CJC Open 3 (2021) 631–638

Original Article

Regional Comparisons of Associations Between Physical Activity Levels and Cardiovascular Disease: The Story of Atlantic Canada

Bartosz Orzel, MSc,[a] Melanie Keats, PhD,[b,c] Yunsong Cui, MSc,[c] and Scott Grandy, PhD[b,c]

[a] Faculty of Medicine, Dalhousie University, Halifax, Nova Scotia, Canada

[b] School of Health and Human Performance, Dalhousie University, Halifax, Nova Scotia, Canada

[c] Atlantic Partnership for Tomorrow's Health, Faculty of Health, Dalhousie University, Halifax, Nova Scotia, Canada

ABSTRACT

Background: Physical inactivity is an important risk factor for cardiovascular disease (CVD). Atlantic Canada is a region with lower physical activity (PA) levels and poorer CVD outcomes than the rest of Canada. Yet, within-region variation is expected. This study aimed to assess the association between PA and CVD and how this relationship varied on a regional level.

Methods: This cross-sectional study used data from the Atlantic Partnership for Tomorrow's Health (PATH) Study. The cohort included 823 CVD cases and 2469 age-, sex-, and province of residence-matched

RÉSUMÉ

Introduction : L'inactivité physique est un facteur de risque important de maladies cardiovasculaires (MCV). Le Canada atlantique est une région où les taux d'activité physique (AP) sont faibles et les issues des MCV sont moins bonnes que dans le reste du pays. Cependant, on s'attend à des variations entre les régions. La présente étude a pour objectif d'évaluer l'association entre l'AP et les MCV, et la façon dont cette relation varie sur le plan régional.

Méthodes : Cette étude transversale a utilisé les données de l'étude La VOIE atlantique (le Partenariat de l'Atlantique pour la santé de demain).

Compared with the rest of Canada, cardiovascular disease (CVD) and its risk factors have been shown to be more prevalent in Atlantic Canada.[1] Some of the highest CVD mortality rates in Canada were observed in Newfoundland and Labrador (NL): 274.3 deaths per 100,000; Nova Scotia (NS): 261.0 deaths per 100,000; Prince Edward Island (PEI): 255.1 deaths per 100,000; and New Brunswick (NB): 246.4 deaths per 100,000. These rates were significantly higher than the 2018 Canadian average of 192.6 deaths per 100,000.[2] To reduce inequalities, population-based interventions must mitigate exposure to disease risks. Consequently, prevention of disease requires an understanding of modifiable disease-specific risk factors (ie, lifestyle behaviours).

A well-established risk factor for CVD is physical inactivity, with low levels of physical activity (PA) being associated with increased risk of CVD.[3-5] Variations in the strength of this association exist cross-nationally[6-9] and within nations at regional[10] and municipal levels.[11] However, few regional studies have categorized associations according to PA levels or have considered PA as their main predictor variable. Thus, studies assessing differences in the association between CVD and PA at this geographic scale are needed. This is particularly true for Atlantic Canada, given the higher prevalence of CVD risk factors and negative health outcomes compared with Canada overall.

This study addressed this gap by comparing associations between different PA levels and CVD events across the 4 Atlantic Canadian provinces. Although Atlantic Canada is united by its Maritime culture, it is also geographically dispersed, and it is expected that CVD burden is experienced unequally among its provinces. Accordingly, the specific study aims were as follows: Estimate associations between PA levels and CVD events (myocardial infarction and/or stroke) among Atlantic Canadian provinces, and assess how the associations were modified following adjustment for CVD-associated variables, including sociodemographic characteristics and measures of health status and lifestyle.

Methods

Design

This analytical cross-sectional study used participant data from the Atlantic Partnership for Tomorrow's Health

Received for publication June 22, 2020. Accepted January 12, 2021.

Ethics Statement: Informed consent was provided before participation in this study, and the protocol was approved by the Dalhousie Research Ethics Board (REB file number: 2018-4478).

Corresponding author: Dr Melanie Keats, School of Health and Human Performance, Faculty of Health, Dalhousie University, 6230 South Street, Halifax, Nova Scotia B3H 4R2, Canada. Tel.: +1-902-494-7173; fax: +1-902-494-5120.

E-mail: melanie.keats@dal.ca

See page 637 for disclosure information.

https://doi.org/10.1016/j.cjco.2021.01.007

controls between the ages 35 and 69. Data collected included self-reported CVD and PA levels as well as information on sociodemographic characteristics, health status, and lifestyle behaviours. Simple and multiple logistic regression were used to assess the association between PA and CVD.

Results: High PA levels were associated with a 26% reduction in the mean probability of CVD compared with low PA levels across the total population. Compared with high PA levels, moderate and low PA levels were associated with increased odds of CVD across all 4 provinces. However, regional variation was observed, with higher odds of CVD for low-to-moderate PA levels in Newfoundland and Labrador and New Brunswick compared with Nova Scotia and Prince Edward Island.

Conclusions: Atlantic Canadians experience regional inequalities in the association between PA and CVD. Future work needs to explore underlying pathways driving these regional differences, which may be the impetus for interventions that mitigate risk and CVD burden in populations of greatest need.

La cohorte comptait 823 cas de MCV et 2 469 témoins de 35 à 69 ans appariés selon l'âge, le sexe et la province de résidence. Les données collectées étaient les suivantes : les MCV et les taux d'AP, ainsi que les renseignements sur les caractéristiques sociodémographiques, l'état de santé et les comportements liés au mode de vie. Nous avons utilisé la régression logistique simple et multiple pour évaluer l'association entre l'AP et les MCV.

Résultats : Les taux élevés d'AP ont été associés à une réduction de 26 % de la probabilité moyenne des MCV comparativement à des taux faibles d'AP dans l'ensemble de la population. Comparativement à des taux élevés d'AP, les taux faibles et modérés d'AP ont été associés à une probabilité accrue de MCV dans les 4 provinces. Toutefois, nous avons observé des variations régionales lors de taux faibles à modérés d'AP, soit une probabilité plus élevée de MCV à Terre-Neuve-et-Labrador et au Nouveau-Brunswick qu'en Nouvelle-Écosse et à l'Île-du-Prince-Édouard.

Conclusions : Les Canadiens de l'Atlantique montrent des inégalités régionales dans l'association entre l'AP et les MCV. D'autres travaux sont nécessaires pour étudier les voies sous-jacentes entraînant ces différences régionales et peuvent donner lieu à des interventions qui allègent le risque et le fardeau des MCV au sein des populations dont les besoins sont les plus grands.

(PATH) Study between 2009 and 2015.[12] The study population included 823 CVD cases between the ages 35 and 69 who were matched on sex, age (+/− 5 years), and province of residence to 3 non-CVD controls using stratified random sampling. A geographic identifier categorized participants into 1 of the 4 Atlantic Canadian provinces.

Measures

CVD events included binary (yes/no) variables for myocardial infarction and/or stroke. PA was categorized as either low, moderate, or high, using the International Physical Activity Questionnaire (IPAQ) as previously described.[13] The IPAQ has acceptable validity and reliability for monitoring PA levels among adult populations.[14] Covariables included those associated with PA and which are also risk factors for CVD.[1,5,6,15-19] Sociodemographic variables included sex, age, ethnicity, education level, working status, and annual household income.

Measures of health included general health status (dichotomized into excellent-to-good and fair-to-poor), CVD risk factors (binary hypertension and diabetes), CVD medications (antihypertensives, hypolipemic agents, and hypoglycemic agents), mental health (binary depression and anxiety), and waist circumference (WC). Depression and anxiety were calculated from the Patient Health Questionnaire (PHQ-9)[20] and the Generalized Anxiety Disorder Scale (GAD-7).[21] Abdominal obesity was defined as having a WC ≥102 cm for men and ≥88 cm for women.[22]

Lifestyle behaviours included sedentary behaviour, alcohol intake, smoking status, sleep, and diet. Sedentary behaviour was dichotomized into < 4 or ≥ 4 hours of time spent sitting per day, as values above this threshold has been shown to be associated with cardiometabolic disease.[23] Smoking was classified into never smoker (< 100 cigarettes in lifetime), past smoker (≥ 100 cigarettes in lifetime but no tobacco products in previous 30 days), or current smoker (≥ 100 cigarettes in lifetime and smoked during the past 30 days). Alcohol was dichotomized into abstainer or occasional drinker (≤ 3 times drinking per month) or regular-habitual (≥ 1 time per week) drinker. Sleep duration was categorized into < 7 hours, 7 to < 8 hours, or ≥ 8 hours per day, according to a dose-response association between sleep duration and CVD events.[19] Finally, daily fruit and vegetable consumption was dichotomized according to whether meeting previous Health Canada Food Guidelines (≥ 7 servings per day).[24]

Statistical analyses

Variables were described as frequencies and proportions (%), with χ^2 and Kruskal-Wallis tests used to determine significant differences between the provinces on categorical or ordinal variables, respectively. Missing PA data were proportional between cases and controls (Supplemental Table S1), and these data were consequently omitted to give a sample of 2261 for the remaining analyses. The current study (n = 2261) had 85% power to detect a statistically significant odds ratio (OR) of 0.72[6,15,25] with a 2-sided $\alpha = 0.05$, a 1:3 ratio of cases to controls, and 78% of controls meeting PA recommendations (moderate-to-high IPAQ PA categories).[26] Multivariable logistic regression was used to estimate ORs and 95% confidence intervals (CIs) of CVD for different PA levels, with associations stratified and compared across the provinces. Estimates were adjusted for the matching variables (Objective 1) and then additionally for the CVD-associated variables (Objective 2). All analyses were performed using STATA, version 13 (StataCorp LLC, College Station, Texas), with P values <0.05 considered statistically significant.

Results

Statistically significant differences between the provinces were observed for all sociodemographic and most health status and lifestyle variables (Table 1). Across the study population,

Table 1. Descriptive characteristics of Atlantic PATH participants in the study population stratified by Atlantic province

	Total (n = 3292)	NS (n = 1776)	NB (n = 908)	PEI (n = 144)	NL (n = 464)	*P* value
Sex						–
Male	1776 (54.0)	932 (52.5)	520 (57.3)	72 (50.0)	252 (54.3)	
Female	1516 (46.0)	844 (47.5)	388 (42.7)	72 (50.0)	212 (45.7)	
Age, years						–
35-39	53 (1.6)	22 (1.2)	24 (2.6)	≤ 5	≤ 5	
40-49	341 (10.4)	154 (8.7)	106 (11.7)	8 (5.5)	73 (15.7)	
50-59	1036 (31.5)	529 (29.8)	333 (36.7)	39 (27.1)	135 (29.1)	
60-69	1862 (56.5)	1071 (60.3)	445 (49.0)	94 (65.3)	252 (54.3)	
Ethnicity						< 0.001
White	2913 (88.5)	1643 (92.5)	789 (86.9)	137 (95.1)	344 (74.1)	
Non-white	193 (5.9)	76 (4.3)	53 (5.8)	≤ 5	61 (13.2)	
Unknown	186 (5.6)	57 (3.2)	66 (7.3)	≤ 5	59 (12.7)	
Education						0.031
High school or less	798 (24.2)	412 (23.2)	232 (25.5)	31 (21.5)	123 (26.5)	
College level	1259 (38.2)	681 (38.3)	322 (35.5)	56 (38.9)	200 (43.1)	
University level	1217 (37.0)	669 (37.7)	352 (38.8)	57 (39.6)	139 (30.0)	
Unknown	18 (0.6)	14 (0.8)	≤ 5	≤ 5	≤ 5	
Working status*						< 0.001
Employed	1679 (51.0)	811 (45.7)	550 (60.6)	75 (52.1)	243 (52.4)	
Retired	1234 (37.5)	750 (42.2)	267 (29.4)	55 (38.2)	162 (34.9)	
Not employed	241 (7.3)	128 (7.2)	57 (6.3)	11 (7.6)	45 (9.7)	
Unknown	138 (4.2)	87 (4.9)	34 (3.7)	≤ 5	14 (3.0)	
Household income, $						0.002
< 50,000	866 (26.3)	471 (26.5)	202 (22.2)	50 (34.7)	143 (30.8)	
50,000-99,999	1288 (39.1)	715 (40.3)	361 (39.8)	57 (39.6)	155 (33.4)	
≥ 100,000	905 (27.5)	476 (26.8)	270 (29.7)	29 (20.1)	130 (28.0)	
Unknown	233 (7.1)	114 (6.4)	75 (8.3)	8 (5.6)	36 (7.8)	
Health status†						0.100
Excellent to good	2852 (86.6)	1561 (87.9)	776 (85.5)	123 (85.4)	392 (84.5)	
Fair to poor	432 (13.1)	208 (11.7)	131 (14.4)	21 (14.6)	72 (15.5)	
Unknown	8 (0.3)	7 (0.4)	≤ 5	≤ 5	≤ 5	
Hypertension						0.016
No	2016 (61.2)	1131 (63.7)	537 (59.1)	88 (61.1)	260 (56.0)	
Yes	1246 (37.9)	633 (35.6)	363 (40.0)	53 (36.8)	197 (42.5)	
Unknown	30 (0.9)	12 (0.7)	8 (0.9)	≤ 5	7 (1.5)	
Diabetes						< 0.001
No	2851 (86.6)	1565 (88.1)	766 (84.3)	121 (84.0)	399 (86.0)	
Yes	407 (12.4)	205 (11.6)	126 (13.9)	18 (12.5)	58 (12.5)	
Unknown	34 (1.0)	6 (0.3)	16 (1.8)	≤ 5	7 (1.5)	
Antihypertensives						0.070
No	2142 (65.1)	1188 (66.9)	581 (64.0)	91 (63.2)	282 (60.8)	
Yes	1150 (34.9)	588 (33.1)	327 (36.0)	53 (36.8)	182 (39.2)	
Hypolipemic agents						0.916
No	2307 (70.1)	1250 (70.4)	638 (70.3)	100 (69.4)	319 (68.8)	
Yes	985 (29.9)	526 (29.6)	270 (29.7)	44 (30.6)	145 (31.2)	
Hypoglycemic agents						0.010
No	3051 (92.7)	1669 (94.0)	821 (90.4)	133 (92.4)	428 (92.2)	
Yes	241 (7.3)	107 (6.0)	87 (9.6)	11 (7.6)	36 (7.8)	
Depression						< 0.001
No	1805 (54.8)	1210 (68.1)	356 (39.2)	38 (26.4)	201 (43.3)	
Yes	516 (15.7)	314 (17.7)	121 (13.3)	10 (6.9)	71 (15.3)	
Unknown	971 (29.5)	252 (14.2)	431 (47.5)	96 (66.7)	192 (41.4)	
Anxiety						< 0.001
No	1964 (59.7)	1304 (73.4)	398 (43.8)	41 (28.4)	221 (47.6)	
Yes	357 (10.8)	220 (12.4)	79 (8.7)	7 (4.9)	51 (11.0)	
Unknown	971 (29.5)	252 (14.2)	431 (47.5)	96 (66.7)	192 (41.4)	
WC‡, cm						< 0.001
Normal	1118 (34.0)	682 (38.4)	323 (35.6)	42 (29.2)	71 (15.3)	
Abdominal obesity	1144 (34.7)	687 (38.7)	335 (36.9)	44 (30.5)	78 (16.8)	
Unknown	1030 (31.3)	407 (22.9)	250 (27.5)	58 (40.3)	315 (67.9)	
Sedentary behaviour, hour						< 0.001
< 4	735 (22.3)	439 (24.7)	173 (19.0)	28 (19.4)	95 (20.5)	
≥ 4	2001 (60.8)	1089 (61.3)	560 (61.7)	88 (61.2)	264 (56.9)	
Unknown	556 (16.9)	248 (14.0)	175 (19.3)	28 (19.4)	105 (22.6)	
Smoking status						0.001
Never	1404 (42.6)	753 (42.4)	413 (45.5)	54 (37.5)	184 (39.6)	
Former	1510 (45.9)	837 (47.1)	395 (43.5)	79 (54.9)	199 (42.9)	
Current	348 (10.6)	172 (9.7)	90 (9.9)	10 (6.9)	76 (16.4)	
Unknown	30 (0.9)	14 (0.8)	10 (1.1)	≤ 5	≤ 5	

Continued

Table 1. Continued.

	Total (n = 3292)	NS (n = 1776)	NB (n = 908)	PEI (n = 144)	NL (n = 464)	*P* value
Alcohol drinking						0.078
Abstain/occasional	1437 (43.7)	777 (43.7)	403 (44.4)	57 (39.6)	200 (43.1)	
Regular/habitual	1637 (49.7)	877 (49.4)	452 (49.8)	84 (58.3)	224 (48.3)	
Unknown	218 (6.6)	122 (6.9)	53 (5.8)	≤ 5	40 (8.6)	
Sleep per day, hour						0.069
< 7	860 (26.1)	432 (24.3)	248 (27.3)	33 (22.9)	147 (31.7)	
7 to < 8	1125 (34.2)	628 (35.4)	323 (35.6)	47 (32.6)	127 (27.4)	
≥ 8	1226 (37.2)	677 (38.1)	318 (35.0)	60 (41.7)	171 (36.8)	
Unknown	81 (2.5)	39 (2.2)	19 (2.1)	≤ 5	19 (4.1)	
Fruits/vegetables						0.015
< 7 daily servings	2634 (80.0)	1428 (80.4)	720 (79.3)	109 (75.7)	377 (81.2)	
≥7 daily servings	509 (15.5)	267 (15.0)	156 (17.2)	30 (20.8)	56 (12.1)	
Unknown	149 (4.5)	81 (4.6)	32 (3.5)	≤ 5	31 (6.7)	
Physical activity						< 0.001
Low	533 (16.2)	191 (10.8)	209 (23.0)	35 (24.3)	98 (21.1)	
Moderate	701 (21.3)	321 (18.0)	235 (25.9)	33 (22.9)	112 (24.2)	
High	1027 (31.2)	529 (29.8)	288 (31.7)	46 (32.0)	164 (35.3)	
Unknown	1031 (31.3)	735 (41.4)	176 (19.4)	30 (20.8)	90 (19.4)	

Values are n (%). ≤ 5, data suppressed because of small cell counts.

NB, New Brunswick; NL, Newfoundland and Labrador; NS, Nova Scotia; PEI, Prince Edward Island; WC, waist circumference.

* Not employed = unemployed or unable to work.

† Excellent to good = excellent, very good, and good.

‡ Abdominal obesity = defined as having a waist circumference of ≥102 cm for men or ≥88 cm for women.

the mean probability of having CVD was statistically significantly lower for high PA levels ($P = 0.001$), with a 26% reduction compared with low PA levels (Fig. 1). For each PA level, PEI had the lowest mean probability of CVD.

Numbers of CVD cases and matched controls used for logistic regression are presented in Supplemental Table S1. Overall, decreasing levels of PA were associated with increasing odds of CVD across all Atlantic provinces (Table 2). However, differences in the extent of the effects were found, with higher odds of CVD for a particular PA level in NL and NB compared with NS and PEI (eg, for a low PA level, the risk of CVD was higher in NL [OR, 1.85; 95% CI, 1.00-3.42; $P = 0.052$] and NB [OR, 1.80; 95% CI, 1.18-2.75; $P = 0.007$] compared with NS [OR, 1.26; 95% CI, 0.86-1.85; $P = 0.230$] and PEI [OR, 1.01; 95% CI, 0.35-2.89; $P = 0.992$]).

The relationship between lower levels of PA and increasing odds of CVD across the provinces generally remained after separately adjusting for all CVD-associated variables (Supplemental Table S2) and with sequential adjustment with the combined sociodemographic, health status, and lifestyle behaviours (Table 3). Higher odds of CVD were again

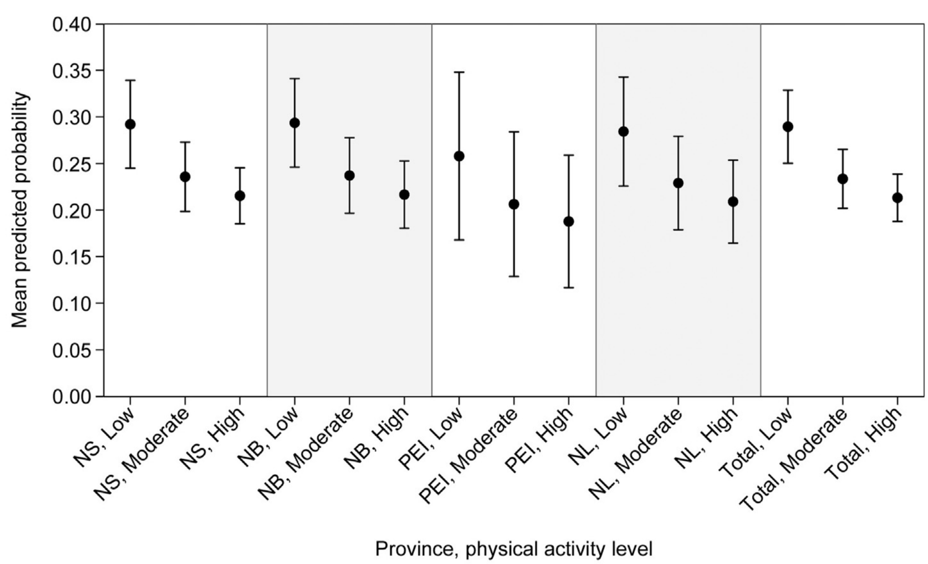

Figure 1. Predicted mean probability of cardiovascular disease by Atlantic province and physical activity level. **Dots** represent means, and **error bars** represent +/− 2 SD. The total mean probability of CVD was statistically significantly lower for high PA levels ($P = 0.001$) compared with low-to-moderate PA levels. CVD, cardiovascular disease; NB, New Brunswick; NL, Newfoundland and Labrador; NS, Nova Scotia; PA, physical activity; PEI, Prince Edward Island, SD, standard deviation.

Table 2. Associations between cardiovascular disease and physical activity stratified by Atlantic province

	NS		NB		PEI		NL	
	OR (95% CI)	*P* trend	OR (95% CI)	*P* trend	OR (95% CI)	*P* trend	OR (95% CI)	*P* trend
Physical activity*		0.230		0.007		0.992		0.052
High	1.00		1.00		1.00		1.00	
Moderate	0.96 (0.69-1.33)		1.21 (0.79-1.84)		0.51 (0.15-1.68)		1.97 (1.10-3.55)	
Low	1.26 (0.86-1.85)		1.80 (1.18-2.75)		1.01 (0.35-2.89)		1.85 (1.00-3.42)	

Observations with missing or unknown values for physical activity level were kept as missing in the models. *P* trend tests for linear trend among different physical activity levels.

CI, confidence interval; NB, New Brunswick; NL, Newfoundland and Labrador; NS, Nova Scotia; OR, odds ratio; PEI, Prince Edward Island

* High physical activity is the reference level. Basic model, with adjustment for matching variables: sex, age, and province of residence.

estimated for a particular PA level in NL and NB compared with NS and PEI following both sets of adjustments. Small sample sizes in PEI and NL meant that some relationships could not be explored.

Discussion

In this population-based study assessing the association between PA and CVD across Atlantic Canada, moderate overall spatial variation was observed. The highest percentages of low PA levels were in PEI (24.3%), NB (23.0%), and NL (21.1%), whereas NS had the lowest percentage (10.8%). Regional differences were also observed in 2017, with the lowest percentage of active individuals in NB (50.6%), followed by NL (52.0%), NS (53.8%), and PEI (55.2%).[27] Similar results were found earlier by Krueger et al.[28] and the Public Health Agency of Canada (PHAC).[1] The discrepancy for PEI may be a byproduct of the Canadian Community Health Survey (CCHS) used in the literature, which captures leisure time PA, whereas the IPAQ additionally captures PA through work, transport, and domestic-related domains.[29] This, along with self-report recall biases, could have produced these discrepancies.

PA has been objectively measured in Canada using accelerometers. The Canadian Health Measures Survey (CHMS)—capturing 96% of the Canadian population—revealed that 29% of adult Canadians were meeting PA guidelines in 2017 (at least 150 minutes of moderate-to vigourous physical activity [MVPA] per week in ≥10-minute bouts).[30] Younger men are more active than women, but these differences disappear after age 40 as PA declines. Moreover, healthy-weight men and women average more MVPA than do overweight and obese people.[31] These objective measures have been compared with self-reported data, which identified up to 40% misclassification of people as meeting PA guidelines based on 1 method vs the other.[32] The least active adults were also more likely to overestimate their PA compared with accelerometer data.[33]

A dose-response relationship was observed, with high PA levels associated with reduced probability of CVD compared with low-to-moderate PA levels. In a systematic review and meta-analysis, shifting to recommended PA levels was associated with a risk reduction of 17% in incidence of CVD and 23% in CVD mortality.[34] Similarly, accelerometer-measured light-intensity PA (LPA) improved numerous cardiometabolic biomarkers including WC, hypertension, and diabetes,[35] whereas increased MVPA was associated with smaller WC and decreased odds of self-reported poor health.[36]

This study identified regional inequalities in the association between PA and CVD. The highest mean probability of CVD for a given PA level was calculated for NB, followed by NS and NL, with the lowest probability in PEI. Based on logistic regression, higher risk of CVD for a given PA level was observed in NL and NB compared with NS and PEI. These inequalities existed following adjustment for the matching variables and generally persisted with additional adjustment for the CVD-associated variables. Few studies have explored geographic variations in this relationship,[7,10,11] and none were identified in Canada.

Questions arise on the factors underlying regional variations. Socioecological models theorize that PA is influenced by multilevel factors at individual and contextual levels.[37] Various biopsychosocial attributes encapsulate the individual level. In a Canadian study, PA was negatively associated with age and positively associated with education, family income, and self-rated health.[38] In our study, NB and NL had higher proportions of young people and higher incomes, which correlated with higher proportions of moderate-to-high PA levels. Yet, NS and PEI had similar PA proportions, possibly owing to the highest proportions of advanced education, high proportions of self-rated health, and additional free time with retirement.[38]

Contextual factors influencing PA include rurality and the built environment. Leisure-time PA is lower in rural areas, decreasing with increasing distance from cities.[1] Built environment features associated with lower rural PA include absence of accessible recreational facilities, absence of sidewalks or walkable destinations, lack of parks, and perceptions of safety and crime.[39] A large portion of Atlantic PATH participants were recruited from Halifax, NS.[12] Thus, rurality may partly account for higher proportions of low PA levels outside of NS, where increased remoteness reduces opportunity for activity-promoting features of the built environment.

Regional variations may also be attributable to the policy environment. This is particularly true of legislation promoting PA early in life, a critical stage that shapes habits throughout the life course.[40] Only NS has updated child-care regulations since 2010, and it is the only Atlantic province explicitly to mention daily PA in legislation or the specific requirements in terms of duration (∼2 hours per day). Similarly, NS requires ≥7 m^2 of outdoor play space requirements per child, NB allocates less at ≥4 m^2 per child, whereas NL and PEI omit these stipulations. Conversely, only NB legislation mentions that screen-viewing time should not be part of daily programming for children.[41] These policy differences early in life may underpin the lower levels of low PA in NS that were seen in our population later in life.

Table 3. Associations between cardiovascular disease and physical activity following sequential adjustment with cardiovascular disease-associated variables, stratified by Atlantic province

	NS			NB			PEI			NL		
	Moderate	Low	*P* trend	Moderate	Low	*P* trend	Moderate	Low	*P* trend	Moderate	Low	*P* trend
Model 1	1.01 (0.70-1.47)	1.03 (0.67-1.59)	0.880	1.20 (0.74-1.95)	1.57 (0.96-2.57)	0.074	0.37 (0.10-1.43)	1.09 (0.32-3.73)	0.888	2.43 (1.21-4.89)	2.01 (0.95-4.23)	0.067
Model 2	0.94 (0.57-1.54)	0.74 (0.36-1.53)	0.421	1.09 (0.36-3.30)	0.75 (0.26-2.16)	0.594	—	—	—	—	—	—
Model 3	0.85 (0.48-1.48)	0.83 (0.37-1.89)	0.663	0.45 (0.11-1.78)	0.49 (0.12-2.13)	0.344	—	—	—	—	—	—

Values are odds ratio (95% confidence interval). (—), No estimate because of zero or sparse observations in cell. Observations with missing or unknown values were kept as missing in the models. *P* trend tests for linear trend among different physical activity levels.

High physical activity is the reference level. Model 1 includes the basic model (adjusted for sex, age, and province of residence) plus additional sociodemographic variables (ethnicity, education level, working status, and household income). Model 2 adds health status variables to Model 1 (health status, hypertension, diabetes, antihypertensives, hypolipemic agents, hypoglycemic agents, depression, anxiety, and waist circumference). Model 3 adds lifestyle and behaviour variables to Model 2 (sedentary behaviour, smoking status, alcohol consumption, sleep duration, and fruit and vegetable consumption).

NB, New Brunswick; NL, Newfoundland and Labrador; NS, Nova Scotia; PEI, Prince Edward Island.

Strengths and limitations

A strength of this study is that it identified regional inequalities in the distribution of a major risk factor contributing to the high overall burden of CVD. Furthermore, by contextualizing variations within differences in combined heart-healthy behaviours, this study can serve as an impetus for targeted PA interventions to reduce CVD inequalities. Finally, a population-based data source was used with urban and rural Atlantic Canadians.

This study also contained limitations. As a cross-sectional study, the cohort may not be representative of the region over time, and the temporal relationship between PA and CVD cannot be elucidated. Future work will benefit from a prospective study design. Despite a large sample size, missing observations and relatively few CVD cases created small sample sizes, leading to imprecise estimates. This was particularly true in PEI and NL, where analyses with multiple parameters on small samples sizes resulted in insufficient degrees of freedom and prevented certain analyses. This can be ameliorated with larger sample sizes, which would enable analyses to facilitate further comparisons with NS and NB. Finally, our study relied upon subjective, self-reported PA levels, wherein 53% reported moderate-to-high PA. Yet, only 29% of CHMS participants met similar PA guidelines when using accelerometers.[30] This discrepancy is largely caused by a social desirability bias, in which respondents often overestimate PA to present themselves more positively.[32] This can be addressed with further regional studies generating objective, accelerometer-driven data.

Conclusions

Geographic variations in associations between PA and CVD exist in Atlantic Canada. The policy implications include how to improve outcomes in each province and how to reduce inequalities compared with the rest of Canada. Future work should explore regional variations using accelerometers. As pathways linking residential environments to PA and CVD are increasingly uncovered, policymakers can capitalize on this information to help reduce regional inequalities.

Acknowledgements

The data in this study came from the Atlantic Partnership for Tomorrow's Health (Atlantic PATH), which is the regional component of the Canadian Partnership for Tomorrow's Health (CanPath), funded by the Canadian Partnership Against Cancer and Health Canada. We thank Atlantic PATH participants who gave their time and personal health history used for this study. We also thank the Atlantic PATH data custodians for their research platform that enabled this study.

Funding Sources

This study was financially supported by the Dalhousie University Research in Medicine (RIM) program as well as by the Atlantic Partnership for Tomorrow's Health (PATH) (2018-106). Funding sources did not have any involvement in the study design, analysis, or interpretation of the results. The expressed views and conclusions are the sole work of the study authors.

Disclosures

The authors have no conflicts of interest to disclose.

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Supplementary Material

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