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Physical activity of Canadian children and youth, 2007 to 2015

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Physical activity of Canadian children and youth, 2007 to 2015

by Rachel C. Colley, Valerie Carson, Didier Garriguet, Ian Janssen, Karen C. Roberts and Mark S. Tremblay

Abstract

Background: This study describes and compares the percentages of Canadian children and youth who adhere to different operational definitions of the moderate-to-vigorous physical activity (MVPA) recommendation of 60 minutes per day.

Data and methods: Data for 6- to 17-year-olds ($n = 5,608$) were collected from 2007 through 2015 as part of the Canadian Health Measures Survey. MVPA was measured using the Actical accelerometer. The MVPA recommendation was operationalized as accumulating 60 minutes of MVPA every day, on most days, and on average.

Results: Data from the most recent cycle of the Canadian Health Measures Survey indicate that 7% of children and youth accumulated at least 60 minutes of MVPA on at least 6 out of 7 days, and 33% achieved a weekly average of at least 60 minutes per day. Boys accumulated more MVPA than did girls, and 6- to 11-year-olds accumulated more MVPA than did 12- to 17-year-olds. Regardless of how adherence to the recommendation is operationalized, MVPA levels among Canadian children and youth did not change over the 9-year period from 2007 to 2015.

Interpretation: The majority of Canadian children do not meet the physical activity recommendation, regardless of the operational definition used. However, the discrepancies between results based on different interpretations of the 60-minutes-per-day recommendation highlight the importance of explicitly reporting how recommendations are operationalized to avoid misinterpreting trends and comparisons.

Keywords: Accelerometer, benchmarking, exercise, health surveys, moderate-to-vigorous physical activity, movement

Physical activity is associated with a range of physical, mental, and social health benefits for children and youth.^{1,2} Guidelines published by the World Health Organization and by several countries recommend that children and youth accumulate a minimum of 60 minutes of moderate-to-vigorous physical activity (MVPA) per day, and advocate engagement in vigorous-intensity physical activity, as well as muscle- and bone-strengthening activities, at least three times per week.³⁻⁶

Since 2007, the nationally representative Canadian Health Measures Survey (CHMS) has used accelerometers to measure MVPA. The first cycle of data, collected between 2007 and 2009, indicated that only 7% of Canadian children and youth met the recommended 60 minutes per day.⁷ Four cycles of CHMS data, collected across nine years (2007 to 2015), are now available and provide an opportunity to update statistics and examine temporal trends in the MVPA of Canadian children and youth.

The recently released *Canadian 24-Hour Movement Guidelines for Children and Youth* integrate recommendations for physical activity, sedentary behaviour, and sleep.⁸ The MVPA recommendation in these new *Guidelines*—60 minutes a day—is consistent with the previous Canadian stand-alone guideline⁴ and with guidelines from other countries and organizations.⁸ Despite between-country consistency in the MVPA recommendation, how this benchmark is assessed varies, thereby limiting comparisons between studies and across jurisdictions. Most notably, operationalization of the “daily” or “per day” aspect of the recommendation differs. Meeting the MVPA recommendation has been operationalized as: at least 60 minutes per day when averaged across a week⁹⁻¹⁴; at least 60 minutes on all 7 days of the week¹⁵⁻²⁷; and at least 60 minutes on at least 5²⁸

or at least 6 days⁷ per week. The percentages of children and youth who meet the recommendation differ, based on how it is operationalized.²⁹⁻³¹

Surveillance recommendations that accompanied the release of the new *Guidelines* suggest that adherence to the MVPA, screen time, and sleep components each be assessed using average daily time.⁸ This is a departure from the original approach to operationalizing the physical activity recommendation as accumulating 60 minutes of MVPA on at least 6 days per week.⁷ The authors of the new *Guidelines* suggested that both operational definitions be applied in the future in order to examine trends in MVPA over time.⁸ They also noted that use of an average rather than a daily measure is supported by the evidence that informed development of the *Guidelines*.^{2,32} This allows for consistency on how the different movement behaviour recommendations are operationalized (for example, avoid requiring 6 out of 7 days for MVPA, while requiring an average daily time for sleep and screen time).⁸ Findings from Cycles 2 and 3 of the CHMS (2009-to-2011 and 2011-to-2013) indicate that the difference between operationalizing 60 minutes per day as an average rather than requiring 60 or more minutes on at least 6 out of 7 days results in a difference in the percentage of children and youth who meet the guideline of 7% versus 36%.³³ This discrepancy signals a need to reconcile how the two measures relate to one and another.

Evidence of a dose-response relationship between physical activity and health¹ suggests that encouraging children and youth to increase their MVPA, regardless of their current baseline level, is warranted. Physical activity recommendations urge inactive children to “slowly increase their activity in small steps”⁵ and promote the idea that the “more physical

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activity children do, the more they will benefit.³³ Therefore, examining MVPA below and above the 60-minutes-per-day benchmark provides complementary information about the percentage of children and youth who are close to achieving or exceeding the current guideline. These additional findings could inform whether strategies to increase physical activity should focus on frequency, duration, or both.

This study describes and compares the percentages of 6- to 17-year-old Canadians who adhere to the current MVPA recommendation, based on different operational definitions. The analysis presents an overview of the accelerometer-measured MVPA levels of Canadian children and youth from 2007 through 2015, using a range of benchmarks above, below, and including the 60-minutes-per-day recommendation. These comparisons help reconcile apparent changes in adherence to the recommendations resulting from the transition in the operational definition in the *Canadian 24-Hour Movement Guidelines*.

Data and methods

Data source

The Canadian Health Measures Survey (CHMS), an ongoing survey conducted by Statistics Canada, collects reported and measured health information from the household population aged 3 to 79. Residents of Indian Reserves, institutions, certain remote regions, and full-time members of the Canadian Forces are excluded.

The analysis pertains to 5,608 children and youth aged 6 to 17. The data were collected by the first four CHMS cycles: Cycle 1 (2007-to-2009; n = 1,473), Cycle 2 (2009-to-2011, n = 1,507), Cycle 3 (2012-to-2013, n = 1,328), and Cycle 4 (2014-to-2015, n = 1,300). Respondents answered an interviewer-administered questionnaire in their home, and within the next 6 weeks, visited a mobile examination centre (MEC) for a series of physical measurements. Ethics approval

for the CHMS was obtained from Health Canada's Research Ethics Board.³⁴ Details about the CHMS are available in previous publications.³⁵⁻³⁹

Measurement of physical activity

Upon completion of the MEC visit, ambulatory respondents were asked to wear an Actical accelerometer (Phillips – Respironics, Oregon, USA) over their right hip on an elasticized belt during their waking hours for 7 consecutive days. All data were blind to respondents while they wore the device. The Actical measures and records time-stamped acceleration in all directions, providing an index of physical activity intensity via a count value for each minute. A valid day was defined as 10 or more hours of wear time. A valid respondent was defined as a minimum of 4 valid days out of a possible 7.⁴⁰ Wear time was determined 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 100.⁴⁰ An established movement intensity threshold was applied to the data to derive time spent in MVPA (at least 1,500 counts per minute).⁴¹ Complete descriptions of the accelerometer data reduction procedures are available elsewhere.^{7,35-38,40}

Statistical analysis

The statistical analyses were organized around four research questions:

1. How many minutes of MVPA do Canadian children and youth accumulate, and does this differ by sex and age group?
2. Have MVPA levels among children and youth changed over time?
3. How does the operational definition of the 60-minutes-per-day recommendation affect the percentage of children and youth meeting the benchmark?
4. Do more stringent (more than 60 minutes per day) or less stringent (up to 60 minutes per day) benchmarks offer additional and/or

What is already known on this subject?

- The moderate-to-vigorous physical activity (MVPA) recommendation for Canadian children and youth has previously been operationalized as accumulation of 60 minutes of MVPA on at least 6 out of 7 days per week.
- Based on this threshold, fewer than 10% of Canadian children and youth meet the recommendation.
- The *Canadian 24-Hour Movement Guidelines*, released in 2016, suggest an alternative operational definition for the recommendation that classifies children and youth as adherent if their average daily MVPA is at least 60 minutes per day.

What does this study add?

- Based on the alternative operational definition, the percentage of children and youth meeting the MVPA recommendation increases from 7% to 33% (2014/2015).
- Regardless of which operational definition is applied, the percentage of children and youth meeting the MVPA recommendation remains low, and has not changed markedly since 2007.

complementary information about temporal changes in MVPA habits among Canadian children and youth?

Descriptive statistics were used to calculate means and 95% confidence intervals overall and by age group and sex. Individual CHMS cycle accelerometer sample weights were used for analyses presenting individual cycle estimates.³⁵⁻³⁸ Pairwise contrasts were used to compare age groups (6 to 11 versus 12 to 17) and sex (boys versus girls).

Valid accelerometer data from each of the four CHMS cycles were stacked and weighted using combined accelerometer survey weights generated by Statistics Canada.⁴² The sample size

for the combined analyses was 5,597 because of a lack of combined weights for a small number of children ($n = 11$) who turned 6 between the household and MEC visits. A trend analysis was performed on average daily minutes of MVPA allowing for linear, square, and cubic effects of time (survey cycle) to be estimated. Linear regression to assess the overall effect of time (survey cycle), while controlling for season, was also performed. Analyses controlled for age, body mass index, household income adjusted for household size quintiles, and highest level of parental education in the household (secondary graduation or less, postsecondary but below bachelor's degree, bachelor's degree or higher).

Achievement of 60 minutes of daily MVPA was measured several ways, reflecting the most common approaches to assessing adherence to the recommendation.

- All days:** Respondents were deemed adherent if they accumulated at least 60 minutes per day on all valid days of accelerometer data (4/4, 5/5, 6/6 or 7/7 days).
- Most days:** Respondents were deemed adherent if they accumulated at least 60 minutes per day on the number of days that corresponded most closely to 70% of days (3/4, 3/5, 4/6 or 5/7 days).
- At least 6 out of 7 days:** Bayesian statistics were used to determine the probability that a respondent would accumulate 60 minutes of MVPA on at least 6 out of 7 days a week based on their valid accelerometer data.^{7,28} The average of all probability values in the sample was then used to obtain the overall percentage of children and youth meeting the recommendation.
- Average:** Average daily minutes of MVPA were calculated using valid days for each respondent. If this value was at least 60 minutes per day, the respondent was deemed adherent.

Table 1

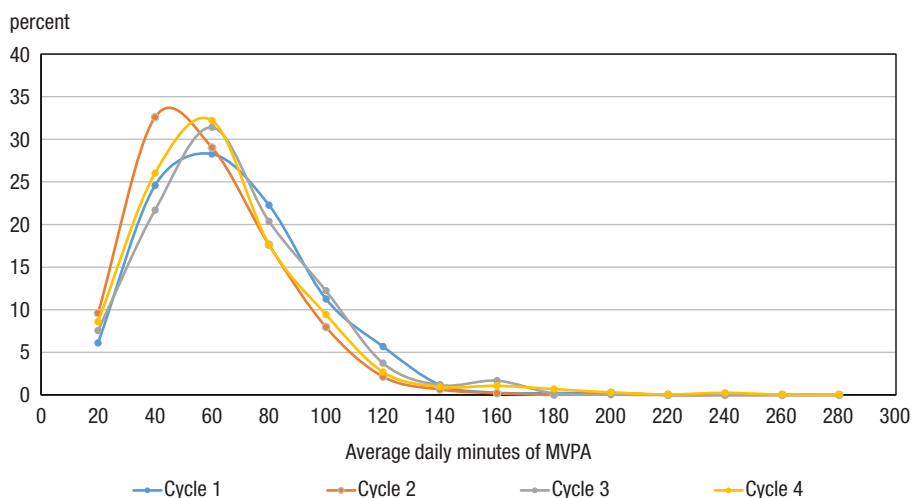
Average minutes per day of moderate-to-vigorous physical activity, by Canadian Health Measures Survey cycle, sex and age group, household population aged 6 to 17, Canada, 2007 to 2015

Sex and age group	2007 to 2009			2009 to 2011			2012 to 2013			2014 to 2015		
	Cycle 1 (n = 1,473)			Cycle 2 (n = 1,507)			Cycle 3 (n = 1,328)			Cycle 4 (n = 1,300)		
	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	to	
Total	57	51	62	49	45	53	57	51	63	55	49	61
6 to 11	63	56	70	54	50	59	65	58	72	62	56	69
12 to 17	51	47	56	44	40	48	50	43	57	48	42	55
Boys	64	57	70	55	49	60	63	55	71	63	55	71
6 to 11	69	60	78	61	55	68	72	62	81	72	62	81
12 to 17	59	53	65	49	43	56	56	47	65	55	47	64
Girls	49	44	54	42	39	46	50	45	54	46	41	51
6 to 11	57	51	63	47	43	51	58	52	63	52	47	58
12 to 17	42	37	48	39	35	42	43	36	49	40	35	45

Source: 2007-to-2009, 2009-to-2011, 2012-to-2013 and 2014-to-2015 Canadian Health Measures Survey.

Figure 1

Weighted distribution of average daily minutes of moderate-to-vigorous physical activity (MVPA), by Canadian Health Measures Survey cycle, household population aged 6 to 17, Canada, 2007 to 2015



Sources: 2007-to-2009, 2009-to-2011, 2012-to-2013 and 2014-to-2015 Canadian Health Measures Survey.

The percentages of children and youth achieving an average MVPA of 15, 30, 45, 60, 75, or 90 minutes per day across valid days were also assessed. A beta-binomial distribution was used to estimate the probability of accumulating 15, 30, 45, 60, 75 or 90 minutes of MVPA on 1 through 7 days a week.⁴³ The estimated population prevalence of achieving each daily threshold was computed as the weighted average of those individual probabilities.

The data were analyzed using SAS 9.3 (SAS Institute, Cary, NC) and SUDAAN 11.0 (RTI International, NC) using appropriate denominator degrees of freedom (DDF) for each CHMS cycle in the SUDAAN procedure statements (DDF for Cycles 1, 3, 4 = 11, Cycle 2 = 13, all cycles = 46). To account for survey design effects, 95% confidence intervals were estimated with the bootstrap technique.³⁵⁻³⁸

Results

Boys, younger children most active

Average daily MVPA for children and youth ranged from a low of 49 minutes in Cycle 2 to a high of 57 minutes in Cycles 1 and 3 (Table 1). In all cycles, boys accumulated more MVPA than did girls ($p < .001$), and 6- to 11-year-olds

accumulated more MVPA than did 12- to 17-year-olds ($p < .001$). Average wear time (range: 13.3 to 13.7 hours per day) and number of valid days (range: 5.8 to 6.1) remained stable across cycles (data not shown).

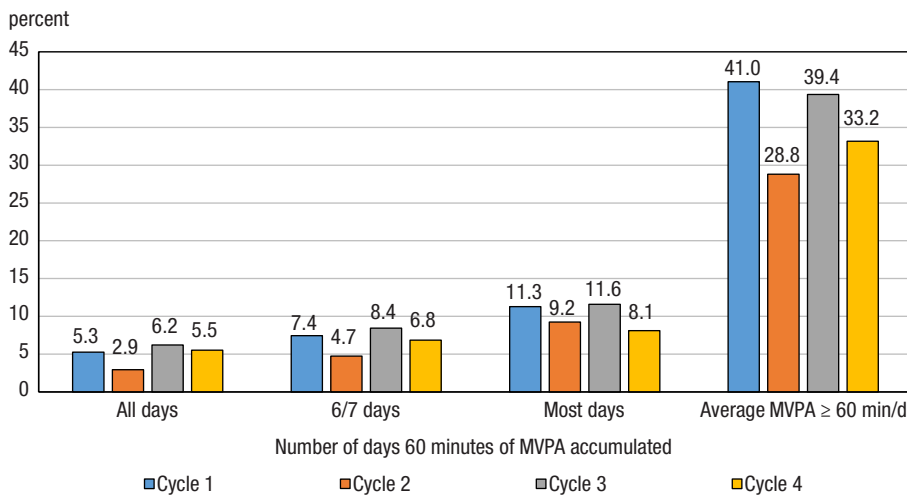
Trends over time

No significant linear trend in average daily minutes of MVPA was evident across

CHMS cycles (Table 1, Figure 1). There was a significant cubic trend in average minutes per day of MVPA ($p = 0.02$), reflecting lower average daily MVPA in Cycles 2 and 4, compared with Cycles 1 and 3.

In a linear regression model that controlled for season, age, sex, body mass index, household income and parental education, the only significant effect of time (survey cycle) was a drop in Cycle 2 (-7 minutes per day, $p < .05$). The effect of season was significant in the model ($p < 0.0001$) and reflected more MVPA in spring, than in winter (-16 minutes per day), summer (-13 minutes per day), and fall (-12 minutes per day).

Figure 2
Percentage accumulating at least 60 minutes of moderate-to-vigorous physical activity (MVPA) all days (4/4, 5/5, 6/6, 7/7), most days (at least 6/7 days), most days (3/4, 3/5, 4/6, 5/7), and on average, by Canadian Health Measures Survey cycle, household population aged 6 to 17, Canada, 2007 to 2015



Sources: 2007-to-2009, 2009-to-2011, 2012-to-2013 and 2014-to-2015 Canadian Health Measures Survey.

Table 2
Average minutes per day of moderate-to-vigorous physical activity (MVPA) of children and youth who meet various operational definitions of 60-minute-per-day MVPA recommendation, household population aged 6 to 17, Canada, 2007 to 2015

Operational definition	Average minutes per day	95% confidence interval		standard error
		from	to	
All days				
4 out of 4	112.3	96.3	128.3	8.0
5 out of 5	106.8	98.1	115.5	4.3
6 out of 6	126.9	112.8	141.0	7.0
7 out of 7	125.5	117.3	133.7	4.1
Almost all days				
At least 6/7 days	119.4	113.4	125.4	3.0
Most days				
3 out of 4	90.7	84.1	97.2	3.3
3 out of 5	81.5	77.4	85.6	2.0
4 out of 6	89.1	85.3	92.9	1.9
5 out of 7	90.8	88	93.6	1.4
Average				
Average daily MVPA at least 60 minutes	83.9	81.9	85.8	1.0

Source: 2007-to-2009, 2009-to-2011, 2012-to-2013 and 2014-to-2015 Canadian Health Measures Survey (combined).

Adherence depends on operational definition

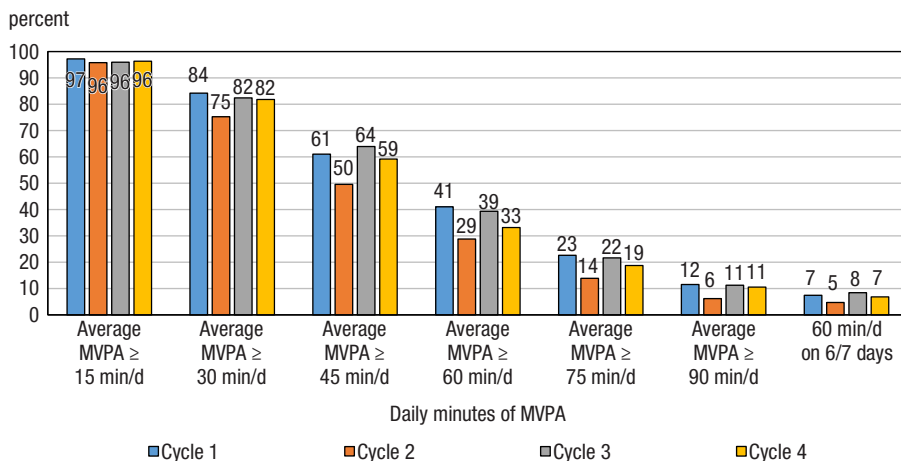
Figure 2 illustrates differences in the prevalence of adherence based on the four operational definitions of the 60-minute MVPA recommendation. When the “all days,” “most days,” or “6/7 days” operational definitions were used, adherence was below 12% in all CHMS cycles. By contrast, when the “daily average” operational definition was used, adherence ranged between 29% and 41% across cycles.

The average daily MVPA of children and youth who accumulated 60 minutes of MVPA on *all* or *6/7 days* ranged from 107 to 127 minutes; the average daily MVPA of those who accumulated 60 minutes on *most days* or *on average* was lower, ranging from 82 to 91 minutes (Table 2). An estimated 35% of children and youth with an average daily MVPA of at least 60 minutes accumulated 60 minutes on 7/7 days of the week (data not shown).

Beyond a single benchmark

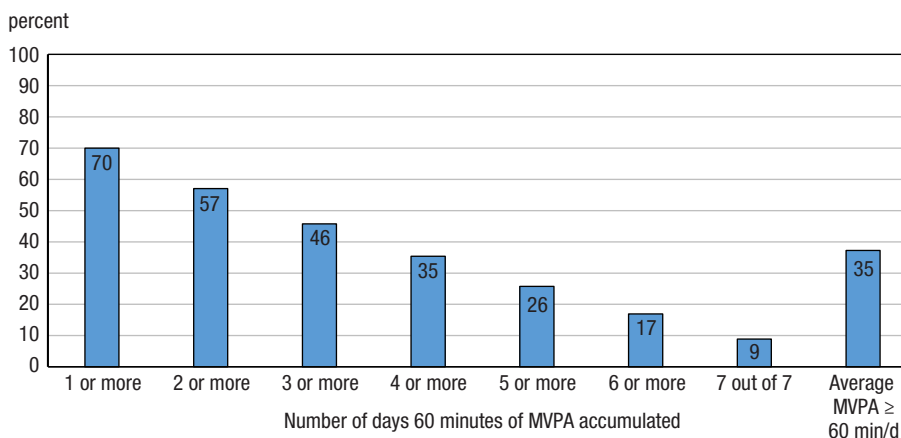
The percentages of children and youth in each CHMS cycle whose average daily MVPA was at least 15, 30, 45, 60, 75, or 90 minutes are presented in Figure 3, with the percentages accumulating 60 minutes on 6/7 days a week included for comparison. The percentages accumulating 60 minutes on 6/7 days a week (range: 5% to 8%) most closely aligned with the

Figure 3
Percentage accumulating average moderate-to-vigorous physical activity (MVPA) of 15, 30, 45, 60, 75 or 90 minutes per day compared with percentage accumulating 60 minutes at least 6 out of 7 days, by Canadian Health Measures Survey cycle, household population aged 6 to 17, Canada, 2007 to 2015



Sources: 2007-to-2009, 2009-to-2011, 2012-to-2013 and 2014-to-2015 Canadian Health Measures Survey.

Figure 4
Percentage accumulating at least 60 minutes of moderate-to-vigorous physical activity (MVPA) on 1 through 7 days per week compared with percentage with average daily MVPA at least 60 minutes, household population aged 6 to 17, Canada, 2007 to 2015



Sources: 2007-to-2009, 2009-to-2011, 2012-to-2013 and 2014-to-2015 Canadian Health Measures Survey.

percentages accumulating an average of 90 minutes per day (range: 6% to 12%). No notable between-cycle changes in achieving a daily average of 15 minutes were apparent. Differences that did emerge in values from 30 minutes per day upward reflected the overall trend, with Cycles 2 and 4 being slightly lower than Cycles 1 and 3 across several measures. The percentages accumulating 60 minutes of MVPA on 1 to 7 days a week

are displayed in Figure 4 for all cycles combined. The percentage with average daily MVPA of at least 60 minutes is included to demonstrate that it corresponds most closely with meeting the 60-minute MVPA recommendation on 4 or more days per week (35%).

Table 3 shows the percentages accumulating various MVPA benchmarks up to and beyond the 60-minute recommendation. Across all cycles,

about 80% of children and youth accumulated 30 minutes on 3 or more days per week, and about 50% did so on at least 6 days. Around half accumulated 60 minutes on 3 or more days per week. Accumulating 75 or 90 minutes every day was rare (fewer than 7%); however, about 50% accumulated 75 to 90 minutes at least 1 day per week.

Discussion

This study examines trends in MVPA levels among Canadian children and youth over a 9-year period, and discusses the implications of a shift in the operational definition of the recommendation. Regardless of how the recommendation was operationalized or the analytical approach used, MVPA levels did not change markedly between 2007 and 2015. Fewer than 10% of children and youth accumulated 60 minutes of MVPA *every day*, and a third accumulated *an average* of 60 minutes a day. The findings highlight the low percentage meeting the recommendation, and the importance of explicitly reporting how it is operationalized.

The lack of a temporal trend in this analysis is consistent with a pedometer-based study by Cameron et al.,⁴⁴ who collected data on 43,806 Canadian children aged 5 to 19 between 2005 and 2015. That study found a modest decline (-6.1%) in median steps per day.⁴⁴ The researchers noted that their results indicated that the national goal set by the Federal-Provincial-Territorial Ministers responsible for sport, physical activity and recreation to increase mean step counts per day from 11,500 to 14,500 by 2015⁴⁵ had not been met. While not reported in the present analysis, step-count values for 6- to 17-year-olds from the CHMS exhibited a similar decrease (-8% from Cycle 1 to Cycle 4). This mirrors the lack of substantive change in average daily minutes of MVPA between Cycle 1 and Cycle 4 (57 to 55 minutes per day or -3.2%). The present study, therefore, adds to the evidence presented by Cameron et al. that the physical activity levels of Canadian chil-

Table 3
Percentage of children and youth accumulating various daily amounts of moderate-to-vigorous physical activity (MVPA), by days active per week and Canadian Health Measures Survey cycle, household population aged 6 to 17, Canada, 2007 to 2015

Minutes of MVPA accumulated	Days out of 7															
	1 or more days				3 or more days				6 or more days				7 days			
	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4
	percentage															
At least 15	99	99	99	99	96	94	94	95	78	71	74	76	64	56	60	62
At least 30	95	93	95	94	84	78	83	82	53	46	54	50	38	31	38	35
At least 45	86	80	86	84	67	58	67	63	32	25	33	30	19	14	19	18
At least 60	75	64	74	68	49	40	51	45	18	13	20	17	10	6	11	9
At least 75	60	48	59	53	35	24	35	29	10	6	11	9	5	2	6	4
At least 90	46	36	46	41	22	15	23	19	5	3	6	5	2	1	3	2

Source: 2007-to-2009, 2009-to-2011, 2012-to-2013 and 2014-to-2015 Canadian Health Measures Survey.

dren and youth have been stable over the past decade.

The discrepancy observed in the percentages of children and youth who meet the 60-minutes-per-day recommendation, depending on the operational definition, is consistent with other research.²⁹⁻³¹ This result is intuitive given that achieving a daily *average* of 60 minutes is easier than accumulating 60 minutes *every day* of the week. By examining multiple MVPA levels below and above 60 minutes per day, it was possible to estimate the frequency and duration of MVPA required to achieve a weekly average of at least 60 minutes per day. The percentage achieving an *average* daily MVPA of 60 minutes (33%) is a better reflection of those who accumulate 60 minutes of MVPA on 4 out of 7 days per week (35%) (Figure 4). Only about a third of those who achieve an *average* daily MVPA of 60 minutes accumulate 60 minutes *every day*. Further evidence of the mismatch between operational definitions can be seen by comparing the average daily MVPA of those accumulating 60 minutes on 6/7 days per week (107 to 127 minutes) with those achieving a daily average of at least 60 minutes (82 to 91 minutes) (Table 2).

The change in the operational definition of the 60-minutes-per-day recommendation without a corresponding change in the amount of MVPA being recommended creates a challenging transition period in the reporting of prevalence, trends and comparisons. Variation in how the recommendation has been operationalized has led

to calls for harmonization and accurate reporting of how the recommendation is interpreted in analyses.²⁹⁻³¹ In the context of the CHMS, the difference in the percentages of children and youth meeting the 60-minute recommendation varies fivefold between the daily (6/7 days)⁷ and the average approaches: 7% versus 33%. The average approach recognizes day-to-day variations in MVPA, which may not be harmful as long as the total weekly volume remains sufficient.¹

Although the gap between operational definitions is large, the take-home message is the same: the majority of Canadian children and youth do not meet the recommendation, a situation that has not changed since 2007. Further, the finding that 33% accumulate an *average* of at least 60 minutes of MPVA is only part of a broader picture—far fewer (17.5%) meet all aspects of the *Canadian 24-Hour Movement Guidelines*.³³ Recent studies have reported that health outcomes improve as more components of the *Guidelines* are achieved.^{33,46} As the new operational definition is adopted, it will be important for researchers to describe their methods carefully (which operational definition was used) and be prudent in making comparisons with other studies.

Strengths and limitations

A strength of the present analysis is examination of MVPA levels below and above the 60-minutes-per-day benchmark. This provides information

about levels that the entire population is achieving, not just the percentage who meet the single recommendation. For example, CHMS findings suggest that the percentages of children and youth who accumulate modest amounts of MVPA (15 or 30 minutes per day, for instance) have not changed over time.

Assessing adherence to the MVPA recommendation alongside a series of complementary measures (for example, average daily minutes of MVPA and number of days that children exceed 60 minutes) creates the context required to understand the overall trend and identify targets for intervention and messaging.

With CHMS accelerometer data (the only nationally representative Canadian dataset), it is possible to track changes in physical activity over time. Accelerometers yield objective information about intensity of movement, and thus, overcome some of the limitations associated with self-reports.⁴⁷ However, accelerometers may underestimate MVPA, as they do not accurately measure the intensity of movement associated with activities such as swimming, cycling, and load-bearing. Further, use of 60-second epochs may not accurately capture the intermittent nature of children's physical activity.⁴⁸

This analysis does not include results or discussion specific to the “vigorous” component of MVPA. This is an important limitation, given that the *Guidelines* recommend vigorous physical activity at least 3 days per week.

The overall response rate to the accelerometer measurement across the four

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

These findings highlight the importance of precise explanations of how guidelines and recommendations are operationalized to be able to conduct between-study

comparisons and tracking of trends over time. Nonetheless, regardless of the operational definition employed, MVPA levels of Canadian children and youth have not changed markedly since 2007, and remain lower than recommended. ■

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