: US Department of Health and Human Services, 2008. Available at: <https://health.gov/paguidelines/2008/>
34. Australian Government Department of Health. [Australia's Physical Activity and Sedentary Behaviour Guidelines](http://www.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-strateg-phys-act-guidelines#apaadult). 2017. Available at: <http://www.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-strateg-phys-act-guidelines#apaadult>
35. World Health Organization. [Global recommendations on physical activity for health](http://www.who.int/dietphysicalactivity/publications/9789241599979/en/). Geneva: World Health Organization, 2010. Available at: <http://www.who.int/dietphysicalactivity/publications/9789241599979/en/>
36. National Health Service. [Physical Activity Guidelines for Adults](https://www.nhs.uk/live-well/exercise/). 2018. Available at: <https://www.nhs.uk/live-well/exercise/>. Accessed September 30, 2018.
37. US Department of Health And Human Services. [Physical Activity Guidelines for Americans, 2nd edition](https://health.gov/paguidelines/second-edition/2018). Washington, DC: US Department of Health and Human Services, 2018. Available at: <https://health.gov/paguidelines/second-edition/2018>
38. Janssen I, Ross R. Vigorous intensity physical activity is related to the metabolic syndrome independent of the physical activity dose. *International Journal of Epidemiology* 2012; 41(4): 1132-1140.
39. Drenowatz C, Prasad VK, Hand GA, et al. Effects of moderate and vigorous physical activity on fitness and body composition. *Journal of Behavioral Medicine* 2016; 39(4): 624-632.
40. Kodama S, Saito K, Tanaka S, et al. Cardiorespiratory fitness as a quantitative predictor of all-cause mortality and cardiovascular events in healthy men and women: a meta-analysis. *Journal of the American Medical Association* 2009;301(19):2024-2035.
41. World Health Organization. [WHO Global Action Plan on Physical Activity 2018-2030: More Active People for a Healthier World](http://www.who.int/ncds/prevention/physical-activity/global-action-plan-2018-2030/en/). Geneva: World Health Organization, 2018. Available at: www.who.int/ncds/prevention/physical-activity/global-action-plan-2018-2030/en/
42. Public Health Agency of Canada. [A Common Vision for Increasing Physical Activity and Decreasing Sedentary Behaviour in Canada: Let's Get Moving](http://www.canada.ca/en/public-health/services/publications/healthy-living/lets-get-moving.html). 2018. Available at: www.canada.ca/en/public-health/services/publications/healthy-living/lets-get-moving.html
43. Raiber L, Christensen RAG, Jamnik V and JL Kuk. Accelerometer thresholds: Accounting for body mass reduces discrepancies between measures of physical activity for individuals with overweight and obesity. *Applied Physiology, Nutrition, and Metabolism* 2017; 42(1): 53-58.