Health Reports

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Release date: November 15, 2023

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ABSTRACT

Introduction

On average, 45% of Canadian adults meet the recommended 150 minutes per week of moderate-to-vigorous physical activity. This singular statistic masks a wide range of adherence levels among different groups within the population. The purpose of this paper is to determine how sex, age, and family arrangement intersect with known risk factors for physical inactivity to identify groups within the Canadian population most at risk of not meeting the physical activity recommendation.

Methods

Using six combined cycles of the Canadian Health Measures Survey (from 2007 to 2019), this study examines how the percentage of Canadian males and females aged 18 to 79 years meeting the physical activity recommendation differs across sociodemographic, family arrangement, and health factors. Logistic regression was used to examine whether the association between specific factors and adherence to the physical activity recommendation differed by sex. Latent class analysis was used to identify sex-specific combinations of sociodemographic, family arrangement and health-related factors within the Canadian population that are associated with varying levels of adherence to the physical activity recommendation.

Results

More males met the physical activity recommendation compared with females (49% versus 38%). Latent classes with the lowest adherence to the physical activity recommendation (19% among females and 29% among males) primarily included those who were single or married with no children and who had a high probability of having many risk factors for physical inactivity, including being older, having a lower education, having lower income, smoking, having central adiposity, and having poor or fair self-rated general health. Latent classes with the highest adherence to the physical activity recommendation (61% among females and 67% among males) primarily included individuals with no spouse and no children and who had a low probability of having any risk factors for physical inactivity. For females, an additional class (32% of which met the physical activity recommendation) comprised young single mothers who had several risk factors for physical inactivity, including having low income, smoking and having central adiposity.

Interpretation

Understanding how risk factors for physical inactivity intersect with sex, age, and family arrangement may inform strategies aimed at increasing physical activity among those who are most vulnerable.

Keywords

exercise, free time, parenthood, aging, intersectionality

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What is already known on this subject?

- Among Canadian adults, 45% meet the physical activity recommendation.

- Physical activity declines with age.

- Men are more active than women.

- Parents of young children are less active than adults with no children.

- The social determinants of health affect lifestyle behaviours, including physical activity.

What does this study add?

- There is wide variation in adherence to the physical activity recommendation according to sex, age, sociodemographic factors, family arrangement and health status.

- Males are more active than females across all age groups, sociodemographic characteristics, family arrangement types, and health statuses. The difference is greater than the average among 35- to 49-year-olds, single parents, and those without abdominal obesity.

- While physical activity declines with age, older Canadians with few risk factors for inactivity are more active than those who also have low income, low education, and poor self-rated health and who are more likely to smoke and be living alone.

- Younger Canadians are more active than older Canadians; however, younger Canadians with children in the household are less active than those without.

Substantive evidence points to a strong dose–response relationship between physical activity and the prevention of premature mortality and several chronic conditions.[1] Among Canadian adults, 45% meet the recommended 150 minutes of moderate-to-vigorous physical activity (MVPA) per week.[2] This singular statistic reflects the average adherence among Canadian adults aged 18 to 79 years and does not provide information about groups within the population that may be more or less likely to meet the physical activity recommendation. Many individual barriers to physical activity have been proposed; however, the compounding effect of having multiple risk factors for physical inactivity is less clear. Further, the interplay of age-related differences in physical activity behaviour and family arrangement with other risk factors for physical inactivity is not well understood. Identification of the most common combinations of age, family arrangement, and risk factors for inactivity in the Canadian context may help to target public health messaging and strategies toward those who need them most.

Previous research has identified many independent sources of influence on physical activity behaviour, including sociodemographic factors (e.g., age, sex/gender, education, and income), family arrangement (e.g., young children in the household and one-parent families), health conditions (e.g., obesity and chronic health conditions) and psychosocial characteristics (e.g., self-rated general and mental health). In Canada, physical activity declines with age, and men are more active compared with women.[2,3] During the COVID-19 pandemic, Canadian women were less active compared with men and reported more barriers and fewer facilitators to physical activity.[4] Women report having less leisure time when compared with men. When women do have leisure time, it is more likely to be fragmented and they are less likely to use it for active pursuits.[5,6] The demands of childrearing and household chores can limit time available for leisure-time physical activity,[6-8] and this may be exacerbated among mothers in one-parent families.[9-10] Canadians with chronic health conditions, who smoke, or who have lower household income and education are also less likely to meet the physical activity recommendation.[11] Inequalities in physical activity exist in Canada, and it is likely that many Canadians have multiple risk factors for inactivity. To date, much of the research on physical activity epidemiology has not considered the intersections among multiple risk factors for physical inactivity.

The intersection of age, sex, and family arrangement with other risk factors for inactivity may provide important insight into those who are facing compounding challenges when it comes to adopting and maintaining an active lifestyle. Such an approach draws from the theory of intersectionality, which acknowledges that multiple, intersecting social statuses should be considered to better understand the synergies between multiple risk factors or correlates of a given outcome.[12] Regression modelling with four-way interactions was used in an analysis of nationally representative Canadian survey data to show that the positive

effect of income on physical activity was strongest among racialized men, that income and physical activity were moderately related among White men and women, but that income had no effect on physical activity among racialized women.[13] Mielke and colleagues used a multiple jeopardy index to show that physical activity was highest among White men with high income and high education and lowest among non-White women with low income and low education (48% versus 9.8%, respectively, met the physical activity guideline).[14] Latent class analysis (LCA) is another technique that can examine how multiple factors intersect to influence physical activity. In addition to identifying important groupings of risk factors, LCA can identify the most common groups within a given population.

The Canadian Health Measures Survey (CHMS) is a nationally representative health survey that has collected data in two-year cycles in the Canadian provinces from 2007 to 2019. Physical activity is objectively measured in the CHMS and is available alongside comprehensive questionnaire-based information about health status, health behaviours, sociodemographic characteristics, and psychosocial characteristics. The objectives of this study are to

1. examine sex differences in how adherence to the physical activity recommendation varies across sociodemographic, family arrangement, and health characteristics,

2. use logistic regression to examine whether the association between specific characteristics and physical activity adherence differs by sex,

3. use LCA to identify groups within the population according to sociodemographic, family arrangement, and health determinants to understand group differences in meeting the physical activity recommendation.

Methods

Data source

Data are from the CHMS, a repeated cross-sectional, nationally representative survey at Statistics Canada that collects self-reported and directly measured health information from the Canadian population aged 3 to 79 years (aged 6 to 79 in Cycle 1) living in private dwellings in the 10 provinces. People living in the three territories or on reserves and settlements in the provinces, the institutionalized population, residents of certain remote regions, and full-time members of the Canadian Forces are excluded (about 4% of the Canadian population). 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), January 2016 to December 2017 (Cycle 5), and January 2018 to December 2019 (Cycle 6). 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 (MEC), where additional questions were asked, a series of physical measurements (e.g., height, weight, and blood pressure) were administered, and accelerometers were provided to participants. More information about the CHMS is available elsewhere.[15-17] The study sample included respondents aged 18 to 79 years from all survey cycles with valid accelerometer data. The total sample of pooled data (n=15,510) from cycles 1 to 6 of the CHMS comprised 7,513 males and 7,997 females.

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. Details of the accelerometer data reduction procedures are available elsewhere.[18,19] 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.[18] Total measured time on each valid day spent in MVPA was determined based on the moderate cut-point (1,535 counts per minute or more).[20] The daily average time spent in MVPA was calculated as the total number of minutes for all valid days, divided by the number of valid days. Adherence to the Canadian physical activity recommendation was assessed based on respondents with a weekly sum of at least 150 MVPA minutes.[21,22]

Family arrangement

Using the living arrangement variable (DHHDLVG) and the respondent's marital status, a four-level family arrangement variable was derived:

1. not married nor living common law and not a parent to any child in the household (referred to as **no spouse, no children**)

2. married or living common law and not a parent to any child in the household (referred to as **with spouse, no children**)

3. dual parent of at least one child in the household (referred to as **dual parent**)

4. single parent of at least one child in the household (referred to as **single parent**)

Risk factors for physical inactivity

Sex (male or female) was reported during the visit to the MEC. Gender (man/woman) was not reported in the CHMS. Age groups were 18 to 34 years, 35 to 49 years, 50 to 64 years, and 65 to 79 years. The highest level of educational attainment was derived as less than a secondary school education, secondary school graduation and a postsecondary degree or diploma. Adjusted household income quintiles were derived by using a modified version of the equivalence score method where total household income is adjusted by a weight factor based on the number of people in the household.[23] Smoking status was dichotomized into daily smoker (yes or no). The number of

chronic conditions (asthma, respiratory conditions, fibromyalgia, arthritis, back problems, high blood pressure, high cholesterol, diabetes, heart disease, cancer, effects of a stroke, thyroid disease, mood disorder, kidney dysfunction, liver or gallbladder problems, hepatitis, other, and gastrointestinal conditions in cycles 5 and 6 only) was summed and dichotomized into none versus one or more. Three levels of health risk from central adiposity were derived using waist-to-height ratios: healthy central adiposity (0.4 to 0.49), increased central adiposity (0.5 to 0.59), and high central adiposity (0.6 or more).[24] Self-rated general and mental health were dichotomized into fair or poor and good, very good, or excellent.

Statistical analysis

Proportions and 95% confidence intervals (CIs) were estimated to examine adherence to the physical activity recommendation by sex across sociodemographic, family arrangement, and health characteristics. For each characteristic, sex-specific univariate logistic models estimated proportion differences (with 95% CIs) in physical activity recommendation adherence. Statistical testing of differences across characteristics was conducted using t-tests. Separate multivariable logistic regression models with listwise deletion (n=278 of 15,510 [less than 2%] were excluded), each with an interaction term between sex and one covariate, adjusting for all remaining covariates, assessed whether the association between a specific characteristic and adherence to the physical activity recommendation differed by sex. Model-adjusted differences by sex and their 95% CIs were estimated by calculating average marginal effects. To account for the survey's complex sampling design, analyses were weighted using the CHMS cycles 1 to 6 combined survey weight. Variance estimation (95% CIs) was done using the replicate weights generated by Statistics Canada. The data were analyzed with SAS 9.4 and SAS-callable

Table 1
Sample size and weighted proportion distribution, total and by sex, across selected characteristics, 2007 to 2019

	Total		Males		Females	
	number	%	number	%	number	%
Total	15,510	100.0	7,513	100.0	7,997	100.0
Sex						
Male	7,513	49.9	...	...	...	...
Female	7,997	50.1	...	...	...	...
Age group						
18 to 34	3,395	28.3	1,614	28.7	1,781	27.9
35 to 49	5,358	29.5	2,603	30.1	2,755	28.8
50 to 64	3,885	28.4	1,945	27.8	1,940	29.0
65 to 80	2,872	13.8	1,351	13.3	1,521	14.3
Highest level of educational attainment						
Less than secondary school graduation	1,662	10.2	837	11.5	825	8.9
Secondary school graduation	3,383	24.5	1,607	25.5	1,776	23.6
Postsecondary graduation	10,326	65.2	4,996	63.0	5,330	67.5
Household income quintiles adjusted for household size						
1st (lowest)	3,202	20.0	1,292	17.2	1,910	22.8
2nd	3,300	19.8	1,542	19.3	1,758	20.4
3rd	3,184	20.0	1,590	19.4	1,594	20.6
4th	3,006	19.8	1,571	21.1	1,435	18.5
5th (highest)	2,818	20.3	1,518	22.9	1,300	17.7
Family structure						
No spouse, no children	4,290	31.6	1,940	32.4	2,350	30.9
With spouse, no children	4,483	33.0	2,364	33.3	2,119	32.7
Dual parent	5,735	31.0	3,034	32.2	2,701	29.7
Single parent	996	4.4	171	2.0	825	6.7
Daily smoker						
Yes	1,954	15.0	1,051	17.8	903	12.2
No	13,520	85.0	6,439	82.2	7,081	87.8
Central adiposity						
No increased health risk	4,113	29.1	1,757	26.6	2,356	31.6
At increased health risk	6,847	42.8	3,693	46.5	3,154	39.1
At even greater health risk	4,498	28.1	2,035	27.0	2,463	29.3
Has at least one chronic condition						
Yes	10,129	63.2	4,731	60.1	5,398	66.4
No	5,381	36.8	2,782	39.9	2,599	33.6
Self-reported general health						
Good, very good, or excellent	14,009	90.1	6,762	89.8	7,247	90.5
Poor or fair	1,500	9.9	750	10.2	750	9.5
Self-reported mental health						
Good, very good, or excellent	14,552	92.9	7,117	94.0	7,435	91.8
Poor or fair	908	7.1	373	6.0	535	8.2
Met physical activity guidelines						
Yes	6,293	43.4	3,415	48.5	2,878	38.2
No	9,217	56.6	4,098	51.5	5,119	61.8

... not applicable
Sources: 2007 to 2009, 2009 to 2011, 2012 to 2013, 2014 to 2015, 2016 to 2017, and 2018 to 2019 Canadian Health Measures Survey, combined.

SUDAAN 11.0.3, using DDF = 68 (denominator degrees of freedom equal to 68) in the SUDAAN procedure statements.

LCA was used to identify similar types of individuals in terms of physical inactivity risk. The technique estimates the characteristics of each latent group and provides the probability that each individual belongs to each group. LCA was conducted separately for males and females. For each sex, a series of models was estimated, starting with a one-class solution and successively increasing the number of classes by one, up to a five-class solution. Models were estimated using unweighted data and evaluated based on interpretability of classes coupled with the following statistical information criteria: Bayesian information criterion (BIC), Akaike information criterion (AIC), sample-size adjusted BIC, and consistent AIC, with

lower scores indicating superior fit. Model classification accuracy was assessed via inspection of average posterior probabilities of class membership and entropy, with values greater than or equal to 0.80 and greater than or equal to 0.70, respectively, representing acceptable classification. The percentage of respondents in each class was also examined to ensure that no class contained less than 5% of the sample. The poLCA package in RStudio 1.4.1106 was used to fit the latent class models.[25] The survey weights were used to estimate probabilities of characteristics by latent class for males and females and were incorporated in sex-specific univariate logistic models to estimate relative risk and 95% CIs of adherence to the physical activity recommendation across classes.

Table 2

Prevalence of meeting the physical activity recommendation, by sex, across selected characteristics, 2007 to 2019

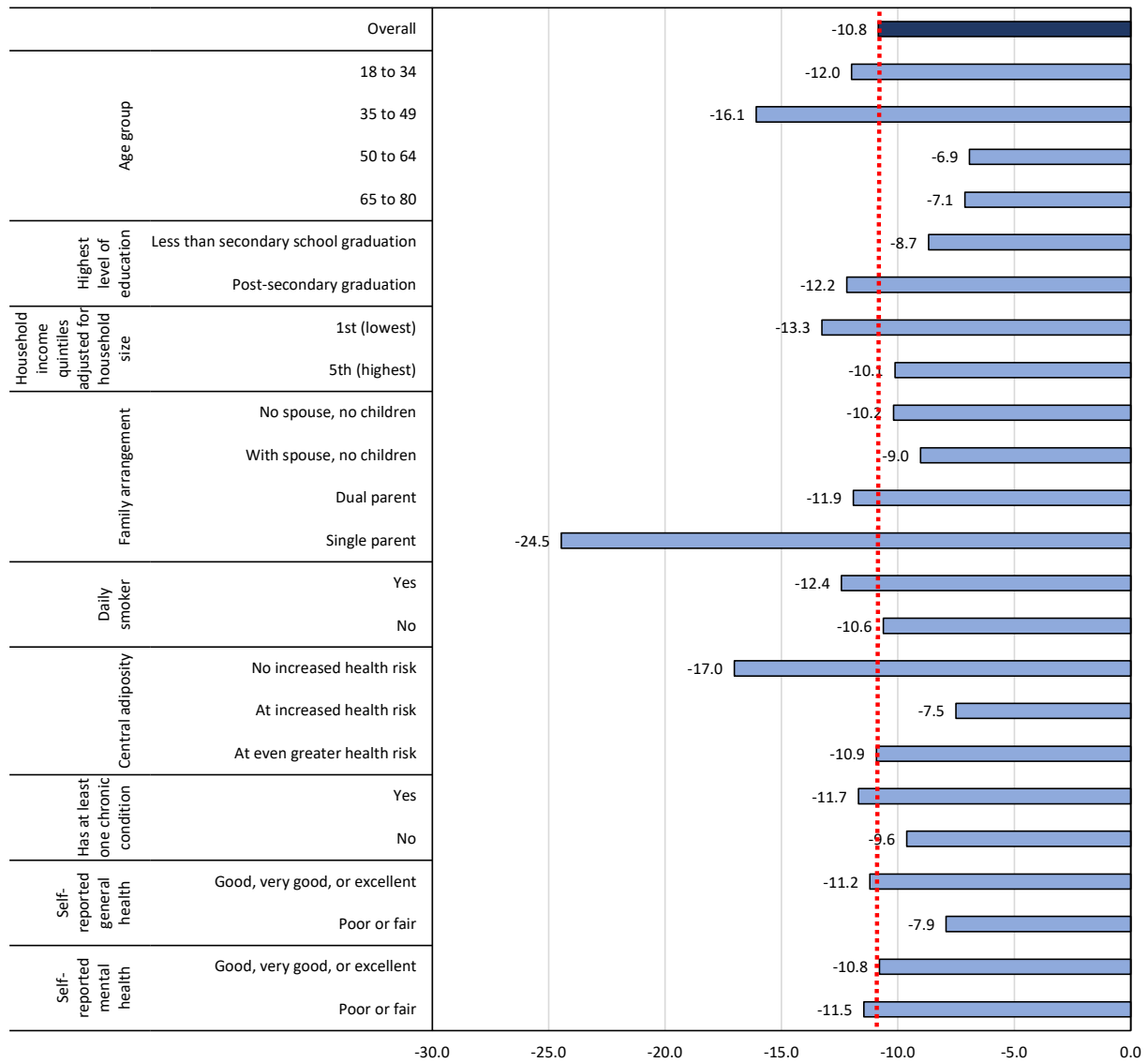| | Males | | | | | | Females | | | | | |
| | | Prevalence | | | Difference in prevalence compared with reference group | | | Prevalence | | | Difference in prevalence compared with reference group | |
| | | | 95% confidence interval | | | 95% confidence interval | | | 95% confidence interval | | | 95% confidence interval | |
	number	%	from	to	%	from	to	number	%	from	to	%	from	to
Total	3,415	48.5	45.0	52.0	…	…	…	2,878	38.2	35.6	41.0	…	…	…
Age group														
18 to 34	999	64.8	58.8	70.4	40.3 **	33.5	47.1	831	53.3	48.1	58.4	32.4 **	26.5	38.3
35 to 49	1,322	51.9	47.2	56.5	27.4 **	22.9	31.8	1,119	35.9	31.9	40.1	15.0 **	10.5	19.5
50 to 64	748	39.5	34.6	44.7	15.0 **	9.7	20.3	622	34.7	31.1	38.6	13.9 **	9.3	18.5
65 to 80[†]	346	24.5	20.8	28.6	…	…	…	306	20.9	17.8	24.3	…	…	…
Highest level of educational attainment														
Less than secondary school graduation[†]	272	33.1	26.1	40.9	…	…	…	180	22.1	18.1	26.7	…	…	…
Secondary school graduation	736	48.9	43.4	54.3	15.7 **	8.4	23.1	644	39.1	34.9	43.4	16.9 **	11.2	22.7
Postsecondary graduation	2,388	51.6	47.8	55.3	18.4 **	10.9	26.0	2,030	40.2	36.6	43.8	18.0 **	12.3	23.8
Household income quintiles adjusted for household size														
1st (lowest)[†]	541	45.8	38.2	53.5	…	…	…	554	32.4	27.9	37.3	…	…	…
2nd	596	41.4	36.2	46.9	-4.3	-13.9	5.2	539	35.0	30.6	39.7	2.6	-3.0	8.2
3rd	715	49.2	42.2	56.4	3.5	-6.5	13.5	564	38.7	33.7	43.9	6.3	-0.3	13.0
4th	743	50.0	44.8	55.2	4.3	-4.8	13.4	586	40.0	34.3	45.9	7.6 *	1.0	14.2
5th (highest)	820	54.5	48.8	60.0	8.7	0.1	17.3	635	47.2	42.5	52.0	14.8 **	8.6	21.1
Family structure														
No spouse, no children	1,034	58.5	53.7	63.2	9.2	-8.6	26.9	930	45.1	40.3	49.9	17.3 **	10.4	24.1
With spouse, no children	866	41.1	37.1	45.2	-8.3	-25.7	9.2	643	35.1	31.2	39.2	7.3 *	1.1	13.5
Dual parent	1,436	46.1	41.2	51.1	-3.3	-20.4	13.9	1,021	36.6	33.0	40.4	8.8 *	2.5	15.1
Single parent[†]	78	49.4	32.3	66.6	…	…	…	282	27.8	22.7	33.5	…	…	…
Daily smoker														
Yes[†]	375	39.0	32.2	46.3	…	…	…	215	22.9	18.5	28.0	…	…	…
No	3,033	50.6	47.2	53.9	11.6 **	5.3	17.9	2,662	40.4	37.6	43.3	17.5 **	12.3	22.7
Central adiposity														
No increased health risk	1,155	70.1	64.8	75.0	38.3 **	33.2	43.4	1,211	53.2	49.0	57.3	30.2 **	25.5	34.9
At increased health risk	1,660	46.0	42.2	49.7	14.1 **	9.9	18.4	1,141	37.7	34.1	41.5	14.7 **	9.9	19.6
At even greater health risk[†]	592	31.8	27.5	36.5	…	…	…	519	23.0	19.6	26.8	…	…	…
Has at least one chronic condition														
Yes[†]	1,905	43.3	39.4	47.4	…	…	…	1,688	33.4	30.5	36.4	…	…	…
No	1,510	56.3	51.8	60.7	13.0 **	8.4	17.6	1,190	47.8	43.7	52.0	14.4 **	10.0	18.8
Self-reported general health														
Good, very good, or excellent	3,208	50.9	47.2	54.5	23.2 **	17.3	29.1	2,742	40.0	37.2	42.8	18.3 **	12.1	24.6
Poor or fair[†]	207	27.7	22.2	33.9	…	…	…	136	21.7	16.3	28.1	…	…	…
Self-reported mental health														
Good, very good, or excellent	3,230	48.7	45.1	52.3	3.0	-7.6	13.7	2,700	38.6	35.9	41.3	3.0	-5.9	11.8
Poor or fair[†]	176	45.7	35.2	56.6	…	…	…	170	35.6	27.2	45.0	…	…	…

… not applicable

[†] Reference category

* significantly different from reference category (p < 0.05)

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

Sources: 2007 to 2009, 2009 to 2011, 2012 to 2013, 2014 to 2015, 2016 to 2017, and 2018 to 2019 Canadian Health Measures Survey, combined.

Figure 1

Differences between females and males in model-adjusted prevalence of meeting the physical activity recommendation, by selected characteristics

	Value
Overall	-10.8
Age group	
18 to 34	-12.0
35 to 49	-16.1
50 to 64	-6.9
65 to 80	-7.1
Highest level of education	
Less than secondary school graduation	-8.7
Post-secondary graduation	-12.2
Household income quintiles adjusted for household size	
1st (lowest)	-13.3
5th (highest)	-10.1
Family arrangement	
No spouse, no children	-10.2
With spouse, no children	-9.0
Dual parent	-11.9
Single parent	-24.5
Daily smoker	
Yes	-12.4
No	-10.6
Central adiposity	
No increased health risk	-17.0
At increased health risk	-7.5
At even greater health risk	-10.9
Has at least one chronic condition	
Yes	-11.7
No	-9.6
Self-reported general health	
Good, very good, or excellent	-11.2
Poor or fair	-7.9
Self-reported mental health	
Good, very good, or excellent	-10.8
Poor or fair	-11.5

Notes: Estimates were produced from separate models in which there was an interaction between sex and a single covariate, adjusting for all remaining covariates. There was a p-value of 0.04 for the Satterthwaite adjusted F-statistic in the model containing the interaction between sex and central adiposity suggesting that the association between central adiposity and meeting the guidelines differed between women and men.

Source: 2007 to 2009, 2009 to 2011, 2012 to 2013, 2014 to 2015, 2016 to 2017, 2018 to 2019 Canadian Health Measures Survey, combined.

Results

Descriptive statistics

Males and females shared a similar distribution across age groups, education levels, and income quintiles, as well as good, very good, or excellent general and mental health (Table 1). There was a higher proportion of single mothers (6.7%) compared with single fathers (2.0%) and a higher proportion of females than males with at least one chronic condition (66.4% versus 60.1%, respectively). By contrast, there was a higher proportion of smokers among males (17.8%) versus females (12.2%), and a higher proportion of males had increased health risk because of central adiposity compared with females (73.5% versus 68.4%, respectively).

The proportion of Canadians meeting the physical activity recommendation was higher among males when compared with females overall and across all characteristics included in the present analysis (Table 2). For both sexes, the proportion

meeting the recommendation decreased with age and increased with education and income. Males and females with no spouse and no children were the family arrangement group with the highest adherence to the physical activity recommendation (58.5% and 45.1%, respectively). Among males, the family arrangement group with the lowest adherence to the physical activity recommendation was those with a spouse and no children (41.1%), while among females, single mothers had the lowest adherence to the physical activity recommendation (27.8%). Among both sexes, smokers, those with increased or high central adiposity, those with at least one chronic condition, and those who rated their general health poorly had lower adherence to the physical activity recommendation compared with their respective reference groups. The proportion of males and females meeting the physical activity recommendation did not differ by self-rated mental health status.

Model-adjusted prevalence estimates

After sociodemographic, family arrangement, and health characteristics were adjusted for, females were less likely than males (10.8 percentage point difference) to meet the physical activity recommendation. This sex difference was markedly greater than the average among 35- to 49-year-olds, single parents, and those with no increased health risk from central adiposity (Figure 1). The sex difference was markedly less than the average among those aged 50 years and older, those at some increased risk from central adiposity, and those reporting poor or fair general health. In the fully adjusted logistic regression model, all characteristics were significantly associated with meeting the physical activity recommendation, except for chronic conditions and self-reported mental health (Satterthwaite F-test greater than 0.05) (data not shown). These two variables were therefore not included in the subsequent LCA.

Latent class analysis

Based on the latent class fit indices and conceptual interpretation of classes (see the Methods section for a description of the criteria), the four-class solution was selected for males and the five-class solution was selected for females (Table 3). A five-class solution did not emerge for males

because this group did not meet the LCA criteria set a priori. Entropy values were adequate for each solution, 0.71 and 0.72, respectively. The average posterior probabilities ranged from 0.79 (Class 2) to 0.89 (Class 3) for the four-class solution for males and from 0.79 (Class 1) to 0.86 (classes 2 and 4) for the five-class solution for females. All classes contained more than 5% of the sample. The four classes for males were ordered from the lowest to the highest percentage meeting the physical activity recommendation. Therefore, Class 1 represents those with the highest risk of not meeting the physical activity recommendation and Class 4 represents those with the lowest risk of not meeting it. A similar approach was taken for females; however, the additional fifth class was identified as unique based on results pertaining to family arrangement and income. Because of low numbers of fathers in one-parent families in the analytical sample of the present study, a unique LCA class did not emerge for this group.

Table 4 describes the probabilities of characteristics by LCA class for males and females. Figure 2 overlays adherence to the physical activity recommendation on a graphical depiction of the probabilities of characteristics by LCA class for males and females. Males and females in Class 1 comprised those who were older (the probability of being aged 50 years or older was 84.1% among males and 99.8% among females); with no children (with or without a spouse); and who had the highest probabilities for all risk factors, including having a lower education, having lower income, being a smoker, having central adiposity, and having poor or fair self-rated general health. Females in Class 1 were more likely to be in the oldest age group compared with males in the same class (53.4% vs. 37.5%, respectively). Males and females in Class 2 also had a high probability of being older (over 80% probability of being aged 50 years or older) and having central adiposity, but unlike those in Class 1, they had lower probabilities of having low income, having a low education, being a smoker, or having poor or fair self-rated general health. Males and females in Class 2 had a spouse with no children. Males and females in Class 3 included those who were aged 35 to 49 years, were dual parents, and had increased central adiposity. Males in Class 3 had higher probabilities of being a smoker and having low income compared with females in Class 3. Males and females in Class 4

Table 3

Fit indices for the latent class analysis for males and females

	Class 1	Class 2	Class 3	Class 4	Class 5
Males					
Bayesian information criterion	101,120.53	97,709.39	95,961.08	95,381.86	95,103.12
Akaike information criterion	94,521.47	97,480.89	95,614.86	94,917.93	94,521.47
Likelihood ratio statistic (G2)	9,595.603	6,099.005	4,209.986	3,499.581	3,073.894
Chi-square test (x2)	19,585.64	12,581.9	7,743.989	5,152.644	3,612.432
Entropy	...	0.802	0.722	0.705	0.681
Females					
Bayesian information criterion	109,911.8	106,037.2	104,586.7	103,762.7	103,082.0
Akaike information criterion	109,800.0	105,806.6	104,237.3	103,294.6	102,495.2
Likelihood ratio statistic (G2)	10,728.98	6,710.304	5,126.487	4,156.74	3,327.796
Chi-square test (x2)	21,488.24	15,162.58	8,259.917	6,190.83	5,092.311
Entropy	...	0.703	0.738	0.745	0.716

... not applicable

Sources: 2007 to 2009, 2009 to 2011, 2012 to 2013, 2014 to 2015, 2016 to 2017, and 2018 to 2019 Canadian Health Measures Survey, combined.

Table 4
Probabilities of sociodemographic characteristics by latent class analysis class for males and females, Canada, 2007 to 2019

	Males				Females				
	Class 1	Class 2	Class 3	Class 4	Class 1	Class 2	Class 3	Class 4	Class 5
					percent				
Percent distribution of latent class analysis classes	18.0	19.9	37.7	24.4	12.7	25.3	27.4	16.7	17.9
Percent meeting the physical activity recommendation	28.7	40.6	50.3	66.7	19.2	33.1	42.1	61.0	32.0
Age group									
18 to 34	0.5	11.2	11.4	90.6	F	4.3	14.9	97.8	35.7
35 to 49	15.4	0.0	67.4	8.2	F	1.9	66.7	F	55.6
50 to 64	46.6	55.7	21.3	1.2	46.4	64.2	18.3	1.5	8.7
65 to 80	37.5	33.2	0.0	0.0	53.4	29.6	0.0	F	0.0
Highest level of educational attainment									
Less than secondary school graduation	45.1	2.0	2.8	8.4	42.1	3.2	0.5	2.8	12.1
Secondary school graduation	24.9	19.1	17.2	43.8	21.8	26.4	9.2	36.5	30.9
Postsecondary graduation	30.0	78.9	80.0	47.8	36.1	70.4	90.3	60.6	57.0
Household income quintiles adjusted for household size									
1st (lowest)	39.3	1.1	10.6	24.5	61.4	1.9	2.1	17.2	61.5
2nd	35.3	9.9	15.4	21.2	30.3	19.1	11.9	22.5	26.2
3rd	15.5	17.9	20.5	21.9	7.1	26.3	24.5	25.5	11.9
4th	7.8	33.4	23.7	16.9	1.2	27.1	30.5	18.5	0.5
5th (highest)	2.1	37.7	29.8	15.5	0.0	25.7	31.0	16.3	0.0
Family structure									
No spouse, no children	39.3	12.2	8.9	80.0	55.3	19.8	6.8	76.8	23.3
With spouse, no children	47.9	84.2	13.1	12.3	37.4	74.5	12.5	22.9	10.2
Dual parent	11.2	2.7	74.0	7.4	2.8	1.6	78.3	0.3	41.4
Single parent	1.6	1.0	3.9	0.3	4.6	4.1	2.3	0.0	25.1
Daily smoker									
Yes	30.0	3.0	15.0	25.2	19.9	7.0	4.6	7.5	29.9
No	70.0	97.0	85.0	74.8	80.1	93.0	95.4	92.5	70.1
Central adiposity									
No increased health risk	6.2	10.4	20.1	64.5	6.7	19.6	33.2	73.5	24.3
At increased health risk	41.2	56.7	57.1	25.6	36.1	44.4	45.2	23.8	38.9
At even greater health risk	52.6	32.9	22.8	9.8	57.2	35.9	21.6	2.7	36.9
Self-reported general health									
Good, very good, or excellent	70.0	94.0	95.2	92.5	72.6	95.9	97.5	95.5	80.3
Poor or fair	30.0	6.0	4.8	7.5	27.4	4.1	2.5	4.5	19.7

F too unreliable to be published

Sources: 2007 to 2009, 2009 to 2011, 2012 to 2013, 2014 to 2015, 2016 to 2017, and 2018 to 2019 Canadian Health Measures Survey, combined.

were aged 18 to 34 years with no spouse and no children. Males in Class 4, compared with females in the same class, were more likely to smoke (25.2% vs. 7.5%, respectively), less likely to have a postsecondary education (47.8% vs. 60.6%), and less likely to have central adiposity (64.5% vs. 73.5%). Individuals in Class 5 (females only) were primarily aged 18 to 49 years and had high probabilities for all risk factors, including having low income, having a low education, being a smoker, having central adiposity, and having poor or fair self-rated general health. Class 5 had the greatest proportion of single mothers (25.1%), which was substantially higher than in all classes.
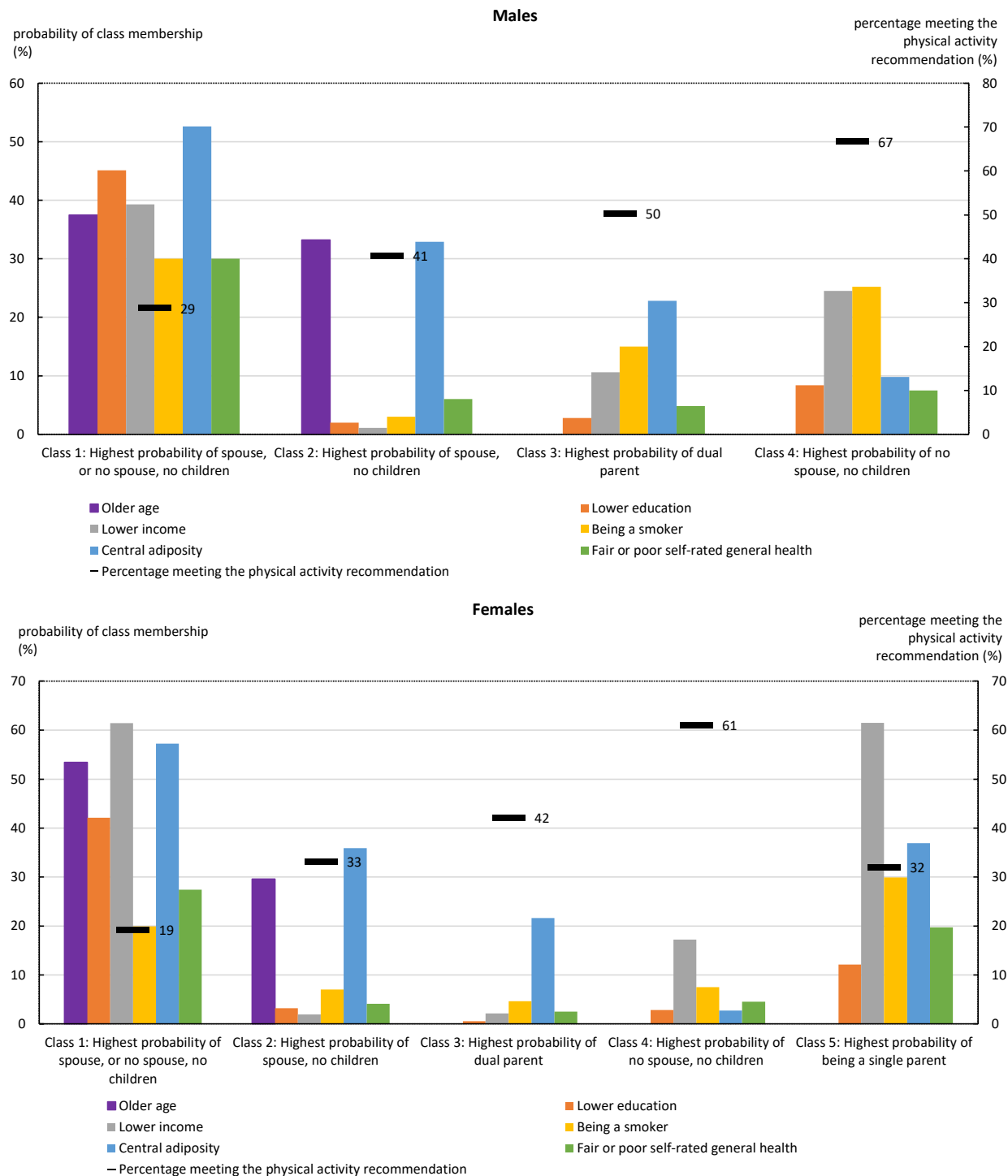
Among males, the likelihood of meeting the physical activity recommendation was higher in Class 2 (1.4 times [95% CI: 1.2 to 1.7]), Class 3 (1.8 times [95% CI: 1.5 to 2.1]), and Class 4 (2.3 times [95% CI: 2.0 to 2.8]) compared with the least active group (Figure 3a). Among females, the likelihood of meeting the physical activity recommendation was higher in Class 5 (1.7 times [95% CI: 1.3 to 2.2]), Class 2 (1.7 times [95% CI: 1.3 to 2.2]), Class 3 (2.2 times [95% CI: 1.8 to 2.8]), and Class 4 (3.2 times [95% CI: 2.5 to 4.0]) compared with the least active group (Class 1) (Figure 3b).

Discussion

Using LCA, the present study identified four groups of males and five groups of females within the Canadian population who have varying adherence to the physical activity recommendation and different combinations of risk factors for physical inactivity. Adherence to the physical activity recommendation ranged widely across the latent classes: 29% to 67% among males and 19% to 61% among females. The latent classes with the lowest proportion of people meeting the physical activity recommendation had higher probabilities of comprising individuals with multiple risk factors for inactivity, including being older, having low income, having a low education, smoking, having poor self-rated health, and having abdominal obesity.

Physical activity levels decline with age.[2] Preferences and reasons for exercise also change across one's lifetime.[26,27] A combination of aerobic, muscle strengthening, and flexibility exercises is recommended for aging adults to increase longevity, prevent chronic disease, and offer numerous cognitive and psychological benefits.[21,22,28] Despite relatively similar age profiles, the difference in favour of Class 2 compared with Class 1 in meeting the physical activity

Figure 2

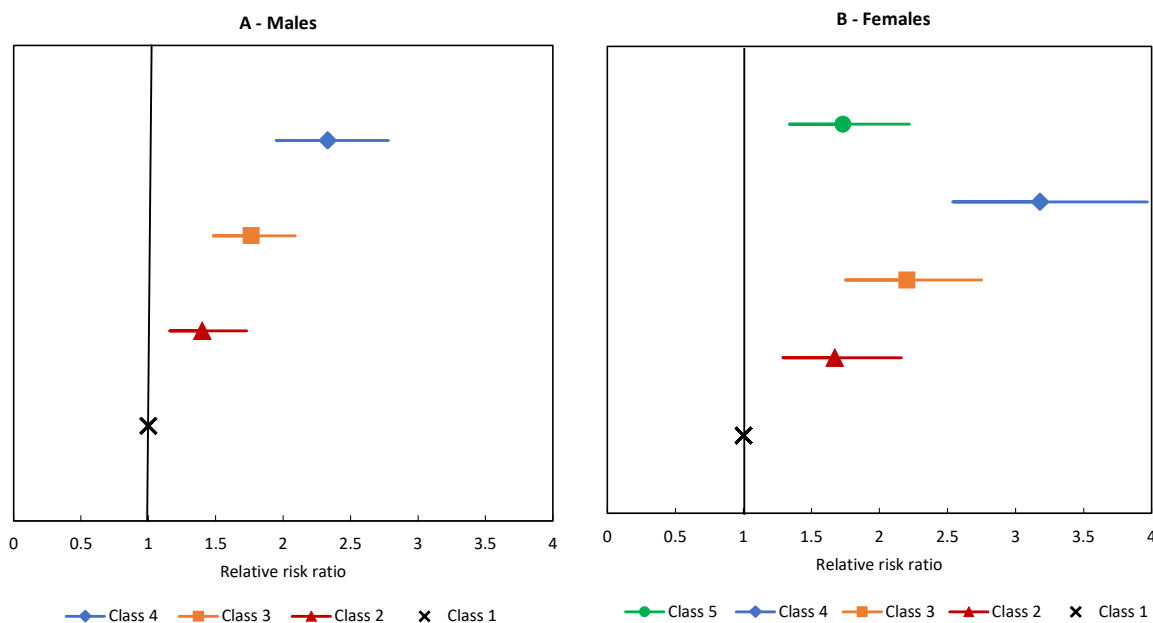**Percentage meeting physical activity recommendation and latent class analysis class composition, by class and sex**

Males

probability of class membership (%)

percentage meeting the physical activity recommendation (%)

- Older age
- Lower education
- Lower income
- Being a smoker
- Central adiposity
- Fair or poor self-rated general health
- Percentage meeting the physical activity recommendation

Class 1: Highest probability of spouse, or no spouse, no children
Class 2: Highest probability of spouse, no children
Class 3: Highest probability of dual parent
Class 4: Highest probability of no spouse, no children

Females

probability of class membership (%)

percentage meeting the physical activity recommendation (%)

- Older age
- Lower education
- Lower income
- Being a smoker
- Central adiposity
- Fair or poor self-rated general health
- Percentage meeting the physical activity recommendation

Class 1: Highest probability of spouse, or no spouse, no children
Class 2: Highest probability of spouse, no children
Class 3: Highest probability of dual parent
Class 4: Highest probability of no spouse, no children
Class 5: Highest probability of being a single parent

Sources: 2007 to 2009, 2009 to 2011, 2012 to 2013, 2014 to 2015, 2016 to 2017, and 2018 to 2019 Canadian Health Measures Survey, combined.

recommendation was greater than 10 percentage points among both males and females. Class 1 had much higher probabilities for many risk factors of inactivity, including having a low education, having low income, living alone and being a smoker. This result confirms that age alone does not explain the decline in physical activity across the lifespan. The combination of older age with low income and unhealthy lifestyle choices put some people at even higher risk for physical inactivity.[29] In other words, not all older Canadians are the same, and some need additional or different support when it comes to adopting

Figure 3
Adjusted hazard risk of meeting the physical activity recommendation by latent class analysis class among males and females

A - Males

B - Females

Relative risk ratio

Relative risk ratio

Class 4   Class 3   Class 2   Class 1

Class 5   Class 4   Class 3   Class 2   Class 1

Source: 2007 to 2009, 2009 to 2011, 2012 to 2013, 2014 to 2015, 2016 to 2017, 2018 to 2019 Canadian Health Measures Survey, combined.

a physically active lifestyle. Helping older Canadians to be active is important given that movement and exercise are key components of strategies to promote healthy aging.[30]

The presence of children in the household, especially younger children, can limit opportunities for physical activity.[7] The present study identified two classes of younger adults (classes 3 and 4), with family arrangement being a key difference between the two classes. Almost two out of three adults in Class 4 were meeting the physical activity recommendation (67% of males and 61% of females), and these individuals had a high probability of being young (over 90% probability of being aged 18 to 34), being unmarried, not having children, and having no risk factors for inactivity. Class 3 adults were less active (50% of males and 42% of females met the physical activity recommendation), and these individuals were slightly older (over 60% probability of being aged 35 to 49) and had the highest probability of being in a dual-parent household. Aside from an increase in the probability of having abdominal obesity, adults in Class 3 did not have more risk factors for inactivity; in fact, they had a lower probability of smoking and were less likely to have low income compared with Class 4. However, adults in Class 3 had a higher probability of being part of a dual-parent household. Time-use research consistently reports that parents have limited free time available to engage in exercise and leisure; among mothers, time use often involves the multitasking of leisure with other tasks such as housework and child supervision.[6] Parents, in particular mothers, often shoulder the burden of a "second shift" of unpaid work at home after their

paid work.[31-33,6] Time-use surveys have also shown that both mothers and fathers spend more time with children today compared with 1986, but the increase has been more pronounced among women.[6,31,34,35] Taken together, the results of the present study align with existing literature that points to parenthood as a life stage where finding time to participate in physical activity may be especially difficult.

The present study found that the proportion of males meeting the physical activity recommendation was 10.8 percentage points higher than that of females. This difference persisted regardless of sociodemographic characteristics and was especially pronounced among 35- to 49-year-olds. Despite a narrowed gender gap in labour force participation over the past few decades,[36] time-use surveys continue to report that women spend more time doing unpaid work, including childcare and household chores (2.7 hours per day among women compared with 1.9 hours per day among men),[6] leaving less time for physical activity for women. Moreover, Canadian women report feeling more time stressed than men, regardless of the workday length or presence of children.[37] Finally, an aging population means that middle-aged adults, often women, are often simultaneously caring for children and aging parents.[31] In 2022, more than half of female individuals aged 15 and older were providing care to children or care-dependent adults (either paid or unpaid), and women were more likely than men to report feeling tired, worried, or anxious about this work.[38] Fatigue from physically demanding jobs may also limit the energy available to pursue activity during leisure time,[39,40] and time-use

surveys have reported that women are less likely than men to choose active pursuits when they do have free time.[6] The findings of the LCA in the present study appear to corroborate a large body of research showing that lack of free time is a powerful barrier to participation in leisure-time physical activity, in particular among women.

One-parent families with children have increased in Canada from 9% of families in 1976 to 16.4% of families in 2021, and mothers account for 77.2% of one-parent families.[41,42] According to the 2021 Census, there are 1,302,670 mothers in one-parent families and 383,670 fathers in one-parent families in Canada.[42] The LCA in the present study identified a fifth class among females, but not males, that was largely composed of single mothers. Mothers in one-parent families have previously been identified as a high-risk group for cardiovascular disease in Canada[9] and the United States.[10] These mothers were 3.3 times more likely to suffer a cardiovascular event compared with partnered mothers.[10] Mothers in one-parent families in these two studies had a similar combination of risk factors for poor health, including low income, low education, poor health, obesity, more distress and depression, less social support, and a higher likelihood of smoking.[9,10] A unique LCA class did not emerge for fathers in one-parent families in the present analysis because of the low sample size of these fathers in the analytical sample. This does not mean they do not exist or that they do not face barriers to physical activity.[43] Single fathers are more likely to lead unhealthy lifestyles, including having a low consumption of fruit and vegetables and a higher likelihood of binge drinking.[43] Single parents, regardless of gender, face a unique combination of socioeconomic and life challenges that impede their ability to engage in healthy lifestyle habits.

The CHMS is a unique health survey that combines direct measures of health behaviours with self-reported sociodemographic and health information. The present study harnesses the large sample afforded by the combination of six cycles of the survey and uses accelerometer-measured physical activity as the primary outcome. Despite the combination of cycles, limitations in data disaggregation were evident. A focus on family arrangement in the present study alongside sociodemographic characteristics precluded additional disaggregation by other important characteristics often included in intersectional analyses, including, but not limited to, population group and immigrant status. While the present study explores issues related to traditional gender roles (e.g., parenting), biological sex is the only variable available in the CHMS. This precludes an in-depth discussion of how sex and gender may differentially affect risk factors for physical inactivity. Further, the clustered sampling design of the CHMS precludes a detailed examination of provincial or urban–rural differences. Future studies that include such characteristics would further add to the understanding of how risk factors for physical inactivity cluster together and where interventions and messaging might be best targeted. In conclusion, the present study illustrates the importance of data disaggregation to identify groups who are struggling to meet the physical activity recommendation. Identification of the most common combinations of risk factors for inactivity in the Canadian context may help to target public health messaging and strategies toward those who need them most.

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