Seasonal Variation in Leisure-time Physical Activity Among Canadians

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ABSTRACT

Background: Cardiovascular disease (CVD) mortality is higher in winter than summer, particularly in cold climates. Physical activity reduces CVD risk but climate impacts participation in physical activity. Canada has substantial climatic variation but its relation with physical activity is understudied. In this investigation, we evaluated the relation between seasonality and physical activity among Canadians.

Methods: We used public domain data from the Canadian Community Health Survey, Cycle 2.2 (CCHS 2.2), a representative, cross-sectional sample of free-living Canadians in 2004. Leisure-time physical activity was measured using a modified version of the Physical Activity Monitor that was validated. Season was determined by the time of the interview, i.e., Winter: January 1 to March 31, Spring: April 1 to June 30, Summer: July 1 to September 30, and Fall: October 1 to December 31. In all multivariate models, we adjusted for age, sex, education, and income adequacy.

Results: There were 20,197 persons aged 19 years and older in this analysis. In the winter, 64% of Canadians were inactive as compared with 49% in the summer. Total average daily energy expenditure was 31.0% higher in summer than winter after multivariate adjustment. Leisure-time physical activity was 86% more likely in the summer than winter (multivariate OR=1.86, 95% CI 1.40, 2.45). The relation between seasonality and physical activity was weakest in Newfoundland and Labrador and stronger in Saskatchewan and British Columbia (p-value for interaction=0.02).

Interpretation: Seasonality impacts physical activity patterns in Canada and varies across the provinces. This needs to be considered in physical activity programming.

MeSH terms: Seasons; physical activity; Canada

La traduction du résumé se trouve à la fin de l'article.

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Physical inactivity contributes to 53% and 47% of the global disease burden in men and women respectively,[1] and 22-39% of coronary heart disease mortality.[2] In North America, physical inactivity costs approximately US$ 56 per person per year;[3] in Canada, the amount is CDN$ 5.6 billion.[4,5]

Physical activity improves most of the risk markers of cardiovascular disease (CVD).[6-8] As CVD mortality is higher in the winter compared to summer months,[9,10] particularly in cold climates,[9] and CVD risk factors such as serum cholesterol,[11] blood pressure,[12-14] and C-reactive protein[15] similarly are higher in winter months compared to summer, it is plausible that physical activity patterns related to season at least partially explain this phenomenon.

The likelihood of meeting recommended physical activity levels is higher in dry, moderate climatic conditions in the United States (US).[16] Physical activity is more likely in men (average 1.4 MET-hours/d) and women (average 1.0 MET-hours/d) in summer compared to winter months in Massachusetts.[17] Congestive heart failure mortality is highest in Quebec in January and declines steadily until September,[18] suggesting that the weather may have clinical significance. Canada has substantial variation in climatic conditions, but the latter's relation with physical activity has not been extensively studied.[19] We therefore conducted this analysis to quantify the relation between seasonality and energy expenditure from leisure-time physical activity and its frequency among Canadians.

METHODS

Study population

In this analysis, we included information on participants of the Canadian Community Health Survey, Cycle 2.2 (CCHS 2.2), conducted by Statistics Canada, that are available for public access.[20] CCHS 2.2 is a cross-sectional survey that collected information related to health status, health care utilization, diet, and health determinants for the Canadian population. The data were collected between January 2004 and January 2005 in the 10 provinces from persons of all ages living in private dwellings, with 98% coverage of the target population.[20] It

TABLE I
Characteristics of Participants by Seasons

	N	Winter	Spring	Summer	Fall
Province					
Newfoundland and Labrador	341	80 (23.5%)	88 (25.8%)	87 (25.5%)	86 (25.0%)
Prince Edward Island	87	23 (26.9%)	23 (26.0%)	21 (24.5%)	20 (22.5%)
Nova Scotia	600	153 (25.6%)	160 (26.6.%)	157 (26.0%)	130 (21.6%)
New Brunswick	483	122 (25.3%)	121 (25.1%)	122 (25.2%)	118 (24.0%)
Quebec	4884	1143 (23.4%)	1185 (24.3%)	1206 (24.7%)	1350 (27.6%)
Ontario	7850	1936 (25.0%)	1911(24.3%)	2088 (26.6%)	1915(24.4%)
Manitoba	969	176 (25.3%)	167 (24.0%)	188 (27.0%)	165 (23.7%)
Saskatchewan	586	153 (26.1%)	137 (23.4%)	144(24.6%)	151 (25.8%)
Alberta	1973	533 (27.0%)	433 (22.0%)	473 (24.0%)	534 (27.0%)
British Columbia	2695	550 (20.46%)	704 (26.1%)	722 (26.8%)	718 (26.7%)
Age (years)					
19-24	2271	539 (23.8%)	569 (25.0%)	521 (23.0%)	641 (28.2%)
25-35	3755	860 (22.9%)	852 (22.7%)	1003 (26.7%)	1039 (27.7%)
36-50	6609	1588 (24.0%)	1660 (25.1%)	1793 (27.0%)	1567 (23.7%)
51-65	4549	1149 (25.3%)	1116 (24.5%)	1135 (25.0%)	1149 (25.3%)
≥66	3013	734 (24.4%)	731 (24.3%)	757 (25.1%)	790 (26.2%)
Sex					
Male	9907	2285 (23.1%)	2433 (24.6%)	2520 (25.4%)	2668 (27.0%)
Female	10,290	2585 (25.1%)	2495 (24.3%)	2690 (26.1%)	2520 (24.5%)
Immigrant status					
Immigrated to Canada	4786	1123 (23.5%)	1163 (24.3%)	1317 (27.5%)	1183 (24.7%)
Born in Canada	15,358	3733 (24.3%)	3753 (24.4%)	3876 (25.2%)	3997 (26.0%)
Ethnicity					
White	16,799	3987 (23.7%)	4153 (24.7%)	4252 (25.3%)	4407 (26.2%)
Non-white	3397	878 (26.1%)	774 (23.0%)	955 (28.4%)	760 (22.6%)
Level of education					
< Secondary	3849	963 (25.0%)	1001 (26.0%)	1000 (26.0%)	885 (23.0%)
Secondary	3576	831 (23.4%)	832 (23.3%)	942 (26.0%)	970 (27.1%)
Other post	1866	462 (24.8%)	402 (21.5%)	518 (27.8%)	484 (25.9%)
Post secondary	10,728	2604 (24.3%)	2629 (24.5%)	2704 (25.2%)	2791(26.0%)
Income adequacy					
Lowest	578	133 (23.1%)	135 (23.5%)	137 (23.8%)	171 (29.7%)
Lower	1104	364 (33.0%)	217 (19.7%)	243 (22.1%)	279 (25.3%)
Middle	3707	974 (26.3%)	918 (24.8%)	881 (23.8%)	934 (25.2%)
Upper Middle	6434	1579 (24.5%)	1532 (23.4%)	1595 (24.8%)	1727 (26.8%)
Highest	6259	1383 (22.1%)	1574 (25.1%)	1800 (28.8%)	1501(24.0%)
Reported morbidity					
With chronic disease	8624	2183 (25.3%)	2077 (24.1%)	2229 (25.6%)	2133 (24.7%)
Without chronic disease	11,527	2679 (23.2%)	2845 (25.0%)	2968 (25.8%)	3034 (26.3%)
Smoking					
Never	9628	2351 (24.4%)	2363 (24.5%)	2509 (26.1%)	2404 (25.0%)
Past	5522	1369 (24.8%)	1317 (23.9%)	1418 (25.7%)	1417 (25.7%)
Current	5027	1146 (22.8%)	1242 (24.7%)	1276 (25.4%)	1362 (27.1%)
Alcohol intake					
<1/month	3297	901(27.3%)	774 (23.5%)	807 (24.5%)	816 (24.7%)
1/month	1634	375 (22.9%)	343 (21.0%)	421 (25.6%)	496(30.4%)
2-3/month	2078	534 (25.7%)	465 (22.4%)	523 (25.1%)	557 (26.7%)
1/week	2614	568 (21.75%)	666 (25.5%)	662 (25.3%)	716 (27.4%)
2-3/week	3399	850 (25.0%)	901 (26.5%)	851 (25.0%)	797 (23.4%)
4-6/week	1045	197 (18.8%)	261 (25.0%)	309 (29.6%)	278 (26.6%)
Daily	1447	301(20.8%)	352 (24.3%)	433 (29.9%)	361 (25.0%)
BMI					
Normal	4822	1114 (23.1%)	1049 (21.8%)	1292 (26.8%)	1367 (28.4%)
Overweight	4227	1059 (25.0%)	935 (22.1%)	1101 (26.0%)	1132 (26.8%)
Obese	2788	756 (27.1%)	767 (27.5%)	649 (23.3%)	615 (22.0%)

excluded persons living in the Territories or Crown Lands, institutional residents, full-time members of the Canadian Forces, and residents of certain remote regions.[20]

Individuals were selected using a multi-stage cluster sampling procedure to obtain a representative sample of the Canadian population. One individual per household was randomly selected with a probability of being selected proportionate to household size.[20] Data on physical activity were collected from respondents aged 12 years and over. We used data on all persons 19 years of age and older (20,197 individuals) in these analyses.

Physical activity

CCHS 2.2 measured participation in leisure-time physical activity using a modified version of the Physical Activity Monitor, based on the Minnesota Leisure-Time Physical Activity Questionnaire (MLTPAQ).[20] The Physical Activity Monitor had very good reliability (r=0.90), criterion validity (compared with maximal oxygen uptake) (r=0.36), and validity when compared with physical activity measured by an alternative questionnaire-based method (r=0.77).[20] Briefly, in the CCHS 2.2 Survey, the participants were asked whether they participated in 1 of 21 activities in the past three months and they were able to report participating in up to 3 additional activities that were not on the list. They were then asked how many times in the past three months they participated in each activity they said they performed. Finally, the participants were asked to estimate the amount of time they spent on each occasion for each activity in four categories: 1-15 minutes, 16-30 minutes, 31-60 minutes, and more than an hour.[20] This was multiplied by the energy cost of the activity expressed as kilocalories expended per kilogram of body weight per hour of activity (kcal/kg per hour)/365 (to convert yearly data into daily data).[4] Statistics Canada derived the energy cost of

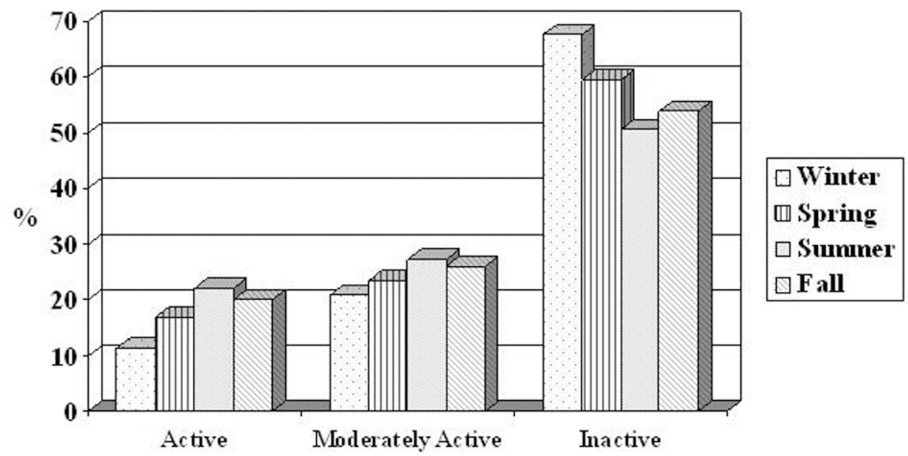

Figure 1. Activity level by season among Canadians in 2004

Inactive	<1.5 METs/day energy expenditure
Moderately active	1.5-2.9 METs/day energy expenditure
Active	≥3.0 METs/day energy expenditure

activities using the method adapted from that described by the Canadian Fitness and Lifestyle Research Institute.[4]

We used the following derived variables from the CCHS 2.2 survey Public Domain Data: average daily energy expenditure, average monthly frequency of physical activity lasting over 15 minutes, energy expenditure from walking in the last 3 months, participation in any leisure-time physical activity in the last 20 months, participation in at least 15 minutes of leisure-time physical activity per day.[20] A physical activity index was calculated based on the total average daily energy expenditure: Inactive if <1.5 METs/day, Moderately Active if 1.5-2.9 METs/day, and Active if ≥3.0 METs/day.[20]

Season

The season was determined by the time of the interview, i.e., Winter: January 1 to March 31, Spring: April 1 to June 30, Summer: July 1 to September 30, and Fall: October 1 to December 31.[20]

Other variables

Income adequacy was a 5-level categorical variable based on total income and total number of people living in the household, as shown in Table I (Lowest, <$10,000 for 1-4 people or <$15,000 for 5+ people [reference]; Lower, $10,000-14,999 for 1-2 persons, $10,000-19,999 for 3-4 persons, or $15,000-29,000 for 5+ people; Middle $15,000-29,999 for 1-2 persons, $20,000-39,999 for 3-4 persons, or $30,000-59,999 for 5+ people; Upper Middle $30,000-59,999 for 1-2 persons, $40,000-79,999 for 3-4 persons, or $60,000-79,999 for 5+ people; Highest ≥$60,000 for 1-2 persons, or ≥$80,000 for 3+ people).[4] Education was classified as: Less than secondary school [reference], Secondary school graduation, No post-secondary education, Some post-secondary education, and Post-secondary degree/diploma).[4] Age was recorded as an ordinal variable categorized into 9-13, 14-18, 19-24, 25-30, 31-35, 36-40, 41-45, 46-50, 51-55, 56-60, 61-65, 66-70, and 70+ years. Sex, the presence of any chronic conditions, immigrant status, and ethnicity (white or non-white) were binary variables. Body mass index (BMI) was computed by dividing weight in kilograms by height in metres squared. We classified people into 3 categories by weight: normal or lower, overweight, and obese using the Canadian Guidelines for Body Weight Classification for adults.[21] Alcohol intake was grouped into frequency of consumption of drinks: <1/month, 1/month, 2-3/month, 1/week, 2-3/week, 4-6/week, and daily.[20]

Statistical methods

Statistics Canada calculated a sample weight for each individual based on the survey design, non-response, age, and sex within each region,[20] which we used in all estimations. First, we evaluated the relation between all independent variables and season by weighted cross-tabulations with each categorical variable and season.

The continuous outcomes of interest were: average daily energy expenditure (METs/d), average monthly frequency of physical activity lasting over 15 minutes, and energy expenditure in walking in last three months (METs). The dichotomous outcomes were: participation in any leisure-time physical activity in the last 90 days, and participation in at least 15 minutes of leisure-time physical activity per day.

For continuous outcomes, we used weighted analysis of covariance, and for binary outcomes, weighted logistic regression. In all multivariate analyses, we adjusted for age (continuous), sex, income adequacy, and education. For continuous outcomes, we calculated percent change by dividing the beta coefficient from the model by the expected value for a male in the lowest education and income categories. To evaluate potential confounding by other factors we additionally adjusted for province, smoking, alcohol intake, BMI, immigrant status, presence of chronic conditions, and ethnicity. Finally, we evaluated whether the relation between physical activity and season was consistent within the provinces. The outcome was physical activity lasting at least 15 minutes; an interaction term was computed between categories of season and provinces and evaluated using the likelihood ratio test by comparing full and reduced models. We used Stata/SE Version 8.0 for all analyses.

RESULTS

Approximately equal numbers of participants were recruited in each season in all the provinces. The characteristics of the participants were mostly similar across seasons. Alcohol intake was more common in summer and smoking less likely in winter. Income adequacy seemed more likely in the summer (Table I).

Physical activity was least likely in the winter, with 64% of Canadians being inactive compared with 49% in the summer (Figure 1). Total average daily energy expenditure was 31.0% higher in the summer compared with winter after accounting for age, sex, education, and income adequacy (Table II). The average frequency of participating in physical activity for at least 15 minutes was 47.6% higher in the summer than in winter. Likewise, energy expenditure from walking was 8.3% more likely in the summer (Table II).

Participation in any leisure-time physical activity was 86% more likely in summer than in winter (OR=1.86, 95% CI 1.40, 2.45) after multivariate adjustment (Table III). Physical activity was also more likely in the spring and fall as compared with winter, but less likely than in the summer. Likewise, participation in physical activity lasting for more than 15 minutes was 72% more likely in the summer as compared to winter (OR=1.72, 95% CI 1.43, 2.06) after multivariate adjustment (Table III). In order to evaluate the role of potential confounders, we further adjusted these analyses for province, the presence of any chronic conditions, immigrant status, ethnicity, BMI, smoking, and alcohol intake. The results did not change appreciably in any of the models.

The proportion of persons participating in physical activity lasting at least 15 minutes was higher among people living in British Columbia (36%), Saskatchewan (31%), Ontario (31%), and Nova Scotia (30%) as compared with those living in Newfoundland and Labrador (27%) and Quebec (25%) (Table IV). The relation between season and physical activity was different in the different provinces. The relation between season and physical activity was weakest in Newfoundland and Labrador (RR of getting at least 15 minutes of physical activity in the fall compared to winter=1.81) and strong in Saskatchewan (RR of getting at least 15 minutes of physical activity in the fall compared to winter=4.89) (p-value for interaction=0.02) (Table IV).

TABLE II
Change in Physical Activity by Season*

	Coefficient†	95% CI	% Change‡	p-value
Average daily energy expenditure (METs)				
Winter (reference)	–			
Spring	0.27	0.14, 0.41	15.4	<0.01
Summer	0.55	0.42, 0.68	31.0	<0.01
Fall	0.50	0.35, 0.64	28.2	<0.01
Average monthly frequency of physical activity lasting over 15 minutes				
Winter (reference)	–			
Spring	2.98	1.34, 4.63	22.4	<0.01
Summer	6.34	4.79, 7.89	47.6	<0.01
Fall	5.24	3.60, 6.89	39.4	<0.01
Energy expenditure in walking in last 3 months (METs)				
Winter (reference)	–			
Spring	3.88	0.48, 7.28	10.4	0.03
Summer	3.09	-0.13, 6.32	8.3	0.06
Fall	2.76	-0.24, 6.24	7.4	0.12

* Adjusted for age (continuous), sex (male reference), income adequacy (lowest [reference], lower, middle, upper, highest), education (less than secondary school education [reference], secondary school graduation, no post-secondary education, some post-secondary education, post-secondary degree/diploma)
† change in physical activity measure by season adjusted for variables listed above
‡ percent change in physical activity of the expected level of physical activity for a 19-year-old male, in the lowest category of income adequacy and education.

TABLE III
Participation in Physical Activity by Season*

	Odds Ratio	95% CI	p-value
Participation in any leisure-time physical activity in the last 90 days			
Winter (reference)	1		
Spring	1.39	1.07, 1.81	0.01
Summer	1.86	1.40, 2.45	<0.01
Fall	1.69	1.27, 2.24	<0.01
Participation in at least 15 minutes of leisure-time physical activity per day			
Winter (reference)	1		
Spring	1.36	1.11, 1.65	<0.01
Summer	1.72	1.43, 2.06	<0.01
Fall	1.51	1.24, 1.83	<0.01

* Adjusted for age (continuous), sex (male reference), income adequacy (lowest [reference], lower, middle, upper, highest), education (less than secondary school education [reference], secondary school graduation, no post-secondary education, some post-secondary education, post-secondary degree/diploma)

INTERPRETATION

Between about half and two thirds of all Canadians were inactive during the year. However, Canadians were substantially more physically active (31-48%) in the summer than in winter after accounting for age, sex, education, income adequacy and other potential explanatory factors. Season was a stronger predictor of physical activity in Saskatchewan, British Columbia, New Brunswick, and Prince Edward Island as compared with Newfoundland and Labrador.

Our results are consistent with those of studies conducted in Massachusetts,[17] Denmark,[22] and Michigan.[23] Physical activity is more likely if the weather is dry and moderate.[16] The differences in the relation between seasonality and physical activity in Canada may be related to differences in temperature and precipitation. For instance, the average temperature and precipitation in August are respectively 18.0° C and 43.2 mm in Regina, 15.5° C and 108.1 mm in St. John's, and 17.6° C and 39.6 mm in Vancouver.[24] The higher average precipitation in St. John's most likely contributes to less physical activity there in the fall, though the temperatures are similar to those in Regina and Vancouver. Thus additional studies to characterize the association between physical activity and daily temperature and precipitation are warranted.

We used physical activity as an outcome rather than obesity because the latter depends on physical activity and diet, and dietary data were not available in this dataset. Moreover, the health benefits of physical activity are unambiguous and undisputed. Physical activity is associated with reduced risk of obesity, CVD, diabetes, certain types of cancers, and other conditions.[25]

This analysis has some limitations. Physical activity related to occupation[26] and daily living[27] are related to obesity but were not measured in this survey. A further limitation of these data was that ethnicity was classified as just white and non-white, whereas BMI, physical activity[28] and cardiovascular disease risk factors vary substantially among ethnic Canadians, even after accounting for differences in physical activity.[29,30]

The reduction in physical activity in winter could also have a measurable impact

TABLE IV

Relation Between Participation in Physical Activity Lasting for At Least 15 Minutes by Province*†

	Participation in Physical Activity for At Least 15 Minutes (%)	Odds Ratio 95% Confidence Interval: Winter (Reference)	Spring	Summer	Fall
	27		0.98	1.41	1.81
Newfoundland and Labrador		1	0.52,1.86	0.63,3.16	0.75,4.39
	26		3.24‡	2.66‡	3.39
Prince Edward Island		1	1.59,6.61	1.08,6.55	0.84,13.64
	30		1.15	2.63‡	2.20
Nova Scotia		1	0.57,2.31	1.02,6.80	0.67,7.27
	27		1.09	3.57‡	3.27‡
New Brunswick		1	0.58,2.05	1.75,7.32	1.08,9.93
	25		0.81	2.03‡	0.85
Quebec		1	0.45,1.44	1.20,3.43	0.50,1.43
	31		1.85‡	1.69‡	2.36‡
Ontario		1	1.29,2.65	1.10,2.59	1.52,3.66
	28		1.24	1.40	1.17
Manitoba		1	0.67,2.32	0.70,2.79	0.63,2.19
	31		1.43	3.30‡	4.89‡
Saskatchewan		1	0.65,3.12	1.40,7.25	2.15,11.10
	29		2.27‡	2.17‡	1.62
Alberta		1	1.08,4.80	1.07,4.42	0.82,3.23
	36		1.71	1.48	3.27‡
British Columbia		1	0.72,4.09	0.52,4.23	1.00,10.73

* Adjusted for season, age (continuous), sex (male reference), income adequacy (lowest [reference], lower, middle, upper, highest), education (less than secondary school education [reference], secondary school graduation, no post-secondary education, some post-secondary education, post-secondary degree/diploma)

† overall p-value for interaction from likelihood ratio test comparing models with interaction term for season and province and model with just main effects <0.02

‡ p-value <0.05 compared to winter in the stratified analysis

on obesity trends. From our data, we estimated that reduced leisure-time physical activity energy expenditure in winter was 8316 kcal/year for a 70 kg man. This can account for just under 1 kg weight gain per year if it is not compensated for by diet or physical activity related to daily living or occupation. However, recently in North America, per capita caloric intake has increased[31] and non-leisure-time physical activity has decreased.[27] Decreased physical activity in winter may explain seasonal variation in temporal patterns of CVD risk factors, but this would need to be verified in future studies. The findings have potential policy implications. For instance, access to facilities is associated with increased participation in physical activity.[32] A strategy to improve access to facilities for physical activity in winter could be to open school swimming pools and athletic facilities to parents and families after school hours.

Seasonality impacts physical activity patterns in Canada. The association between seasonality and physical activity is different across the provinces. This needs to be taken into account in the development of programming for physical activity.

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RÉSUMÉ

Contexte : La mortalité due aux maladies cardiovasculaires (MCV) est plus élevée l'hiver que l'été, surtout sous les climats froids. L'activité physique réduit le risque de MCV, mais le climat a une incidence sur la participation à l'activité physique. Il existe des variations climatiques importantes au Canada, mais leurs liens avec l'activité physique n'ont pas été suffisamment étudiés. Dans cette étude, nous avons analysé la relation entre les cycles saisonniers et l'activité physique dans la population canadienne.

Méthode : Nous avons utilisé les données du domaine public de L'Enquête sur la santé dans les collectivités canadiennes, cycle 2.2 (ESCC 2.2), soit un échantillon représentatif transversal de Canadiens en milieu naturel en 2004. Nous avons mesuré l'activité physique durant les loisirs à l'aide d'une version modifiée et validée du Sondage indicateur de l'activité physique. La saison a été déterminée selon le moment des entretiens : l'hiver du 1er janvier au 31 mars, le printemps du 1er avril au 30 juin, l'été du 1er juillet au 30 septembre, et l'automne du 1er octobre au 31 décembre. Dans tous nos modèles à plusieurs variables, nous avons apporté les ajustements nécessaires selon l'âge, le sexe, le revenu (adéquat ou non adéquat) et l'instruction.

Résultats : Notre analyse a porté sur 20 197 personnes de 19 ans et plus. L'hiver, 64 % des Canadiens étaient sédentaires, contre 49 % l'été. La force dépensée quotidiennement était en moyenne de 31 % plus élevée l'été que l'hiver, après l'apport des ajustements nécessaires. L'activité physique durant les loisirs était plus courante l'été que l'hiver, dans une proportion de 86 % (RC multivarié=1,86, IC de 95 %=1,40-2,45). Nous avons observé la relation la plus faible entre les cycles saisonniers et l'activité physique à Terre-Neuve-et-Labrador et la relation la plus forte en Saskatchewan et en Colombie-Britannique (valeur prédictive d'interaction=0,02).

Interprétation : Les cycles saisonniers influent sur les habitudes d'activité physique au Canada, et cette influence varie d'une province à l'autre. Ce sont des aspects dont il faudrait tenir compte dans les programmes d'activité physique.

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