SSM - Population Health 16 (2021) 100964

Contents lists available at ScienceDirect

SSM - Population Health

journal homepage: www.elsevier.com/locate/ssmph

Barriers to physical activity for adults in rural and urban Canada: A cross-sectional comparison

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ARTICLE INFO

Keywords:
Rural health
Barriers
Physical activity
Exercise
Health promotion
Social-ecological model
Rural-urban disparities

ABSTRACT

Background: Individual differences in physical activity behavior are associated with a collection of individual and environmental factors manifesting as barriers to participation. Understanding how barriers to physical activity differ based on sociodemographic characteristics can support identification and elimination of health inequities.
Objectives: To compare the odds of reporting individual and environmental barriers to physical activity in rural and urban adults, and explore interactions between rural-urban location and sociodemographic factors to characterize patterns in barriers to physical activity.
Design: Cross-sectional.
Methods: We analyzed the 2017 Canadian Community Health Survey Barriers to Physical Activity Rapid Response, with a final weighted sample of 24,499,462 (unweighted n=21,967). The likelihood of reporting each barrier domain based on rural-urban location was examined using binary logistic regression following a model-fitting approach with sociodemographic characteristics as covariates or interaction terms.
Results: Adjusting for sociodemographic factors, rural residents showed 85% higher odds of reporting at least one social or built environmental barrier (OR=1.85 [1.66, 2.07]). Compared to urban residents, rural residents showed significantly higher odds of reporting barriers to facility access (OR=4.15 [3.58, 4.83]) and a lack of social support to be active (OR=1.17 [1.04, 1.32]). Urban residents reported lower preference for physical activity, lower enjoyment of physical activity and lower confidence in their ability to regularly engage in physical activity. Interactions between socioeconomic status and location were identified related to enjoyment and confidence to be active. There was no effect of location on predicting the odds of reporting an individual resource-related variable (e.g., time, energy).
Conclusions: Despite being more likely than urban residents to prefer and enjoy physical activity, rural residents have fewer opportunities and receive less social support to be active. It is important to consider geographic location when characterizing barriers to physical activity and in the development of context-specific health promotion strategies.

1. Introduction

Regular participation in physical activity has well-established benefits for noncommunicable disease prevention and management, life expectancy, and quality of life (Clarke & Janssen, 2021; Ekelund et al., 2019; Lee et al., 2012; Marquez et al., 2020). Consistent inequities in physical activity participation can contribute to widening health inequities (Eikemo et al., 2014; WHO, 2013). To support uptake and promotion of physical activity guidelines, it is necessary to characterize barriers to physical activity behavior, particularly in populations at increased risk of inactivity.

Compared to adults living in urban centres, rural residents have a poorer overall health status, higher rates of noncommunicable disease, and reduced life expectancy (Long et al., 2020; Pong et al., 2009). Multiple sociostructural and environmental factors have been associated with rural-urban health inequities (Marmot et al., 2008; Leipert and George, 2008). Rural residents tend to be less physically active and more sedentary compared to their urban counterparts (Martin et al., 2005;

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https://doi.org/10.1016/j.ssmph.2021.100964
Received 26 August 2021; Received in revised form 21 October 2021; Accepted 9 November 2021
Available online 12 November 2021

Parks et al., 2003), although there is evidence to suggest this trend varies by country, region, measurement approach (i.e., device-based vs. self-report), and sociodemographic factors such as sex (Yip et al., 2016; Fan et al., 2014; Forbes et al., 2020; Pelletier, White, et al., 2021). Considering the undeniable benefits of physical activity, adopting a location-specific approach to characterizing barriers to physical activity will aid the development of strategies to address rural-urban health inequities.

According to the social-ecological model of behavior, physical activity is shaped by interdependent factors at individual, social, environmental, and policy levels (Bauman et al., 2012; Sallis et al., 2006). Based on the social-ecological framework, barriers to physical activity can be classified at individual/intrapersonal (e.g., time, cost), social/-interpersonal (e.g., support from family, seeing other people be active), policy (e.g., traffic controls and zoning guidelines), and structural/built environmental (e.g., access to facilities) levels (Bauman et al., 2012; Sallis et al., 2006). Engagement in physical activity reflects the combination of intrapersonal and interpersonal factors within a given environment and the fit between individual and environmental circumstances. Compared to their urban counterparts, rural residents in the United States are more likely to report lower social support, limited access to and distance from exercise facilities, and built environment characteristics such as lack of accessible facilities, sidewalks and bike paths as barriers to physical activity (Brownson et al., 2000; Eyler, 2003; Parks et al., 2003; Wilcox et al., 2000). In contrast to the barriers imposed by rural environments, common features of urban environments such as access to exercise facilities, active transportation opportunities, and increased density and mixed land use facilitate physical activity participation (McCormack & Shiell, 2011; Heath et al., 2006).

In addition to the distinct social and built environmental context of rural communities, patterns of sociodemographic factors including income, educational attainment, and age vary between rural and urban populations – all factors associated with physical activity engagement (Plotnikoff et al., 2004; Singh, 2003; Zarifa et al., 2019). In our recent study examining the odds of meeting physical activity guidelines, we identified an interaction between rural-urban location and self-identified sex (Pelletier, White, et al., 2021). In this analysis, rural males were more likely to meet physical activity guidelines compared to urban males and urban females were more likely to meet physical activity guidelines compared to rural females (Pelletier, White, et al., 2021). Considering sociodemographic factors as covariates and/or moderators in the relationship between barriers to physical activity and rural-urban location is important as some barriers, such as social support and time, are more important for women (Sallis et al., 1992), and the relationship between facility access and physical activity varies based on education (Pan et al., 2009).

To understand patterns in barriers to physical activity we conducted a study aimed at: 1) comparing the odds of reporting individual and environmental barriers to physical activity in rural and urban adults; and 2) exploring the interaction between rural-urban location and sociodemographic factors to characterize barriers to physical activity.

2. Methods

2.1. Participants

We analyzed cross-sectional data from the 2017 cycle of the Canadian Community Health Survey (CCHS; response rate: 62.8%). The CCHS is an annual survey providing a representative sample of the Canadian population over 12 years of age. The CCHS excludes less than 3% of the Canadian population, including individuals living on Indigenous reserves and Crown Lands, full time members of the Canadian Forces, institutional residents, youth in foster care, and residents of other remote regions.

The Barriers to Physical Activity Rapid Response module was an optional component for CCHS respondents during the 2017 data collection cycle (collected between July and December, response rate: 61.6%) and additionally excludes those residing in the Canadian territories.

Prior to conducting any assessments of the data, we excluded all youth participants (age <18, n = 2149). Subsequently, we excluded adults who reported currently being pregnant or who did not answer (n = 296), and individuals with missing data (refusal or not stated responses) or an answer of "don't know" on any variable of interest (n=3611). Our final, unweighted sample of adult survey respondents was n=21,967, corresponding to a population-weighted n=24,499,462 Canadians per weights provided by Statistics Canada. All data were vetted following Statistics Canada policies to protect participant confidentiality.

2.2. Variables

2.2.1. Barriers to physical activity

Ten barriers were assessed with the CCHS Barriers to Physical Activity Rapid Response. One question regarding access to showers or change rooms at a participants' place of work was removed from our analysis (BPA_050). This question was only asked for a small subset of the sample based on employment status. Thus, nine barriers are included in this analysis. We categorized barriers as individual (motivation- or resource-related) and environmental (social and built) based on the social-ecological model and to align with previous work (Bauman et al., 2012; Pan et al., 2009; Sallis et al., 2006). Participants rated their agreement with a series of statements related to individual (6 items) and environmental (3 items) barriers to physical activity from 1 = strongly agree to 4 = strongly disagree. Barriers were recoded into numeric binary variables, collapsing "Strongly Agree" and "Agree", and "Disagree" and "Strongly Disagree". Barriers were coded as 1 (barrier reported) or 0 (no barrier reported).

We divided individual barriers into resource-related barriers (3 items) and motivation-related barriers (3 items). Individual resource-related barriers were measured with the following items:

- "I have enough energy to be physically active on a regular basis"
- "I have enough time to be physically active on a regular basis"
- "I can afford the costs of being physically active on a regular basis"

Individual motivation-related barriers were measured with the following items:

- "I prefer to be physically active rather than sitting or lying down" For example, physical activities could include doing chores around the house, biking to work, playing sports and going to the gym. Activities while sitting or lying down could include watching TV, reading or using electronics.
- "I am confident in my ability to engage in physical activity"
- "I enjoy being physically active"

Three items measured environmental barriers including social (2 items) and built (1 item) environment:

- "I often see people in my community being physically active" Community means an area around your house, school or work, where you spend most of your time.
- "I receive support to be physically active on a regular basis from friends, family members or other people in my life"
- "My neighbourhood has several free or low-cost recreation facilities, such as parks, walking trails, bike paths, recreation centres, playgrounds or public swimming pools"

2.2.2. Sociodemographic information

Participants were asked to self-identify their sex, with the options of male or female. Age was self-reported and treated as a grand-mean-centred

continuous measure. Body mass index (BMI) was derived from self-reported height and weight, adjusted for self-report bias (Gorber et al., 2007), and grand-mean-centred. The three-level variable EHG2DVR3 was used to describe participants' education (less than secondary school graduation/secondary school graduation/post-secondary certificate, diploma, or university degree). A fifteen-level variable, INCDVHH, reflected participant's self-reported household income and was collapsed into roughly equal quintiles across the following income divisions: $0–29,999; $30,000–59,999; $60,000–99,999; $100,000–149,999; ≥$150,000. Self-identified sex was coded male=0 and female=1; education and income were coded such that the mode represented the reference level for the regression intercept (education: secondary school graduation=0; income: $60,000–99,999=0).

2.2.3. Perceived health

Perceived health status was reported across five levels, ranging from poor to excellent using the GENDVHDI variable. We coded this variable to "centre" a relatively representative categorical rating (Good=0) to serve as a reference level within the regression analyses.

2.2.4. Sense of belonging to community

Respondents' sense of belonging to their community was included in the analysis based on previous quantitative (Yip et al., 2016) and qualitative (McGannon et al., 2014; Witcher et al., 2007) work indicating the role of community social engagement as a facilitator of physical activity behavior in rural communities. The variable GEN_030 was used to assess sense of belonging across four levels from Very Strong to Very Weak. This variable was reverse coded such that Very Weak=0 served as the reference level.

2.2.5. Season of data collection

The CCHS sampling strategy is subdivided into two equal data collection periods spanning: 1) July to September (Summer/Fall); and 2) October to December (Fall/Winter). Because these sampling periods roughly correspond to changing seasons, which are associated with a fluctuation in physical activity participation (Turrisi et al., 2021), this variable was included as a potential factor of interest in the regression analyses. The first sampling period in the rapid response module (July–September) was coded as 0 to anchor the regression analyses.

2.3. Data analysis

Data analysis was conducted using R 3.4.3 (R Core Team, 2019) and packages arsenal (Heinzen et al., 2019) and survey (Lumley, 2019). For all analyses, survey weights were employed to ensure the sample was representative of the Canadian population and bootstrap replicate weights were employed for variance calculations due to the complex clustering in CCHS sampling procedures.

We examined the odds of reporting barriers to physical activity using binary logistic regression with a model-fitting approach. Only variables that contributed to explaining significant variance in the outcome were retained, except for the location variable which was always retained given *a priori* aims.

For each outcome, a base model was first computed to examine the effect of location as a predictor[1] of reported barriers. Subsequently, a covariate model was estimated adding all *a priori* identified covariates. Next, covariates were removed sequentially in order of smallest t-values, and model comparisons were conducted until no further covariates could be removed from the model without reducing its explanatory power. The remaining model terms were then systematically estimated in 2-way interactions with the location factor, after which any significant 2-way interactions were explored with 3-way interaction tests. Model comparisons were conducted to determine whether interaction terms added meaningfully to each model. In all cases, the final model presented represents the optimally fitted model for the dataset, retaining location as a factor of theoretical interest. Models were examined for influential cases per the recommendations for binomial logistic regression (Zhang, 2016).

To reduce the number of tests conducted across the nine barrier items, we first collapsed barriers into three high-level factors: social and built environmental, individual motivation-related, and individual resource-related (Bauman et al., 2012; Pan et al., 2009; Sallis et al., 2006). Each was treated as a binary outcome (i.e., any environmental barrier reported=1 vs. none reported=0) and the effect of location examined. If the effect of location was non-significant in the optimally fitted model, we did not pursue further analysis of barriers. Where the effect of location remained significant in the optimally fitted model, we conducted a follow-up series of models using the separate barrier items comprising the high-level category (e.g., environmental barriers were examined individually in distinct models).

3. Results

3.1. Participants

Participant sociodemographic characteristics by rural-urban location are presented in Table 1. The excluded sample differed significantly from the included sample on several sociodemographic characteristics and the reporting of several barriers to physical activity (Tables 2 and 3).

3.2. Barriers to physical activity

Irrespective of location, the most reported barriers were lack of time (21.4% reporting) and lack of support to be physically active (22.7% reporting; Table 4). For urban residents, the most reported barriers were lack of support to be active (22%) and lack of time (21.8%). For rural residents, the most reported barriers were lack of facility access (28.7%) and lack of support to be active (26%). Seventy-one percent of rural residents reported at least one social or built environmental barrier compared with 44.5% of urban residents, while individual resource-related (50.8% urban; 47.1% rural) and individual motivation-related (26% urban; 21.4% rural) barriers were reported with similar frequency by location.

3.3. Individual resource-related barriers

3.3.1. Any barrier

There was no effect of location in predicting the odds of reporting any individual resource-related variable either in the base model ($p > .20$) or after controlling for sociodemographic factors, OR=0.95, 95% CI [0.84, 1.07], p=.393. No further analyses were conducted on separate barrier items (Table 5).

3.4. Individual motivation-related barriers

3.4.1. Any barrier

Rural residents had lower odds of reporting at least one motivation-related barrier in the base model (OR=0.78, 95% CI [0.69, 0.89], p=.0002) and in the optimally fitted model (OR=0.69, 95% CI [0.60,0.79], $p < .0001$; Table 6). After accounting for covariates, 30% of urban and 22.9% of rural residents reported at least one motivation-related variable.

[1] Note that we employ the term "predictor" strictly with respect to its statistical usage within the scope of regression model outcomes for our cross-sectional analysis, from which directionality of relationships between variables and/or their causal relations to one another cannot be assessed. This usage is distinguishable from the usage of the term "predictor" to reflect concepts such as risk or protective factors, or other causal relations. We do not advance any causal interpretations in the present analysis.

Table 1
Population-weighted demographics by rural-urban location.

Variables of interest		Rural (N = 4209008)		Urban (N = 20290454)		Total (N = 24499462)		p-value
		N	%/SE	N	%/SE	N	%/SE	
Season	**Summer**	2012891	47.8	10218419	50.4	12231310	49.9	0.262
	Fall	2196117	52.2	10072035	49.6	12268152	50.1	
Sex	**Male**	2072934	49.2	10270509	50.6	12343443	50.4	0.282
	Female	2136074	50.8	10019945	49.4	12156019	49.6	
Age	**Mean**	50.6	0.354	46.1	0.138	46.9	0.102	<.001
	95% CI	[49.9, 51.3]		[45.8, 46.3]		[46.7, 47.1]		
BMI	**Mean**	28.3	0.137	27.2	0.074	27.4	0.068	<.001
	95% CI	[28.0, 28.5]		[27.1, 27.4]		[27.3, 27.5]		
Education	**Less than high school**	677597.1	16.1	1731009.5	8.5	2408606.6	9.8	<.001
	High school	1206112.2	28.7	5033644	24.8	6239756.2	25.5	
	Post-secondary	2325298.4	55.2	13525800.5	66.7	15851098.9	64.7	
Income	**$0–29,999**	485665.7	11.5	2563632.1	12.6	3049297.8	12.4	<.001
	$30–59,999	942434.9	22.4	4041778	19.9	4984212.9	20.3	
	$60–99,999	1126413.9	26.8	4927414.2	24.3	6053828.1	24.7	
	$100–149,999	899355.1	21.4	4251121.1	21.0	5150476.2	21.0	
	$150,000+	755138	17.9	4506508.5	22.2	5261646.5	21.5	
Perceived Health	**Excellent**	1032096.9	24.5	4968586	24.5	6000682.9	24.5	0.02
	Very good	1565836.6	37.2	7808784.6	38.5	9374621.2	38.3	
	Good	1145131.2	27.2	5649887.1	27.8	6795018.3	27.7	
	Fair	347232.5	8.2	1475061.9	7.3	1822294.4	7.4	
	Poor	118710.4	2.8	388134.4	1.9	506844.8	2.1	
Sense of Belonging to Community	**Very Strong**	854929.3	20.3	3281955.4	16.2	4136884.7	16.9	<.001
	Somewhat strong	2077782	49.4	10527191.8	51.9	12604973.8	51.5	
	Somewhat weak	988478.6	23.5	5063461.5	25.0	6051940.1	24.7	
	Very Weak	287817.7	6.8	1417845.3	7.0	1705663	7.0	

P-values obtained by *t*-test for continuous variables or Chi-square test for categorical factors.

Table 2
Population-weighted demographics for included vs. excluded participants.

Variables of interest		Excluded (N=4331267.6)		Included (N=24499461.6)		Total (N=28,830,729.2)		p-value
		N	%/SE	N	%/SE	N	%/SE	
Location	**Urban**	3628699.7	83.8	20290454	82.8	23919153.7	83.0	0.271
	Rural	702567.9	16.2	4209007.6	17.2	4911575.5	17.0	
Season	**Summer**	2171827	50.1	12231310	49.9	14403137	50.0	0.889
	Fall	2159441	49.9	12268152	50.1	14427593	50.0	
Sex	**Male**	1837785	42.4	12343442	50.4	14181227	49.2	<.001
	Female	2493482	57.6	12156019	49.6	14649501	50.8	
Age	**Mean (SE)**	54.4	0.5	46.8	0.1	48	0.1	<.001
	95% CI	[53.4, 55.5]		[46.7, 47.1]		[47.9, 48.1]		
BMI	**Mean (SE)**	27.6	0.2	27.4	0.1	27.4	0.1	0.39
	95% CI	[27.2, 27.9]		[27.3, 27.5]		[27.3, 27.5]		
Education	**Less than high school**	788053.8	20.4	2455527.2	9.8	3243581	11.3	<.001
	High school	1003997.4	26.1	6361309.1	25.5	7365306.5	25.5	
	Post-secondary	2061957.2	53.5	16159884.5	64.7	18221841.7	63.2	
Income	**$0–29,999**	765471.3	17.7	3049297.8	12.4	3814769.1	13.2	<.001
	$30–59,999	1189721.1	27.5	4984212.9	20.3	6173934	21.4	
	$60–99,999	1020559.8	23.6	6053828.1	24.7	7074387.9	24.5	
	$100–149,999	722784.9	16.7	5150476.2	21.0	5873261.1	20.4	
	$150,000+	632730.5	14.6	5261646.6	21.5	5894377.1	20.4	
Perceived Health	**Excellent**	339047.4	7.9	507274.4	2.1	846321.8	2.9	<.001
	Very good	593031.3	13.8	1823839	7.4	2416870.3	8.4	
	Good	1392037.4	32.3	6800777.6	27.7	8192815	28.4	
	Fair	1170851.4	27.2	9382566.9	38.3	10553418.3	36.6	
	Poor	815534.9	18.9	6005768.8	24.5	6821303.7	23.7	
Sense of Belonging to Community	**Very Strong**	395390.7	12.2	1781127.6	7.0	2176518.3	7.5	<.001
	Somewhat strong	692068.2	21.3	6319699.4	24.7	7011767.6	24.3	
	Somewhat weak	1578679.5	48.6	13162662.4	51.5	14741341.9	51.1	
	Very Weak	581186.4	17.9	4319915.1	16.9	4901101.5	17.0	

P-values obtained from *t*-test or Chi-square test as appropriate.
Note: total included n's for individual self-report variables may sum to greater than the sample-wide included N due to participants missing data on some but not all items. All participants with missing data on any item were marked for sample-wide exclusion.

Table 3
Population-weighted reporting of barriers for included and excluded participants.

Variables of interest		Excluded (N=4331267.6)		Included (N=24499461.6)		Total (N=28,830,729.2)		p-value
		N	%/SE	N	%/SE	N	%/SE	
Prefer to be active than sitting/lying down	**Strongly agree**	59766.23	1.8	364652.64	1.4	424418.87	1.5	0.004
	Somewhat agree	388393.32	11.4	2422832.66	9.5	2811225.98	9.8	
	Somewhat disagree	1810701.69	53.1	12561610.41	49.4	14372312.1	49.9	
	Strongly disagree	1150313.71	33.7	10072458.54	39.6	11222772.25	38.9	
Sees people in community being active	**Strongly agree**	90460.47	2.8	372717.84	1.5	463178.31	1.6	<.001
	Somewhat agree	498240.93	15.5	3269083.82	12.8	3767324.75	13.1	
	Somewhat disagree	1924449.75	60.0	15153196.09	59.1	17077645.84	59.2	
	Strongly disagree	691612.94	21.6	6830967.36	26.7	7522580.3	26.1	
Receives support to be physically active	**Strongly agree**	165187.5	5.0	790384.8	3.1	955572.3	3.3	<.001
	Somewhat agree	771864.3	23.6	4999807	19.6	5771671.3	20.0	
	Somewhat disagree	1701320.8	51.9	13239604.5	51.8	14940925.3	51.8	
	Strongly disagree	638092.8	19.5	6524467.4	25.5	7162560.2	24.8	
Has enough energy to be physically active	**Strongly agree**	878143.32	25.6	7888364.37	31.1	8766507.69	30.4	<.001
	Somewhat agree	1969322.26	57.5	14427542.27	56.8	16396864.53	56.9	
	Somewhat disagree	484760.1	14.1	2647277.67	10.4	3132037.77	10.9	
	Strongly disagree	93998.87	2.7	441320.34	1.7	535319.21	1.9	
Has enough time to be physically active	**Strongly agree**	687973	20.0	5983834.5	23.6	6671807.5	23.1	0.066
	Somewhat agree	1961285.3	57.0	13972368.6	55.0	15933653.9	55.3	
	Somewhat disagree	685402.3	19.9	4749147.1	18.7	5434549.4	18.8	
	Strongly disagree	106408	3.1	684310.5	2.7	790718.5	2.7	
Can afford to be physically active	**Strongly agree**	549635.1	16.9	6483431.8	25.3	7033066.9	24.4	<.001
	Somewhat agree	1929996	59.3	14848993.4	58.1	16778989.4	58.2	
	Somewhat disagree	634826.5	19.5	3572545.6	14.0	4207372.1	14.6	
	Strongly disagree	139338.8	4.3	671962.1	2.6	811300.9	2.8	
Neighbourhood has several free/low-cost facilities	**Strongly agree**	865148.06	28.1	9124212.2	35.4	9989360.26	34.6	<.001
	Somewhat agree	1649956.33	53.5	13467874.05	52.3	15117830.38	52.4	
	Somewhat disagree	478851.81	15.5	2564759.97	10.0	3043611.78	10.6	
	Strongly disagree	87922.57	2.9	592004.21	2.3	679926.78	2.4	
Has confidence in ability to be physically active	**Strongly agree**	1005478.9	29.6	9854006.7	38.7	10859485.6	37.7	<.001
	Somewhat agree	1959451.9	57.7	13669967.4	53.7	15629419.3	54.2	
	Somewhat disagree	338191.5	10.0	1595908.7	6.3	1934100.2	6.7	
	Strongly disagree	91420.7	2.7	316303.3	1.2	407724	1.4	
Enjoys physical activity	**Strongly agree**	1012888.25	29.7	9921909.78	39.0	10934798.03	37.9	<.001
	Somewhat agree	2099144.11	61.6	13786627.89	54.2	15885772	55.1	
	Somewhat disagree	264094.29	7.8	1558592.06	6.1	1822686.35	6.3	
	Strongly disagree	29473.81	0.9	157999.01	0.6	187472.82	0.7	
Has access to showers at or near work	**No**	1092824.2	38.8	9632549.4	37.0	10725373.6	37.2	0.246
	Yes	1067459	37.9	10850832.2	41.7	11918291.2	41.3	
	Not applicable	654242.6	23.2	5532821.8	21.3	6187064.4	21.5	
Number of social and built environmental barriers	**0**	1462692.8	56.1	16429488.58	62.7	17892181.38	62.1	0.008
	1	773658.62	29.7	7132026.4	27.2	7905685.02	27.4	
	2	295804.26	11.3	2230102.5	8.5	2525906.76	8.8	
	3	76816.96	2.9	430139.07	1.6	506956.03	1.8	
Number of individual barriers	**0**	1464091	51.2	15219868.1	58.6	16683959.1	57.9	<.001
	1	704910.6	24.7	5666590.8	21.8	6371501.4	22.1	
	2	338786	11.9	2809016.3	10.8	3147802.3	10.9	
	3+	350239.8	12.3	2277226.8	8.8	2627466.6	9.1	
Number of motivation-related individual barriers	**0**	2470805.43	77.0	21145223.89	82.5	23616029.32	81.9	<.001
	1	521035.59	16.2	2897694.48	11.3	3418730.07	11.9	
	2	144692.07	4.5	1167901.15	4.6	1312593.22	4.6	
	3+	72745.72	2.3	410630.87	1.6	483376.59	1.7	
Number of resource-related individual barriers	**0**	1751483.9	56.2	16547853.6	64.3	18299337.5	63.5	<.001
	1	857618.7	27.5	6051014.9	23.5	6908633.6	24.0	
	2	383543.5	12.3	2504463.2	9.7	2888006.7	10.0	
	3+	122321.8	3.9	612429.6	2.4	734751.4	2.5	
Number of motivation-related individual barriers (continuous)	**Mean (SE)**	0.321	0.02	0.238	0.01	0.26	0.01	<.001
	95% CI	[0.285, 0.356]		[0.238, 0.266]		[0.247, 0.273]		
Number of resource-related individual barriers (continuous)	**Mean (SE)**	0.639	0.03	0.502	0.01	0.516	0.01	<.001
	95% CI	[0.588, 0.690]		[0.482, 0.521]		[0.498, 0.535]		

Table 4
Population-weighted frequency of barriers reported by rural-urban location.

Domain	Item		Urban (n=20290454)	Rural (n=4209008)	Total (n=24499462)
Individual motivation-related barriers	Prefer to be active	no barrier	17959591 (88.5%)	3853494 (91.6%)	21813085 (89.0%)
		barrier	2330863 (11.5%)	355514 (8.4%)	2686377 (11.0%)
	Confidence to be active	no barrier	18751193 (92.4%)	3906477 (92.8%)	22657670 (92.5%)
		barrier	1539261 (7.6%)	302531 (7.2%)	1841792 (7.5%)
	Enjoy activity	no barrier	18877756 (93.0%)	3967611 (94.2%)	22845367 (93.2%)
		barrier	1412698 (7.0%)	241396 (5.7%)	1654094 (6.8%)
Social and built environmental barriers	See people active in community	no barrier	17497544 (86.2%)	3520208 (83.6%)	21017752 (85.8%)
		barrier	2792910 (13.8%)	688800 (16.4%)	3481710 (14.2%)
	Receive support to be active	no barrier	15833855 (78.0%)	3114416 (74.0%)	18948271 (77.3%)
		barrier	4456599 (22.0%)	1094592 (26.0%)	5551191 (22.7%)
	Access to free or low-cost facilities	no barrier	18493058 (91.1%)	3002813 (71.3%)	21495871 (87.7%)
		barrier	1797396 (8.9%)	1206195 (28.7%)	3003591 (12.3%)
Individual resource-related barriers	Has energy to be active	no barrier	17785534 (87.7%)	3735362 (88.7%)	21520896 (87.8%)
		barrier	2504920 (12.3%)	473646 (11.3%)	2978566 (12.2%)
	Has time to be active	no barrier	15870781 (78.2%)	3385728 (80.4%)	19256509 (78.6%)
		barrier	4419673 (21.8%)	823279 (19.6%)	5242952 (21.4%)
	Can afford to be active	no barrier	16911558 83.3%)	3522204 (83.7%)	20433762 (83.4%)
		barrier	3378897 (16.7%)	686804 (16.3%)	4065701 (16.6%)

Table 5
Odds ratios for the effect of location on likelihood of reporting individual resource-related barriers (reference: urban).

	Any resource-related barriers	Can afford to be active	Has time to be active	Has energy to be active
Base model	0.93 [0.78, 0.97]	not run	not run	not run
Final model	0.95 [0.84, 1.07]			

Note: although the CI for the base model doesn't include 1, the p-value of the regression slope estimate is > 0.20.

3.4.2. Preference to be active

Rural residents had lower odds of reporting barriers related to preference to be active compared with laying down (i.e., they were more likely to report a preference to be active)[2] in the base model (OR=0.71, 95% CI [0.60, 0.84], $p < .0001$) and in the optimally fitted model (OR=0.69, 95% CI [0.58, 0.81], $p < .0001$). In the final model, 18.8% of urban and 13.8% of rural residents reported this barrier. No interactions with location were significant.

3.4.3. Enjoyment of physical activity

Rural residents showed lower odds of reporting enjoyment of physical activity as a barrier (i.e., they more commonly reported enjoying activity) in the base model (OR=0.81, 95% CI [0.68, 0.97], p=.023) and after controlling for sociodemographic factors as well as a significant location x income interaction (Fig. 1). The effect of location was significant for the lowest income group (OR=0.48, 95% CI [0.32, 0.71], p=.0003) and for the middle-income group (OR=0.58, 95% CI [0.38, 0.88], p=.010), but non-significant for all other groups (all $ps > .20$). Because income categories were derived from weighted cumulative frequencies to ensure roughly equal quintiles, this inconsistent pattern is unrelated to sample size across income categories.

3.4.4. Confidence to be active

The base model revealed no significant effect of location in predicting barriers related to confidence to be active, OR=0.94, 95% CI [0.80, 1.12], p=.502. The effect of location became significant in the optimally fitted model (OR=0.59, 95% CI [0.40, 0.85], p=.005) with an identified education x location interaction (Fig. 2). For people with a

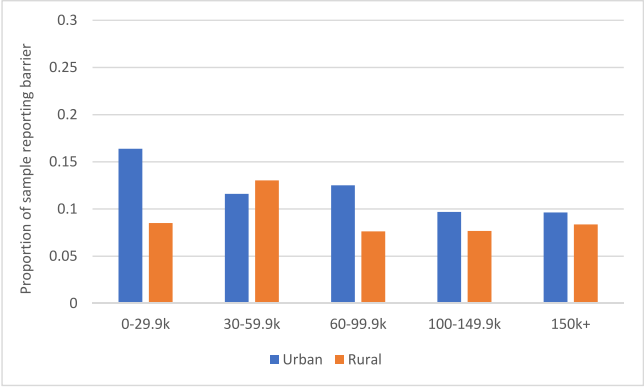

Fig. 1. Proportion of sample reporting barriers related to enjoyment of physical activity (income * location)—higher # reflects more people reporting.

Table 6
Odds ratios for the effect of location on likelihood of reporting individual motivation-related barriers (reference: urban).

	Any motivation-related barriers	Prefer to be active	Confidence to be active	Enjoy physical activity
Base model	0.78 [0.69, 0.89]	0.71 [0.60, 0.84]	0.94 [0.80, 1.12]	0.81 [0.68, 0.97]
Final model	0.69 [0.60, 0.79]	0.69 [0.58, 0.81]	<Secondary school: 0.62 [0.43, 0.91]	Income$0-29.9k: 0.48 [0.32, 0.71]
			Secondary school: 0.59 [0.40, 0.85]	Income$30-59.9k: 1.14 [0.83, 1.57]
			Post-secondary: 0.96 [0.74, 1.23]	Income$60-99.9k: 0.57 [0.38, 0.88]
				Income$100-149.9k: 0.77 [0.51, 1.18]
				Income$150k+: 0.86 [0.50, 1.46]

Note: The optimally fitted model for reporting any motivation-related barrier included the covariates age, BMI, income, perceived health, and sense of belonging to community. The optimally fitted model for preference to be active included the same covariates with the addition of sex. The optimally fitted model for confidence to be active included sex, age, BMI, income, perceived health, sense of belonging to community, and education. The optimally fitted model for enjoyment of physical activity included covariates sex, BMI, income, perceived health, and sense of belonging to community.

[2] Note that we have retained the wording of survey items provided by Statistics Canada to facilitate replicability of analysis.

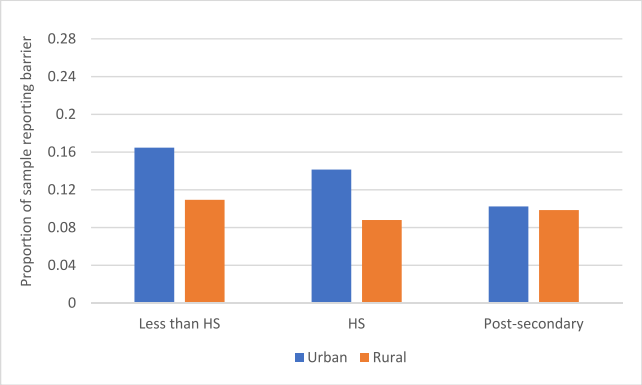

Fig. 2. Proportion of sample reporting barriers related to confidence to be active (education * location)—higher # reflects more people reporting barrier. *Note:* HS, high school.

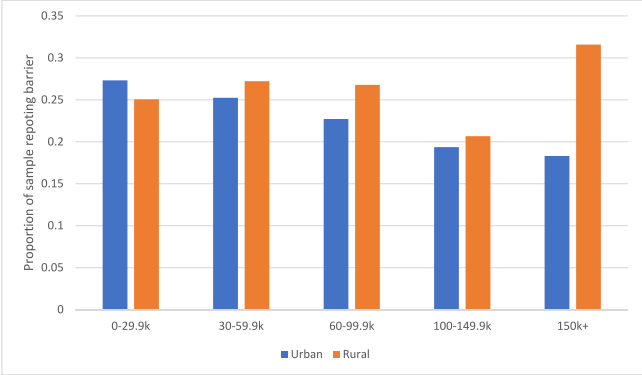

Fig. 3. Proportion of sample reporting barriers related to seeing people active in community (income * location) – higher value = more people reporting.

post-secondary education, location did not predict barriers to confidence ($p > .70$), while for people reporting an education attainment at high school or less, rural residents had lower odds of reporting lack of confidence as a barrier (high school OR=0.59, 95% CI [0.40, 0.85], p=.005; less than high school OR=0.62, 95% CI [0.43, 0.91], p=.015).

3.5. Social and built environmental barriers

3.5.1. Any barrier

Rural residents showed significantly higher odds of reporting at least one social or built environmental barrier compared to urban in the base model (OR=1.86, 95% CI [1.67, 2.07], $p < .0001$) and after accounting for covariates (OR=1.85, 95% CI [1.66, 2.07], $p < .0001$; Table 7). There were no significant interactions. In the optimally fitted model, approximately 57.8% of urban residents reported at least one environmental barrier compared with 71.8% of rural residents.

3.5.2. Seeing people active in community

In the base model, rural residents demonstrated higher odds of barriers related to seeing other people being active in their community (i.e., rural residents were less likely to report seeing other people being active in their community), OR=1.23, 95% CI [1.07, 1.41], p=.004. A significant location x income interaction was observed in the optimally fitted model (Fig. 3). Examining the effect of location across income categories revealed that this effect was non-significant (all $ps > .10$) for all income categories except the wealthiest, for which the effect of location was significant, OR=2.06, 95% CI [1.39, 3.05], p=.0003. Wealthy rural residents had higher odds of reporting this barrier, meaning they reported seeing people being active in their community less regularly compared to wealthy urban residents.

3.5.3. Support to be active

Rural residents showed higher odds of reporting barriers to receiving support to be physically active compared to urban in the base (OR=1.25, 95% CI [1.11, 1.40], p=.0002) and optimally fitted model (OR=1.17, 95% CI [1.04, 1.32], p=.010). Per the final model, 39.6% of urban and 43.5% of rural residents reported this barrier. No interactions with location were significant.

3.5.4. Access to facilities

In the base model, the effect of location was significant such that rural residents showed higher odds of reporting barriers related to the availability of free or low-cost facilities compared to urban, OR=4.13, 95% CI [3.57, 4.79], $p < .0001$. The effect of location remained in the optimally fitted model (OR=4.15, 95% CI [3.58, 4.83], $p < .0001$). In this model 20.2% of urban and 51.3% of rural residents reported barriers to facility access. There were no interactions between location and any sociodemographic factor.

4. Discussion

The aim of this study was to compare patterns in barriers to physical activity between urban and rural-dwelling adults while considering salient sociodemographic factors. Findings demonstrate that rural residents were more likely to report social and built environmental barriers to physical activity and less likely to report individual-motivation related barriers, though some of these outcomes were qualified by interactions with sociodemographic characteristics. There was no difference in the odds of reporting individual-resource related barriers based on rural-urban location. Income and education moderated the relationship between motivation-related barriers and location and there were no interactions for rural-urban location and social and built environmental barriers (i.e., rural residents of all sociodemographic groups reported similar environmental barriers to activity).

Table 7
Odds ratios for the effect of location on likelihood of reporting social and built environmental barriers (reference: urban).

	Any environmental barriers	See people active	Access to facilities	Support to be active
Base model	1.86 [1.67, 2.07]	1.22 [1.07, 1.41]	4.13 [3.57, 4.79]	1.25 [1.11, 1.40]
Final model	1.84 [1.65, 2.06]	Income$0-29.9k: 0.89 [0.67, 1.19] Income$30-59.9k: 1.11 [0.86, 1.43] Income$60-99.9k: 1.24 [0.94, 1.65] Income$100-149.9k: 1.09 [0.78, 1.50] Income$150k+: 2.06 [1.39, 3.04]	4.15 [3.58, 4.83]	1.17 [1.04, 1.32]

Note: The optimally fitted model for reporting any social or built environmental barrier included covariates season of data collection, sex, age, income, perceived health, and sense of belonging to community. The optimally fitted model for seeing people active in community included covariates season of data collection, sex, income, and sense of belonging to community. The optimally fitted model for access to facilities included covariates age, income, perceived health, and sense of belonging to community. Finally, the optimally fitted model for receiving support to be active included covariates season of data collection, sex, age, income, perceived health and sense of belonging to community.

4.1. Individual motivation and resource barriers

Our findings identify urban residents as more likely to report motivation-related barriers and a lower preference for physical activity as a barrier. However, this overall effect was qualified by an interaction between income and location such that lower preference for physical activity was only observed for urban residents within the lowest and middle-income categories; all other income categories showed no significant effect of location in relation to enjoyment of physical activity. Similarly, rural residents reported lower odds of reporting barriers related to confidence in abilities to be active compared to urban residents, but this difference was only observed for participants without post-secondary education. A positive association between socioeconomic status (as measured by education and/or income) and physical activity has been commonly reported in population-based studies (Droomers et al., 2001; Hankonen et al., 2017). Our findings suggest a more complex relationship between individual barriers to physical activity and location contingent on socioeconomic status. This complex, possibly non-linear relationship is consistent with other work, identifying the importance of considering the interaction of socioeconomic status by location and access to different types of physical activity (Eime et al., 2015).

Individual resource-related barriers (including personal energy, time, and cost) were reported by both urban and rural residents, however the odds of reporting these barriers did not differ by location. Geographical discrepancies in physical activity behavior appear to be driven by factors beyond individual-level resources and are heavily shaped by the built and social environment warranting attention for the entire population.

4.2. Social and built environmental barriers

Rural-dwelling adults are more likely than urban adults to report social and built environmental barriers to physical activity. Over 70% of rural residents reported at least one environmental barrier and, after adjusting for sociodemographic factors, over 50% reported not having access to free or low-cost facilities in their neighbourhood. There were no interactions between sociodemographic factors and location in predicting barriers to facility access, suggesting facility access is an issue for rural residents independently of self-identified sex, age, income, education, BMI, perceived health, sense of belonging and season of data collection.

Access to facilities is one of the most consistently reported environmental correlates of physical activity behavior across different populations (Bauman et al., 2012; Choi et al., 2017; Humpel et al., 2002; Parks et al., 2003; Wendel-Vos et al., 2007). A positive dose-response relationship has been identified between the number of places to be active and likelihood of meeting physical activity guidelines (Parks et al., 2003). The significantly higher odds of reporting this barrier among rural residents may suggest that lack of facilities is a key driver of physical activity inequities, although additional work is needed to confirm how these barriers impact physical activity participation based on rural-urban location.

Previous work has suggested access to spaces to be active in rural communities is dependent on socioeconomic position, noting access to indoor facilities for exercise and access to walking trails was higher among women with more education and higher income (Brownson et al., 2000). In our study, reported barriers to facility access were significantly associated with income; however, there were no interactions with any factor by location. The lack of a location-income interaction suggests income is similarly associated with facility access for rural and urban residents, while rural residents face further barriers to facility access unique to their geographic location.

Rural residents reported having lower social support to be active compared to urban residents, independently of all sociodemographic covariates. Social environmental barriers to physical activity are commonly reported among rural residents (Parks et al., 2003). The lack of social support may be particularly important for rural residents who commonly report engagement in physical activity to connect with their community and identify health and physical activity in relation to their social networks (McGannon et al., 2014; Pelletier, Ward, et al., 2021; Seguin et al., 2014). Future work is needed to confirm whether social support barriers relate to engagement in physical activity differently for rural and urban residents. As supportive social environments are an important facilitator of physical activity (McNeill et al., 2006), developing active living strategies that foster social support is a potential area of focus for physical activity promotion in rural communities.

Physical activity promotion initiatives and messaging focusing on individual factors, such as motivation to being active, benefits of being active over being sedentary (e.g., move more, reduce sedentary behavior) (Faught et al., 2020), may not be effective for rural populations, as these factors present less of a perceived barrier to activity compared to environmental factors. Instead, efforts should focus on the creation of safe, accessible spaces for activity, promote the use of outdoor recreation spaces, and provide strategies to support others (e.g., family, friends, neighbours) to be active. Our findings support the need for unique approaches to physical activity promotion with context-specific messaging for rural and urban communities (Milton et al., 2020), and collaborative action with policy makers and community planners to encourage the creation of built environments supportive of physical activity (Nykiforuk et al., 2018; Sallis et al., 1998).

For this analysis, we dichotomized rural and urban based on Statistics Canada definitions. Although the CCHS data does provide location classifications based on metropolitan influenced zone and a four-level indicator of population center size, these different definitions of rurality did not considerably alter observed patterns of reporting barriers in our analysis. Future work should continue to explore degree of rurality and remoteness in considering location-based differences in physical activity.

4.3. Limitations

The excluded sample differed from the included sample on several sociodemographic factors and reported barriers. Excluded participants were more likely to be female, have lower educational attainment and income, not meet recommended activity guidelines, and have more reported barriers to activity. Our findings thus reflect a group of people who are more physically active and have a higher socioeconomic status than the general Canadian population. We cannot make assumptions about rural-urban differences in barriers to physical activity for the excluded group. This is partially a limitation of the CCHS dataset related to biases in survey completion. The list of barriers used in this analysis were pre-defined and thus do not necessarily reflect all potential barriers experienced or a comprehensive assessment of factors impacting activity. Only one item was used to assess built environment characteristics (access to facilities), and a more robust analysis of barriers to physical activity should include a detailed exploration of built and natural environmental characteristics in rural areas. Additionally, our central theoretical focus was rural-urban location and we did not explore nuanced or interacting relationships between other sociodemographic factors (e.g., income x sex) and reported barriers to physical activity. These remain important questions for future study.

5. Conclusion

In a representative Canadian sample, people living in rural communities of any sociodemographic background are more likely to report social and built environmental barriers to physical activity than those living in urban centres. Both urban and rural residents reported time and cost as barriers to physical activity, however rural residents report additional environmental barriers including lack of facility access and inadequate social support. Future work should explore how these

perceived barriers relate to physical activity behavior in both urban and rural communities to advocate for physical activity policy implementation, direct population health interventions, and support the contextually relevant messaging of physical activity guidelines.

Author credit statement

Chelsea Pelletier: Conceptualization, Methodology, Writing – original draft preparation, Writing – review & editing, Project administration, Funding acquisition. **Nicole White:** Methodology, Data curation, Formal analysis, Writing - original draft preparation, Writing – review & editing, Visualization. **Annie Duchesne:** Conceptualization, Methodology, Writing – review & editing, Funding acquisition. **Larine Sluggett:** Conceptualization, Methodology, Writing – review & editing.

Ethical statement

Access to data used in this manuscript is regulated and vetted by Statistics Canada to protect participant confidentiality. As such, Research Ethics Board approval is not required (per Tri-Council Policy Statement Article 2.2 and 2.4).

Funding

This study was funded by a Research Data Centre award from the University of Northern British Columbia. The funding body had no role in the design of the study, data analysis, interpretation of data, or in preparation of this manuscript.

Declaration of competing interest

None.

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