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by Didier Garriguet and Rachel C. Colley

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..	not available for a specific reference period
...	not applicable
0	true zero or a value rounded to zero
0^s	value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
^{p}	preliminary
^{r}	revised
x	suppressed to meet the confidentiality requirements of the *Statistics Act*
^{E}	use with caution
F	too unreliable to be published
*	significantly different from reference category ($p < 0.05$)

A comparison of self-reported leisure-time physical activity and measured moderate-to-vigorous physical activity in adolescents and adults

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Abstract

Background
Systematic reviews and results of Statistics Canada surveys have shown a discrepancy between self-reported and measured physical activity. This study compares these two methods and examines specific activities to explain the limitations of each method.

Data and methods
Data are from cycle 1 (2007 to 2009) and cycle 2 (2009 to 2011) of the Canadian Health Measures Survey. The survey involved an interview in the respondent's home and a visit to a mobile examination centre (MEC) for physical measurements. In a questionnaire, respondents were asked about 21 leisure-time physical activities. They were requested to wear an Actical accelerometer for seven days after the MEC visit. The analysis pertains to respondents aged 12 to 79 who wore the accelerometer for 10 or more hours on at least four days (n = 7,158).

Results
Averages of self-reported leisure-time physical activity and moderate-to-vigorous physical activity measured by accelerometer were within a couple of minutes of each other. However, at the individual level, the difference between estimates could exceed 37.5 minutes per day in one direction or the other, and around 40% of the population met physical activity thresholds according to one measurement method, but not according to the other. The disagreement is supported by weak observed correlations.

Interpretation
The lack of a systematic trend in the relationship between the two methods of measuring physical activity precludes the creation of correction factors or being confident in using one method instead of the other. Accelerometers and questionnaires measure different aspects of physical activity.

Keywords
Data collection, direct measure, misclassification, motor activity, movement

Authors
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A large body of evidence supports an association between physical activity and health.[1-3] This evidence was instrumental in revision of the Canadian Physical Activity Guidelines, published in 2011.[4]

Once guidelines have been established, surveillance is required to assess compliance and track temporal trends. Prior to the Canadian Health Measures Survey (CHMS), physical activity surveillance in Canada relied on self-reports in response to the Canadian Community Health Survey (CCHS). CCHS data showed an increase from 51.8% in 2003 to 53.9% in 2012 in the percentage of people who were at least moderately active (average daily energy expenditure from leisure-time activities of at least 1.5 METs, or the equivalent of 30 minutes walking).[5] In 2007, for the first time in a national survey, the CHMS used accelerometers to measure physical activity. Accelerometers are small devices worn on the waist that provide time-stamped objective measurement of human movement. According to accelerometer data from the first two CHMS cycles (2007 to 2009 and 2009 to 2011), fewer than 10% of adolescents[6,7] and 15% of adults[8,9] were meeting the physical activity guidelines.

The discrepancy between self-reported and measured physical activity is not new, and has prompted a number of comparative studies of children[10] and adults.[11] Most of this research relied on small samples, and results were inconclusive: in 60% of the studies of adults, self-reported physical activity estimates exceeded measured estimates. As well, the difference between reported and measured physical activity varied greatly between studies. A comparison with American data from the National Health and Nutrition Examination Survey (NHANES),[12] showed discrepancies similar to those observed in Canadian surveys.

This paper has two objectives. The first is to compare self-reported and measured physical activity collected by the CHMS. The second objective is to explore the limitations of each method, by examining the physical activities reported in greater detail.

Methods

Data source

Data for this study are from cycles 1 and 2 of the CHMS. Cycle 1 was conducted from March 2007 through February 2009 and collected information from respondents aged 6 to 79 living in private households in 15 locations across Canada. Cycle 2 took place from August 2009 through November 2011 and collected data from respondents aged 3 to 79 living in private households in 18 locations across Canada.

Residents of Indian Reserves, institutions, some remote regions, or areas with low population density, and full-time members of the Canadian Forces were excluded. The sample represents more than 96% of the Canadian population.[13,14] The CHMS was designed to produce national-level estimates representative of the population of the ten provinces and three territories.[15] Ethics approval was obtained from Health Canada's Research Ethics Board.[16] Detailed information about the content and sample design of the CHMS is available elsewhere.[13-16]

As well as an in-person interview to gather socio-demographic, health and lifestyle information, the CHMS involved a visit to a mobile examination center (MEC) for direct physical measures. Respondents who were unable to visit the MEC could opt to have their direct measures taken at home.[17]

The total population for the combined cycles was derived from the average population total for each collection period (cycle 1: 2007 to 2009 / 23 months; cycle 2: 2009 to 2011 / 28 months). Each cycle was adjusted based on the number of sites by cycle and region. Therefore, the combined estimates reflect the average Canadian household population during the study timeframe (2007 to 2011). The combined response rate for the activity monitor, including the response rates for the household questionnaire, the MEC and returning the activity monitor with at least four valid days, is 42.1%. More information about combining CHMS cycles is available elsewhere.[18]

A total of 7,158 CHMS participants aged 12 to 79 were selected for this study, based on the availability of self-reported and measured data.

Self-reported physical activity

Self-reported leisure-time physical activity (LTPA) was assessed in the CHMS household questionnaire. Respondents aged 12 or older were asked if they had engaged in any of the following activities in the previous three months: walking for exercise, gardening or yard work, swimming, bicycling, popular or social dance, home exercises, ice hockey, ice skating, in-line skating or rollerblading, jogging or running, golfing, exercise classes or aerobics, downhill skiing or snowboarding, bowling, baseball or softball, tennis, weight-training, fishing, volleyball, basketball, soccer, or any other. For each activity reported, respondents were asked the frequency in the past three months, and the average duration of each session: 1 to 15 minutes, 16 to 30 minutes, 31 to 60 minutes, or more than one hour. Average minutes of participation in each activity per day were determined by assigning the mid-point value for each category chosen and 60 minutes for the last category. All minutes were summed to derive average minutes of LTPA per day.

Measured physical activity

To make comparisons between measurement methods more valid, the self-reported LTPA estimates in the present analysis excluded activities that are not well measured by accelerometry: bicycling, swimming, weight training and fishing. Accelerometers worn on the hip cannot detect upper-body movement, nor can they accurately capture movement associated with gliding activities such as skating and bicycling.[19,20] Accelerometry captures minimal count values during bicycling that do not accurately reflect the true amount of movement or energy expenditure associated with the activity.[19,20] Although CHMS respondents were told to wear the monitor all the time except when sleeping, few will wear it in water (the belt would be wet for the rest of the day); therefore, swimming was removed from the self-reported LTPA sum. Weight training was removed because accelerometry does not capture the additional energy expenditure associated with weight bearing.[21] Although fishing is listed among the activities in the LTPA questionnaire, it is largely a sedentary pursuit that would register very little on an accelerometer.

For ease of reading, LTPA that includes all activities is referred to as LTPA (all), and LTPA excluding bicycling, swimming, weight training and fishing, as LTPA (with exclusions).

Accelerometry data reduction

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 seven consecutive days. The Actical (dimensions: 2.8 x 2.7 x 1.0 centimetres; weight: 17 grams) measures and records time-stamped acceleration in all directions, providing an index of physical activity intensity. The digitized values are summed over a user-specified interval of one minute, resulting in a count value per minute (cpm). The Actical has been validated to measure physical activity in adults and children.[22-25]

The monitors were initialized to start collecting data in one-minute epochs at midnight following the MEC appointment. All data were blind to respondents while they wore the device. Respondents were given a prepaid envelope in which to return the monitors to Statistics Canada, where the data were downloaded, and the monitor was checked to determine if it was still within the manufacturer's calibration specifications.[26]

A valid day was defined as 10 or more hours of wear-time. 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 two minutes of counts between 0 and 100. For each minute, the level of movement intensity corresponding to at least moderate–to-vigorous physical activity (MVPA) was set at 1,535 cpm for adolescents[24] and at 1,500 cpm for adults.[23] For each respondent, minutes of MVPA were summed for each day and averaged for valid days.

Meeting the guidelines

New Canadian Physical Activity Guidelines, published in 2011,[4,27] recommend that adolescents aged 12 to 17 get 60 minutes of MVPA daily. The prevalence of compliance with the guide-

lines will be defined as having at least 60 minutes of MVPA on at least six out of seven days.[6] The guidelines recommend that adults obtain 150 minutes of MVPA per week, accumulated in bouts of 10 or more minutes.

LTPA was reported in average minutes per day. Average daily minutes of accelerometer-measured MVPA using every minute and using 10-minute bouts only were compared with average daily minutes of reported LTPA in order to approximate the physical activity guidelines, because the information on the questionnaire did not pertain to bouts or daily activities. Thresholds used for comparison were set at 60 minutes a day for adolescents and 150 minutes a week (21.4 minutes a day) for adults.

Statistical analysis

Descriptive statistics were used to present results and mean differences between LTPA and MVPA in minutes, and to describe MVPA by type of activity and the prevalence of meeting the physical activity guidelines or a given threshold. The distribution of the difference between LTPA (with exclusions) and MVPA (Figure 2) is presented as 25-minute intervals of the differences (within ±12.5 minutes of each other, ±12.5 to 37.5 minutes, ±37.5 to 62.5 minutes, or ±62.5 minutes' difference).

Pearson correlations were calculated based on each valid day pairing of LTPA and MVPA. Classification of respondents as meeting or not meeting the physical activity guidelines was presented where a disagreement emerged between LTPA and MVPA.

All statistical analyses were performed using SAS v9.2 (SAS Institute, Cary, NC) and were based on weighted data for respondents with at least four valid days of accelerometer data. To account for survey design effects of the CHMS, standard errors, coefficients of variation, and 95% confidence intervals were estimated with the bootstrap technique using 24 degrees of freedom.[18,28,29] Statistical significance was set at 0.05.

Results

Minutes vary with method

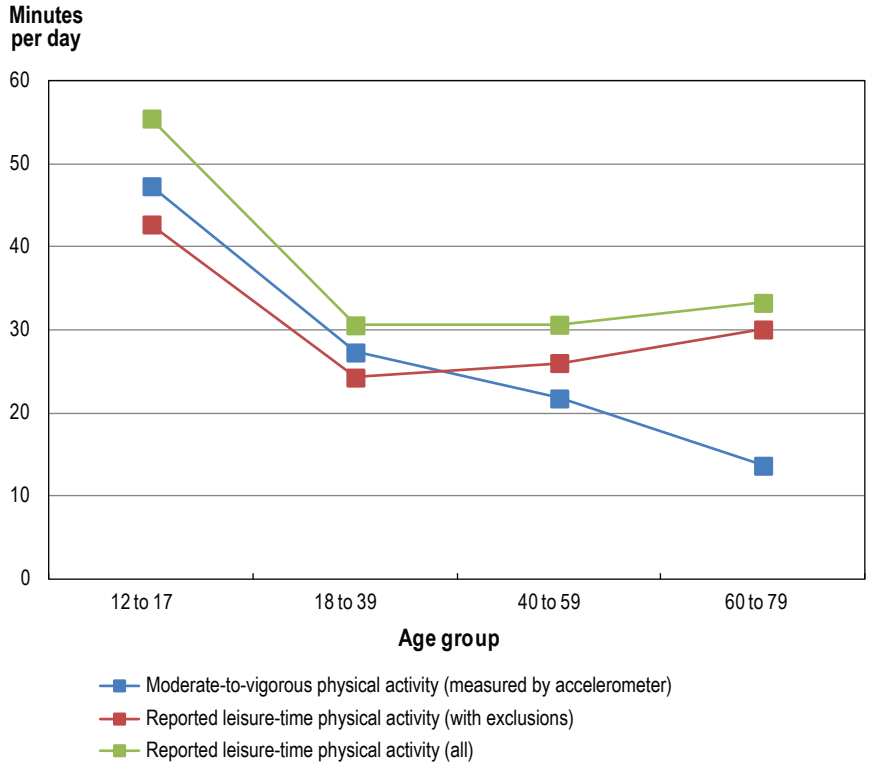
Figure 1 shows average daily minutes of accelerometer-measured MVPA and self-reported LTPA (all and with exclusions) by age group. Average minutes of MVPA were lower at older ages. Adolescents aged 12 to 17 reported more minutes of LTPA (all and with exclusions) than did people in older age groups. However, 60- to 79-year-olds reported more LTPA (all and with exclusions) than did 18- to 39-year-olds.

For people younger than age 40, MVPA estimates were between the two LTPA estimates (all and with exclusions). Older adults reported more LTPA (all and with exclusions) than what was measured with the accelerometer.

At ages 12 to 17 and 18 to 39, MVPA exceeded LPTA (with exclusions): +4.6 minutes and +3 minutes, respectively. By contrast, at ages 40 to 59 and 60 to 79, MVPA was less than LPTA (with exclusions): -4.3 minutes and -16.4 minutes, respectively. Differences varied by sex, especially in younger age groups (data not shown).

Average differences between measurement methods were within a couple of minutes, but the distribution of the difference was much wider (Figure 2). For 30% of adolescents aged 12 to 17, the difference between LTPA (with exclusions) and MVPA was within 12.5 minutes. However, 16% of them had at least 37.5 minutes more measured MVPA than LTPA (with exclusions), and 10% had at least 37.5 minutes less measured MVPA than LTPA (with exclusions). At ages 18 to 79, the distribution was more symmetrical: for 45% of people in this age range, MVPA was within 12.5 minutes

Figure 1
Daily minutes of accelerometer-measured moderate-to-vigorous physical activity and self-reported leisure-time physical activity with and without four activities, by age group, household population aged 12 to 79, Canada, 2007 to 2011



Note: Excluded activities are swimming, cycling, weight training and fishing.
Source: 2007 to 2009 and 2009 to 2011 Canadian Health Measures Survey, combined.

of LTPA (with exclusions); 16% had differences of more than ±37.5 minutes.

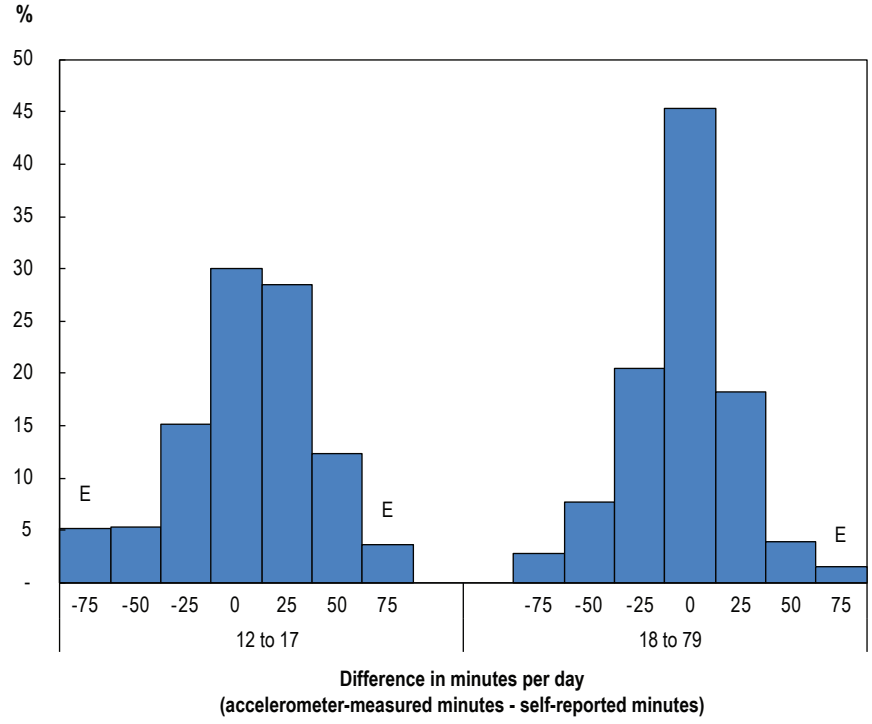
The discrepancy between LTPA (with exclusions) and MVPA is also reflected in weak Pearson correlations. Correlation coefficients by age group ranged from 0.22 to 0.26. Differences were pronounced by sex, with male correlations varying from 0.26 to 0.29 at ages 18 to 59, compared with 0.15 to 0.19 for their female counterparts. For older adults, the male correlation was lower at 0.20, while the female correlation was highest of all at 0.37 (data not shown).

Table 1 presents a detailed picture of the activities included in the LTPA estimates: average daily time reported for each of 24 activities, percentage of people who reported any time for each activity, and total minutes of MVPA for people who did or did not participate in that activity.

The four activities that are difficult to measure with an accelerometer (bicycling, swimming, weight training and fishing) accounted for 12.7, 6.3, 4.6 and 3.2 minutes of LTPA, respectively, for the four age groups (youngest to oldest). This represented 10% (ages 60 to 79) to 23% (ages 12 to 17) of all LTPA minutes reported. People who reported bicycling or weight training had significantly more minutes of MVPA than did those who did not engage in at least one of these activities.

For most activities, minutes of LTPA were lower at older ages. The two exceptions were walking and gardening/yard work. At all ages, walking made the largest single contribution to LTPA, rising from 12% of all LTPA minutes at ages 12 to 17 to 41% at ages 60 to 79. People aged 40 or older who reported walking had significantly more MVPA minutes than did those who did not report walking. Gardening/Yard work also accounted for more leisure time at older ages—24% of all LTPA minutes at ages 60 to 79, compared with 3% at ages 12 to 17. However, respondents reporting this activity did not have a difference in minutes of MVPA or lower amounts of MVPA than people who did not garden or do yard work.

Figure 2
Distribution of difference in minutes per day between accelerometer-measured moderate-to-vigorous physical activity and self-reported leisure-time physical activity (with exclusions), by age group, household population aged 12 to 79, Canada, 2007 to 2011



[E] use with caution
Note: Excluded activities are swimming, cycling, weight training and fishing.
Source: 2007 to 2009 and 2009 to 2011 Canadian Health Measures Survey, combined.

Meeting the guidelines

Figure 3 shows the extent to which people aged 12 to 79 met the physical activity guidelines or specific thresholds, according to measured MVPA, and also, according to self-reported LTPA.

In terms of MVPA, and based on a threshold of 60 minutes on at least six out of seven days for adolescents and 150 minutes a week (accumulated in bouts of 10 or more minutes) for adults, the percentages meeting the guidelines ranged from 4% (ages 12 to 17) to 19% (ages 18 to 39), and have been reported in earlier research.[7,9]

Thresholds of an average of 60 minutes a day of MVPA for adolescents and all minutes for adults (instead of bouts of at least 10 minutes) yielded much higher percentages meeting the guidelines (22% to 51%). Except for the oldest age group, these estimates fell between estimates calculated using minutes of LTPA (all) and LTPA (with exclusions).

The four excluded activities influenced the percentages meeting the thresholds based on minutes of LTPA. Between 14% and 29% more respondents met the thresholds when bicycling, swimming, weight training and fishing were included in LTPA estimates. This was twice as much as when these four activities were excluded.

Table 2 shows the percentages of respondents classified as meeting physical activity thresholds according to one measure, but not according to the other. Between 26% (females aged 12 to 17) and 46% (women aged 18 to 39) had different classifications depending on whether MVPA or LTPA (with exclu-

Table 1
Average daily leisure-time physical activity (LTPA) minutes reported, percentage participating and total daily minutes of moderate-to-vigorous physical activity (MVPA), by participation status, activity and age group, household population aged 12 to 79, Canada

	12 to 17				18 to 39			
			Total MVPA minutes				Total MVPA minutes	
Activity	LTPA minutes reported	Percent reporting %	Activity participant	Activity non-participant	LTPA minutes reported	Percent reporting %	Activity participant	Activity non-participant
Walking	6.9	60.3	45.8	49.5	8.1	65.8	27.3	27.3
Gardening/Yard work	1.5	36.8	46.7	47.6	2.6	39.3	23.7*	29.6
Swimming	4.0	54.7	47.7	46.8	1.1	30.0	27.8	27.1
Bicycling	5.4	53.6	51.4*	42.6	1.6	29.0	32.2*	25.3
Popular or social dance	2.2	40.6	47.1	47.4	1.1	24.2	30.7*	26.2
Home exercises	3.3[E]	40.8	46.6	47.8	3.8	38.8	28.1	26.8
Ice hockey	2.9[E]	18.3	52.6	46.1	0.5	7.4	35.5*	26.6
Ice skating	0.7	19.6	52.9*	45.9	0.2[E]	9.7	28.3	27.2
Rollerblading	1.2[E]	15.1	54.7*	46.0	0.2[E]	6.5[E]	35.5[E]	26.7
Jogging or running	3.7	57.8	50.5*	42.9	2.1	33.1	35.6*	23.1
Golfing	0.3[E]	12.0[E]	50.3	46.9	0.3	12.0	33.3	26.5
Exercise class or aerobics	1.7	16.0	46.3	47.5	1.0	12.8	33.0*	26.4
Downhill skiing/Snowboarding	0.5[E]	13.1[E]	58.4*	45.6	0.1[E]	6.0[E]	40.6*	26.4
Bowling	0.4	24.0	48.7	46.8	0.2[E]	13.0	32.4	26.5
Baseball or softball	1.0[E]	17.7	52.1	46.3	0.2[E]	4.6[E]	33.6	27.0
Tennis	0.5	13.3	49.0	47.0	0.2[E]	6.1[E]	42.5*	26.3
Weight training	3.0	30.1	49.4	46.4	3.3	28.1	35.2*	24.2
Fishing	0.4[E]	12.0	46.8	47.4	0.3[E]	11.5	30.4	26.9
Volleyball	2.8	34.2	47.9	47.0	0.2	6.5	29.5	27.1
Basketball	4.5	45.1	54.1*	41.7	0.5[E]	9.6	36.0	26.4
Soccer	3.6	46.1	51.2*	44.0	F	10.1	39.2*	25.9
Other 1	4.2	37.9	49.1	46.2	1.8	22.1	31.7*	26.0
Other 2	0.8[E]	10.8	51.7	46.8	0.1[E]	2.9[E]	32.4	27.1
Other 3	0.3[E]	4.1[E]	54.3	47.0	F	0.8[E]	30.3	27.3

	40 to 59				60 to 79			
			Total MVPA minutes				Total MVPA minutes	
Activity	LTPA minutes reported	Percent reporting %	Activity participant	Activity non-participant	LTPA minutes reported	Percent reporting %	Activity participant	Activity non-participant
Walking	10.5	67.2	23.5*	18.2	13.8	69.3	16.4*	7.5[E]
Gardening/Yard work	5.5	55.7	22.3	21.1	7.9	56.4	14.7	12.3
Swimming	0.8	20.0	24.3	21.1	0.9[E]	13.0	18.5	12.9
Bicycling	1.6	23.4	27.2*	20.1	1.1	12.2	17.9*	13.1
Popular or social dance	0.6[E]	17.5	21.0	21.9	0.6	13.3	14.8	13.5
Home exercises	3.6	34.4	23.7	20.7	3.2	27.9	16.8*	12.4
Ice hockey	0.2[E]	3.5[E]	25.5	21.6	F	0.7[E]	25.2[E]	13.6
Ice skating	0.2[E]	5.0[E]	27.8	21.4	F	F	22.6[E]*	13.5
Rollerblading	F	1.7[E]	23.4	21.7	F	F	24.3[E]	13.6
Jogging or running	1.2	16.0	30.1*	20.2	0.3[E]	3.3	28.5*	13.2
Golfing	0.5[E]	12.7	23.6	21.5	1.0	10.6	18.2*	13.1
Exercise class or aerobics	1.0	9.5	26.7*	21.2	1.1	8.1	21.2*	13.0
Downhill skiing/Snowboarding	F	F	28.7*	21.6	0.0[E]	0.6[E]	34.5[E]*	13.5
Bowling	0.2	6.4	19.6	21.9	0.3[E]	4.9	8.0*	13.9
Baseball or softball	F	1.9[E]	23.4	21.7	F	F	F	13.7
Tennis	0.1[E]	3.5[E]	29.0	21.5	0.1[E]	1.4[E]	20.7[E]	13.6
Weight training	1.9	20.2	29.4*	19.8	1.0	9.3	22.9*	12.7
Fishing	0.3[E]	7.8[E]	20.6	21.9	0.3[E]	5.7	8.9*	13.9
Volleyball	0.1[E]	2.3[E]	17.8	21.8	0.0	0.0	0.0*	13.7
Basketball	0.1[E]	3.3[E]	24.3	21.7	F	F	F	13.6
Soccer	0.2[E]	4.1[E]	27.9	21.5	F	F	F	13.6
Other 1	1.5	16.6	25.1*	21.1	1.4	11.3	17.8*	13.1
Other 2	0.3[E]	3.8[E]	28.0*	21.5	0.1[E]	2.1	25.2[E]	13.4
Other 3	F	F	34.7*	21.6	F	F	14.4[E]	13.7

[E] use with caution
F too unreliable to be published
* significantly different from total minutes of MVPA of activity non-participant. ($p < 0.05$)
Source: 2007 to 2009 and 2009 to 2011 Canadian Health Measures Survey, combined.

sions) was used. In most age group/sex categories, around 40% were not classified the same way on both measures.

Generally, at ages 12 to 39, a higher percentage met the thresholds based on MVPA but not based on LTPA (with exclusions) than the other way around. At age 40 or older, particularly among 60- to 79-year-olds, most of the difference reflects meeting the thresholds based on LTPA (with exclusions), but not based on MVPA.

Discussion

This analysis reveals discrepancies between accelerometer-measured MVPA and self-reported LTPA. Although averages were close to each other, differences between estimates could exceed 37.5 minutes in one direction or the other. Around 40% of the population met physical activity thresholds according to one measurement method, but not according to the other. This disagreement is reinforced by the weak correlations observed.

The lack of a systematic trend in the relationship between the two measurement methods is important because it precludes future attempts to create correction factors or to be confident in using one method rather than the other. Accelerometers and questionnaires measure different aspects of physical activity. The present study reflects that reality by providing evidence of the range of difference between the approaches.

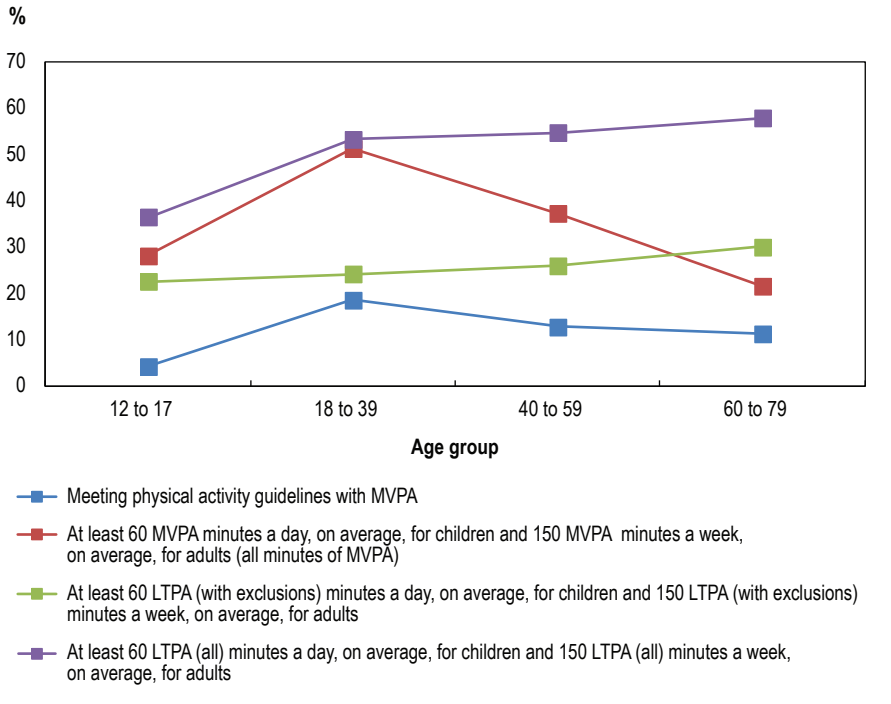
Similar results were obtained in the United States from NHANES [12]—fewer than 10% of adults met the physical activity guidelines based on accelerometer results, compared with 62% based on self-reported data. As noted in two review articles comparing direct and indirect measures of physical activity,[10,11] there was no systematic positive or negative difference between MVPA and LTPA; the difference varied by age and sex and by person within a category.

Limitations specific to each method of measurement have been cited to explain some of these differences. This study makes it possible to further quantify these limitations and better understand the lack of agreement by examining the detailed list of physical activities used in the LTPA calculation.

An important limitation of accelerometry is its inability to accurately measure activities such as swimming, bicycling and weight training. The results of this study show that younger people report these activities in greater volume and frequency. If accelerometers could measure these activities, MVPA would likely increase more in the younger age group, which would make the MVPA gradient from younger to older age groups steeper. Similarly, respondents engaged in bicycling or weight training are already accumulating more minutes of MVPA, potentially further increasing the difference if these activities were captured by the accelerometer. This, however, does not help to explain the increase in LTPA at older ages.

Another potential limitation of accelerometry is the thresholds used to qualify the intensity of one minute of MVPA. If thresholds are too high, minutes of MVPA are missed. It is also possible that these intensity thresholds differ by age group. Lowering the thresholds would mean capturing moderate activity levels when walking at a slower pace. It was beyond the scope of this paper to examine the appropriateness of the intensity thresholds. Rather, the analysis relied on published thresholds developed under controlled laboratory conditions.[23,24] The intensity thresholds were applied to the data, and all observations above the threshold were counted as moderate.

Figure 3
Percent meeting physical activity guidelines and other thresholds according to accelerometer-measured moderate-to-vigorous physical activity and self-reported leisure-time physical activity, household population aged 12 to 79, Canada, 2007 to 2011



MVPA = moderate-to-vigorous physical activity
LPTA = leisure-time physical activity
Note: For 12- to 17-year-olds, the physical activity guideline used is 60 minutes a day on a least six out of seven days a week. For those aged 18 or older, the physical activity guideline used is 150 minutes a week, on average, accumulated in bouts of a least 10 minutes. Excluded activities are swimming, cycling, weight training and fishing.
Source: 2007 to 2009 and 2009 to 2011 Canadian Health Measures Survey, combined.

This objective approach is, in fact, an important strength of accelerometry.

Self-reported LTPA, too, has limitations. Like MVPA, LTPA decreased with age for most self-reported activities. The exceptions were walking and gardening/yard work, with minutes reported and participation rates rising at older ages. However, a social desirability bias may be present. Adams has shown that this bias is more likely to apply to light or moderate activities than to vigorous ones.[30]

As well, it is possible that respondents are correctly reporting the activity, but that the intensity level is not high enough to be recorded by the accelerometer. This includes walking at a slower pace than what is considered "moderate" by an accelerometer, or gardening while sitting. For example, respondents who reported 60 minutes of gardening during which they were largely kneeling or sitting would end up with 60 minutes of LTPA, but only a few, if any, minutes of accelerometer-measured MVPA. The large percentages of LTPA among older people that were attributable to walking and gardening may explain the differences between LTPA and MVPA in the older age group.

Two limitations of self-reports may also be contributing to underestimates of LTPA. The CHMS questionnaire does not ask about active transportation or physical activity at work or school, so such activity is not captured in LTPA. However, for some people, this could be a significant amount of physical activity that would be captured by accelerometers. Also, the allowable duration of LTPA per activity is capped at 60 minutes on the questionnaire, which poses a problem for activities that can last longer, such as bicycling and golfing.

Another limitation is that the collection periods differ. MVPA is measured the week after the MEC visit, whereas LTPA reflects the three months before the interview. Both theoretically represent "usual" physical activity; however, week-to-week variations could explain a considerable amount of the difference observed between methods in this analysis.

Table 2
Percent of respondents classified as meeting physical activity threshold according to accelerometer-measured data or self-reported data but not according to both, by age group and sex, household population aged 12 to 79, Canada, 2007 to 2011

	Meeting thresholds according to average daily minutes of accelerometer-measured MVPA, but not according to self-reported LTPA (with exclusions)			Meeting thresholds according to self-reported LTPA (with exclusions), but not according to average daily minutes of accelerometer-measured MVPA		
		95% confidence interval			95% confidence interval	
Age group/Sex	%	from	to	%	from	to
12 to 17						
Total	18.9	14.6	23.1	13.4	10.2	16.5
Male	25.7	19.3	32.1	11.9	7.9	16.0
Female	11.4	7.9	14.9	14.9	10.7	19.2
18 to 39						
Total	25.5	21.3	29.7	18.2	13.9	22.4
Male	27.7	21.5	33.8	14.2[E]	8.9	19.4
Female	23.3	18.1	28.6	22.2	16.6	27.7
40 to 59						
Total	14.9	12.7	17.1	25.5	21.5	29.6
Male	17.4	13.7	21.0	21.2	16.6	25.8
Female	12.5	8.7	16.2	29.8	23.9	35.7
60 to 79						
Total	4.3[E]	2.5	6.1	37.5	33.6	41.4
Male	5.0[E]	2.8	7.2	36.8	33.2	40.5
Female	3.6[E]	1.4	5.7	38.1	31.7	44.5

[E] use with caution

MVPA = moderate-to-vigorous physical activity

LPTA = leisure-time physical activity

Notes: For 12- to 17-year-olds, the physical activity threshold is 60 minutes a day on average. For those aged 18 or older, the physical activity threshold is 150 minutes a week on average. The four excluded activities are swimming, cycling, weight training and fishing.

Source: 2007 to 2011 and 2009 to 2011 Canadian Health Measures Survey, combined.

What is already known on this subject?

- According to self-reported data from the Canadian Community Health Survey, 53.9% of people were moderately active during their leisure time.
- Accelerometer-based data from the Canadian Health Measures Survey show that 15% of adults and fewer than 10% of adolescents met guidelines for moderate-to-vigorous physical activity.
- Results of systematic reviews of comparisons of these two methods of measuring physical activity have been inconclusive.

What does this study add?

- Averages of self-reported leisure-time physical activity and measured moderate-to-vigorous physical activity were within a couple of minutes of each other.
- However, at the individua level, the absolute difference between measured and self-reported physical activity could exceed 37.5 minutes per day.
- Misclassification of people as meeting the guidelines is 40%.
- Self-reported walking and gardening account for the discrepancy between the results of the measurement methods in the older age group.

In addition, the concepts differ: LTPA captures leisure time spent on activity that individuals can recall, while accelerometry captures any movement at a defined intensity. For example, someone reporting that they played hockey for one hour (LTPA) might have only 20 minutes (MVPA) recorded on an accelerometer.

The LTPA module of the CHMS cannot assess compliance with the physical activity guidelines. For children, the guidelines call for at least 60 minutes of physical activity every day. For adults, the guidelines state that physical activity should be accumulated in bouts of at least 10 minutes. LTPA is currently reported as a daily average using all minutes (not necessarily bouts of activity).

However, the guidelines were not necessarily developed with measured physical activity in mind since most of the research conducted prior to the development of the physical activity guidelines used self-reported estimates

Conclusion

Accurate estimates of physical activity are important for health surveillance. Self-reports, which have been used for years, provide important context surrounding physical activity, including details of specific activities. Nonetheless, the self-reported questionnaire now used by the CHMS does not allow assessments of compliance with current physical activity guidelines, because it does not take into account the notion of bouts or the daily variation of physical activity. Although the new accelerometry data make it possible to assess compliance with the guideline metrics, this method may not capture all movement. The two measures complement each other by mitigating their respective limitations. For example, activities not captured by accelerometry, such as bicycling and weight training, are easily captured in a questionnaire. At the same time, social desirability cannot affect accelerometry. New self-reported instruments are planned for future CHMS cycles and other surveys. This study can serve as a baseline for comparison and validation exercises. ■

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