



Article

The association between social cohesion and physical activity in Canada: A multilevel analysis



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A B S T R A C T

Although previous research has shown that social cohesion may promote physical activity, social cohesion at the individual level was not always differentiated from social cohesion at the community level, and studies were often limited to specific population subgroups or geographical areas. We addressed the above limitations through the use of a multilevel modelling approach and nationally-representative data from the 2009–2014 Canadian Community Health Survey. Physical activity level was operationalized as average daily energy expenditure; social cohesion was assessed by self-rated sense of belonging to the local community; and communities were represented by Canada's Forward Sortation Areas. The sample included 245,150 respondents from 1570 communities. Geographical location was found to explain a significant proportion (4.1%) of the overall variance in physical activity level. After adjusting for age, sex, household income, education and urban-rural status, both individual- and community-level social cohesion were found to be positively associated with physical activity ($p < 0.001$ for both). Thus, efforts to promote social cohesion and integration within communities may also promote physical activity and overall health.

Introduction

Physical activity refers to the expenditure of energy to produce bodily movements using skeletal muscles, and includes activities ranging from those that are light (e.g., walking) to those that are vigorous and demanding such as muscle strengthening exercises (World Health Organization, 2010, 2015). The World Health Organization (WHO) recommends that adults aged 18 to 64 years engage in at least 150 minutes of moderate-to-vigorous physical activity every week (World Health Organization, 2016). Regular engagement in physical activity is associated with numerous health benefits, including reductions in the risk of obesity, type 2 diabetes and certain cancers, as well as improvements in bone and muscle strength, mental health and overall longevity (Centers for Disease Control and Prevention, 2014). Globally, approximately 1 in 5 adults is physically inactive, but among the most developed countries, this rate is closer to 1 in 3 (Dumith, Hallal & Reis, 2011). The public health importance of physical activity is evident in the finding that physical inactivity results in approximately 3.2 million deaths globally every year, and represents the fourth leading risk factor for death worldwide (World Health Organization, 2010).

In Canada, only 15% of adults meet physical activity guidelines set

out by the WHO (Colley et al., 2011). Considering the well-documented benefits associated with physical activity and the vast array of health risks associated with physical inactivity, it is unsurprising that physical inactivity represents a significant burden to the Canadian health care system, accounting for an estimated \$6.8 billion in annual health care costs (Colley et al., 2011; Janssen, 2012; Warburton, Nicol & Bredin, 2006).

Previous research suggested that the study of physical activity should be conducted through an ecological framework, where physical activity is seen as being affected by both intra- and extra- individual factors (Spence & Lee, 2003). Individual factors refer to characteristics of a particular person, and may include sociodemographic attributes such as age, sex, and socioeconomic status (McNeill, Stoddard, Bennett, Wolin & Sorensen, 2012). Extra-individual or contextual factors act through the social context of an individual's daily life, and may include influences within one's family, community or neighbourhood (McNeill et al., 2012). Investigating influences at multiple levels is particularly important for the understanding of physical activity behaviour, because physical activity is influenced by individual-level, social-environmental, and physical-environmental factors simultaneously (Li et al., 2005).

Of the many social factors hypothesized to affect physical activity,

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social cohesion is interesting and promising because it may contribute to promoting physical activity in various ways. At the neighbourhood level, a high level of social cohesion is associated with less crime, and low neighbourhood crime rates tend to be associated with greater engagement in physical activity (Ferreira et al., 2007; Sampson, Raudenbush & Earls, 1997). Also, residents of socially cohesive neighbourhoods may be more likely to organize local sports leagues and other community activities that present opportunities to engage in physical activity (Cohen, Finch, Bower & Sastry, 2006). At the individual level, it is important to feel socially connected to the community because it may increase the likelihood that one will take advantage of local opportunities to engage in physical activity. Social cohesion is generally defined as the result of “building shared values and communities of interpretation, reducing disparities in wealth and income, and generally enabling people to have a sense that they are engaged in a common enterprise, facing shared challenges, and that they are members of the same community” (Maxwell, 1996). In previous research, social cohesion was operationalized as an individual's perception of the overall level of cohesion in his or her neighbourhood, as well as the individual's contributions to neighbourhood cohesion through social participation, engagement, and other activities that foster a sense of belonging (Addy et al., 2004; Ball et al., 2010; Brennan, Baker, Haire-Joshu & Brownson, 2003; Kaczynski & Glover, 2012; Legh-Jones & Moore, 2012; Mendes de Leon et al., 2009; Lindström, Moghaddassi & Merlo, 2003; Pabayo, Belsky, Gauvin & Curtis, 2011; Strong, Reitzel, Wetter & McNeill, 2013; Ueshima et al., 2010; Wen, Kandula & Lauderdale, 2007; Yang, Tan & Cheng, 2014). An individual's perceived level of neighbourhood social cohesion was found to be beneficial for physical activity behaviour in numerous studies. (Brennan et al., 2003; Kaczynski & Glover, 2012; Mendes de Leon et al., 2009; Pabayo et al., 2011; Strong et al., 2013; Wen et al., 2007). Similar findings have been reported in a study that investigated connectedness to the local community, which was found to be associated with a higher odds of engaging in physical activity (Yang et al., 2014); other studies found trust of neighbours and social participation to be associated with either a greater likelihood of being physically active, or a lower likelihood of being physically inactive (Addy et al., 2004; Legh-Jones & Moore, 2012; Ueshima et al., 2010).

Social cohesion can also be assessed as a group-level influence, where it is often operationalized as an average score among individuals within a community or neighbourhood (Andrade et al., 2015; Cradock, Kawachi, Colditz, Gortmaker & Buka, 2009; Fisher, Li, Michael & Cleveland, 2004; Jongeneel-Grimen, Droomers, van Oers, Stronks & Kunst, 2014; King, 2008; Utter, Denny, Robinson, Ameratunga & Milfont, 2011). Neighbourhood social cohesion was found to be associated with an increased odds of being physically active or engaging in any physical activity, and a decreased odds of being physically inactive (Andrade et al., 2015; Cradock et al., 2009; Jongeneel-Grimen et al., 2014; King, 2008). Some studies included social cohesion, participation, or capital as both an individual- and group-level influence, but all were limited to neighbourhoods in one city (Ball et al., 2010; Gao, Fu, Li & Jia, 2015; Mendes de Leon et al., 2009; Lindström et al., 2003; Pabayo, Molnar, Cradock & Kawachi, 2014). Moreover, all but one (Lindström et al., 2003) were limited to a specific population subgroup such as women (Ball et al., 2010), older adults (Gao et al., 2015; Mendes de Leon et al., 2009), or adolescents (Pabayo et al., 2014).

There is substantial evidence indicating that increasing social cohesion is a promising avenue for promoting physical activity. A systematic review of public health initiatives designed to increase physical activity found the promotion of social support for physical activity in community settings to be effective (Kahn et al., 2002). This was reflected in another review of physical activity interventions that suggested increasing social support for physical activity within specific neighbourhoods was effective for increasing physical activity (Heath et al., 2012). From a policy perspective, targeting physical activity

through interventions that build on social cohesion is practical because it is less costly (Heath et al., 2012). For example, the creation of physical activity support groups within communities has been found to be an effective, low-cost method of increasing walking (Kriska et al., 1986; Lombard, Lombard & Winett, 1995). Moreover, social support interventions and several other community-based interventions aimed at promoting physical activity were deemed to be cost-effective public health strategies for preventing chronic disease (Roux et al., 2008).

To the best of the authors' knowledge, no study to date has investigated social cohesion as a multilevel influence on physical activity in a large, generalizable population from across an entire country. Thus, the main objective of this study is to assess the association between physical activity and individual- and community-level social cohesion among adults from communities across Canada.

Methods

The data for this study came from 2009–2010, 2011–2012, and 2013–2014 cycles of the Canadian Community Health Surveys (CCHS). The CCHS is an annual cross-sectional survey that collects information related to determinants of health, health status, and health care utilization among individuals 12 years of age or older in Canada (Statistics Canada, 2015a). To obtain the sample of respondents, households were selected using three sampling frames. In total, 49.5% of the households was selected from an area frame containing a list of dwellings, 49.5% was selected from a list of telephone numbers, and the remaining 1% was selected from random digit dialing (Statistics Canada, 2015a). The sampling strategy was based on that of the Canadian Labour Force Survey, which employed a multistage cluster design with samples of geographical regions containing multiple dwellings in the first stage, individual dwellings in the second stage, and individual respondents from the chosen dwellings in the final stage (Statistics Canada, 2008b). Data were collected via computer-assisted interviewing, either in-person or over the telephone (Statistics Canada, 2015a). In 2010, the overall response rate was 71.5%, and ranged from 61.7% to 84.8% across Health Regions (Statistics Canada, 2016). For this study, all analyses were limited to non-pregnant adults aged 18 to 64 years. Older adults and pregnant women were excluded due to concerns that their ability to engage in physical activity may be limited by mobility impairments. Respondents from the three territories were excluded because they lacked data for household income, a key control variable in the analysis.

Average daily energy expenditure (EE) in kilocalories per kilogram of body weight was the indicator of physical activity level. The CCHS asked respondents about their participation in various activities (e.g., sports, hobbies, exercise) in terms of frequency (within a given time period) and duration (average duration). A metabolic equivalent (MET) value was assigned to each activity as an indicator of intensity. To calculate daily energy expenditure, the MET value of each activity was multiplied by N (the number of times a respondent engaged in the activity in the past 12 months) and D (the average duration of the activity in hours), then divided by 365. Due to the highly right-skewed distribution of the daily EE variable, the data were ranked in ascending order and grouped into 10 deciles for the analysis. Sense of belonging to the local community on a 4-point scale was selected as the indicator of an individual's level of social cohesion, conceptualized as connectedness to his or her community. Respondents were asked “How would you describe your sense of belonging to your local community? Would you say it is...?” The response options were very strong, somewhat strong, somewhat weak, or very weak, coded as 4, 3, 2, and 1, respectively. In the analysis, sense of belonging was treated as a continuous variable to avoid the loss of variation in data associated with the categorization of variables (Lovasi et al., 2012). In the multilevel models, community-level social cohesion was defined as the average score for sense of belonging within a community. Resultantly, communities with a high level of social cohesion are those

in which a large proportion of residents reported having a strong sense of belonging to the local community.

Community was defined as what some refer to as a neighbourhood, a geographical unit in which the circumstances are shared by residents (Chaskin, 1997). Using neighbourhoods with pre-determined geographical boundaries is advantageous in public health research because it allows for the analysis of health data from secondary sources such as the CCHS that also include data pertaining to areas within these boundaries (Weiss, Ompad, Galea & Vlahov, 2007). Communities were represented by Forward Sortation Areas (FSAs), geographical units defined by the first three characters of a postal code in Canada (Statistics Canada, 2008a). Using FSAs as the geographical unit was appropriate because they are larger than full Postal Codes which often include only one street block, but smaller than Census Subdivisions, the next largest geographical areas, which frequently include entire municipalities and therefore may be too large to represent communities in urban settings (Statistics Canada, 2015b). There was some concern that estimate of community-level social cohesion may not be meaningful in FSAs with very few respondents, so only FSAs with at least 5 respondents were included in the analysis.

All analyses were performed in SAS version 9.3. In addition to accounting for the idea that an individual tends to be more similar to persons in the same neighbourhood than to those from other neighbourhoods, multilevel regression models allow for the testing of hypotheses that are multilevel in nature (Brauer & Mikkelsen, 2010). The first multilevel regression model (Model 1) was used to compute an intraclass correlation coefficient (ICC), which describes the extent to which data within a cluster are correlated (Park & Lake, 2005). The ICC in this analysis describes the proportion of variance in physical activity level that is attributable to communities. In the second multilevel regression model (Model 2), both the intercept and individual-level social cohesion were defined as random effects to allow for their effects to vary across communities (Bell, Ene, Smiley & Schoeneberger, 2013; Hayes, 2006) while the community-level social cohesion was entered as a fixed effect. Age, sex, household income, education and urban-rural status were included as control variables. All descriptive statistics and regression models were calculated using sampling weights provided in the CCHS, which was necessary to allow for estimates to be calculated from survey data that is representative of the population in Canada. In the CCHS, a survey weight is provided for each respondent, and corresponds to the number of individuals the respondent represents in the covered population (Statistics Canada, 2011). Missing data were filled in using multiple imputation, and 10 imputations in total were performed using the PROC MI procedure. Data were imputed for variables in order from those that have the lowest proportion of missing data to those that have a highest proportion of missing data (sense of belonging, education, household income). Frequency tables were produced for each imputation to verify that the imputed data are plausible in that all intervals were appropriate and that the imputed data fell between the minimum and maximum values for each variable. For each multilevel model, the relevant statistical model was fitted to each of the 10 imputed data sets, and the results were pooled using the PROC MIANALYZE procedure to obtain results that take into account the range of estimates from all 10 imputations.

Results

Descriptive Statistics

The study sample included 245,150 respondents from 1,570 communities. Overall, 21,126 respondents representing 9.1% of the sample had missing data for the variables utilized in this study, and therefore had missing data imputed. The mean value for daily EE was 2.256 kcal/kg/day (SD = 2.563), and the mean value for sense of belonging was 2.688 (SD = 0.904) on a scale from 1 to 4. Physical

Table 1
Characteristics of the sample of adults aged 18 to 64 years in Canada.

	Percentage (%)
Sex	
Male	49.9
Female	50.1
Age Group	
18 to 24	14.2
25 to 34	20.2
35 to 44	21.1
45 to 54	22.8
55 to 64	21.8
Sense of Belonging	
Very Weak	9.0
Somewhat Weak	28.2
Somewhat Strong	47.9
Very Strong	14.9
Weight Status	
Normal weight (BMI < 25)	50.5
Overweight (BMI ≥ 25)	49.5
Education Attainment	
Grade 8 or lower	2.5
Grade 9 to 10	4.1
Grade 11 to 13	3.3
Secondary school	19.0
Some post-secondary	7.2
Trade certificate or diploma	11.2
College diploma or certificate	23.0
University below Bachelor's level	3.7
Bachelor's degree	17.9
Above Bachelor's degree	8.0
Urban-Rural Status	
Urban	82.5
Rural	17.4

Table 2
Summary of physical activity level deciles of adults aged 18 to 64 years in Canada.

	Proportion (%)	Mean Daily EE (SD)
Decile 1	12.0	0.025 (0.049)
Decile 2	8.9	0.299 (0.087)
Decile 3	10.8	0.647 (0.121)
Decile 4	8.0	1.005 (0.092)
Decile 5	11.5	1.387 (0.155)
Decile 6	8.9	1.897 (0.153)
Decile 7	11.0	2.470 (0.218)
Decile 8	9.3	3.221 (0.242)
Decile 9	9.6	4.304 (0.457)
Decile 10	10.0	7.618 (2.900)

Abbreviations: EE (energy expenditure in kcal/kg/day); SD (standard deviation)

activity level tended to decline with age and increase with household income, education, and social cohesion. Overall, males tended to be more physically active than females, and residents of rural areas tended to be more physically active than their urban counterparts. (Table 1 and 2).

Multilevel Regression Models

Results from the null model (Model 1) indicate that there is evidence of correlation in physical activity data within communities, suggesting that there is variation in physical activity between geographically-bound areas. The variance within communities was 9.477, while the variance between communities was 0.401. These values correspond to an ICC of 0.041, indicating that geographical location explained 4.1% of the total variance in physical activity level.

Table 3

Results from the multilevel models assessing the association between social cohesion and physical activity among adults aged 18 to 64 years in Canada.

	Model 1	Model 2
Variance Component		
Between community	0.401	0.368
Within community	9.477	8.901
ICC	0.041	0.040
Intercept	5.484 (5.449, 5.519)	3.310 (2.783, 3.836)
β Coefficients (95% CI)		
I_Cohesion		0.357 (0.331, 0.382)
C_Cohesion		0.784 (0.589, 0.978)
Age		-0.028 (-0.028, -0.027)
Sex		-0.252 (-0.274, -0.230)
Income		0.125 (0.120, 0.130)
Education		0.087 (0.082, 0.093)
Urban-Rural Status		-0.041 (-0.089, 0.007)

Notes: (1) Variance components and parameter estimates significant at a p-value of 5% are bolded

Models: (1) Null model without independent variables; (2) Fully-adjusted model

Abbreviations: ICC (intraclass correlation coefficient); I_Cohesion (sense of belonging); C_Cohesion (community-level social cohesion)

Results from the multivariable model (Model 2) suggest that, controlling for age, sex, household income, education and urban-rural status, both social cohesion (sense of belonging) at the individual level and social cohesion at the community level are significantly associated with physical activity. Although the association between physical activity and social cohesion at both levels was statistically significant, the association with community-level social cohesion was stronger. With a β coefficient of 0.784 deciles, the association between community-level social cohesion and physical activity is approximately two-folds greater in magnitude in comparison to the association between individual-level social cohesion and physical activity. Finally, comparing the results from the multivariable model to the null model, declines were seen for both within- and between-community variance. The variance between communities declined by 8.2% to 0.368, while the variance within communities saw a 6.1% decline to 8.901. These reductions in variance following the addition of social cohesion and accompanying covariates suggest that these variables could explain some of the variance in physical activity level from the null model. (Table 3).

Discussion

This study aimed to assess the multilevel association between social cohesion and physical activity. It presents a novel contribution to the existing body of literature by investigating social cohesion as a multi-level influence in a large, generalizable population from across an entire country. The finding that geographically-defined communities account for a significant proportion of the variation in physical activity suggests that the contextual effect of residing in a specific area may influence physical activity behaviour. This reinforces the appropriateness of treating individual respondents as being clustered within communities. The finding that both individual- and community-level social cohesion are significantly associated with physical activity after controlling for one another (and a number of control variables) suggests that increases in social cohesion at each level may be associated with increases in physical activity.

The observation of a significant positive association between individual-level social cohesion and physical activity supports findings from previous research. Past studies found that a higher level of social cohesion at the individual level was associated with either an increased likelihood of engaging in physical activity or a lower likelihood of being physically inactive (Legh-Jones and Moore, 2012; Ueshima et al., 2010; Yang et al., 2014). The finding that individuals who report having a

stronger sense of belonging to the community tend to be more active is plausible considering that previous research found factors such as social participation, connectedness to the community, and trust of neighbours to be beneficial for physical activity behaviour (Legh-Jones and Moore, 2012; Ueshima et al., 2010; Yang et al., 2014). Notably, the present study included a far more diverse population than the aforementioned studies, which were limited to just adolescents (Yang et al., 2014) or respondents from one particular city (Legh-Jones and Moore, 2012; Ueshima et al., 2010).

The finding of a significant positive association between community-level social cohesion and physical activity is consistent with findings from other studies that also analyzed physical activity as a continuous outcome and reported a similar relationship (Fisher et al., 2004; Utter et al., 2011). These results also align with those from previous research indicating that a higher level of neighbourhood social cohesion is associated with either a greater likelihood of being physically active or a lower likelihood of being physically inactive (Andrade et al., 2015; Craddock et al., 2009; Jongeneel-Grimen et al., 2014; King, 2008). The finding that both individual- and community-level social cohesion remained significantly associated with physical activity after controlling for one another distinguishes the present study from most others. Of the 5 identified studies that investigated social cohesion as both an individual- and community-level influence, only one study found that social cohesion or capital at both levels were significantly associated with physical activity or inactivity (Ball et al., 2010). Most studies found that only social cohesion at the individual level was associated with physical activity (Gao et al., 2015; Mendes de Leon et al., 2009; Lindström et al., 2003), while one study found that neither measure of social cohesion was associated with physical activity (Pabayo et al., 2014). However, it is possible that differences in study populations (i.e., cultural differences across 4 countries, an adolescent sample versus a sample of older adults) and specific measures of social cohesion and physical activity contributed to the inconsistent findings.

There exist theories that potentially explain why community-level social cohesion may have a positive influence on physical activity. Social cohesion at the community level predominantly refers to the absence of social conflict and the presence of strong social bonds among residents (Berkman and Kawachi, 2000). A reduced level of social conflict is important because it contributes to a lower prevalence of crime, a community characteristic consistently associated with greater engagement in physical activity (Ferreira et al., 2007; Sampson et al., 1997). The strong social bonds aspect of community cohesion is also important, because it may increase the prevalence of collective engagement in physical activity among residents (Kahn et al., 2002). It was interesting to see that the associations between physical activity and social cohesion at both levels remained significant even after adjusting for both measures of social cohesion and a number of covariates. This indicates that an individual's sense of belonging to the local community and the overall level of cohesion in that community could both potentially be related to physical activity behaviour. A possible explanation for this is that while a higher level of community-level cohesion may result in more local opportunities to engage in physical activity, having a strong sense of belonging to the community provides additional benefit because it increases the likelihood that an individual will take advantage of these opportunities.

Findings from this study have several implications for the promotion of physical activity and health. In communities where few residents feel that they belong, physical activity could potentially be increased by promoting social engagement and participation among community members. For example, previous research found that behaviour change interventions targeting entire communities are promising for creating social and cultural change that may lead to improvements in physical activity behaviour (Mummery and Brown, 2008). Where the overall level of social cohesion is already high, further benefits may be achieved by socially integrating residents who do not already feel that they belong. Moreover, it has been suggested that

social cohesion interventions may result in even greater benefits when combined with other efforts to facilitate physical activity. One such example is increasing social cohesion while simultaneously increasing the walkability of the physical environment. Previous research found that residents of neighbourhoods with a high level of walkability and social connectedness engaged in significantly more physical activity than residents of neighbourhoods with only either a high level of walkability or a high level of social connectedness (Kaczynski and Glover, 2012). Furthermore, community integration has been associated with the ability to recall disseminated health promotion messages, and thus the promotion of social cohesion may also increase the efficacy of future public health initiatives (Viswanath, Randolph Steele & Finnegan, 2006).

Limitations

Findings from this study must be interpreted in light of some limitations. Due to the cross-sectional nature of the data used, causality cannot be inferred, as the direction of the relationship between social cohesion and physical activity is unclear. While increases in social cohesion may lead to increases in physical activity, it is also possible for social cohesion to improve as a by-product of more community members engaging in physical activity in the neighbourhood. Also, cohort cycle was not taken into account in the analysis, leading to the assumption that a period effect does not exist. Moreover, the study used a crude measure of social cohesion that included data from only one survey item asking respondents to rate their sense of belonging to the local community. Although most aspects of social cohesion may affect an individual's sense of belonging, one survey item is unlikely to be sufficient to capture all elements of social cohesion. Physical activity level was determined using self-reported data, implicating some degree of bias associated with non-objective data. However, the measure of physical activity took into account frequency, duration, and intensity, and the use of self-reported data allowed for a far larger sample than would have been possible had an objective measure (e.g., accelerometer) been used. Transport physical activity (e.g., walking or cycling for transportation) was not included in the measure of physical activity, and therefore was not accounted for. Further, ethnicity and immigrant status were not included in the analysis, so there is a lack of insight into if and how the association between social cohesion and physical activity is affected by ethnicity or immigrant status.

Conclusions

The present study proposed that social cohesion can be assessed as a multilevel influence because it is possible for an individual to reside in a community with a high level of social cohesion without feeling socially included, and vice-versa. Geographically-defined communities explained a significant proportion of the variance in physical activity level across Canada. Results from the analysis suggest that both an individual's extent of social inclusion and the contextual effect of the overall level of social cohesion in his or her community are positively associated with physical activity. These findings indicate that improvements in an individual's sense of cohesion in the local community and the overall level of social cohesion of that community could both be associated with increases in physical activity. Future research should aim to address the limitations of this study by using a more comprehensive measure of social cohesion, and by gaining insight into the causal relationship between social cohesion and physical activity through natural experiments such as the evaluation of programs or policies.

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