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Increased Prevalence of Chronic Disease in Back Pain Patients Living in Car-dependent Neighbourhoods in Canada: A Cross-sectional Analysis

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Objectives: Chronic diseases, including back pain, result in significant patient morbidity and societal burden. Overall improvement in physical fitness is recommended for prevention and treatment. Walking is a convenient modality for achieving initial gains. Our objective was to determine whether neighbourhood walkability, acting as a surrogate measure of physical fitness, was associated with the presence of chronic disease.

Methods: We conducted a cross-sectional study of prospectively collected data from a prior randomized cohort study of 227 patients referred for tertiary assessment of chronic back pain in Ottawa, ON, Canada. The Charlson Comorbidity Index (CCI) was calculated from patient-completed questionnaires and medical record review. Using patients' postal codes, neighbourhood walkability was determined using the Walk Score, which awards points based on the distance to the closest amenities, yielding a score from 0 to 100 (0-50: car-dependent; 50-100: walkable).

Results: Based on the Walk Score, 134 patients lived in car-dependent neighborhoods and 93 lived in walkable neighborhoods. A multivariate logistic regression model, adjusted for age, gender, rural postal code, body mass index, smoking, median household income, percent employment, pain, and disability, demonstrated an adjusted odds ratio of 2.75 (95% confidence interval, 1.16 to 6.53) times higher prevalence for having a chronic disease for patients living in a car-dependent neighborhood. There was also a significant dose-related association ($p=0.01$; Mantel-Haenszel chi-square=6.4) between living in car-dependent neighbourhoods and more severe CCI scores.

Conclusions: Our findings suggest that advocating for improved neighbourhood planning to permit greater walkability may help offset the burden of chronic disease.

Key words: Chronic disease, Back pain, Walking, Residence characteristics, Comorbidity, Physical fitness

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INTRODUCTION

Chronic diseases, including back pain, can be challenging to remediate, and have a significant impact on the quality of life of the afflicted population, the overall economy, and the healthcare system at large [1]. The economic burden attributed to chronic disease includes wage and productivity loss, along with an increased demand for persistent healthcare services, specialist referrals, adjunct treatments, and pharmacotherapy [2]. In 2008, the cost of chronic diseases in Canada was estimated at $192 billion Canadian dollar (equivalent to approximately 15% of Canada's gross domestic product) [3], and it has continued to rise.

Physical inactivity is associated with chronic diseases and poor health [1,4,5]. Although there are many possible mechanisms as to how and why exercise is beneficial, a general exercise program is regarded as one of the simplest and strongest evidence-based recommendations for the management of back pain [6-8] and other chronic diseases. For the majority of the population, walking is a convenient means by which to perform regular exercise; a recent systematic review of 17 studies demonstrated that walking is an effective treatment for chronic musculoskeletal afflictions [9,10].

While many studies have focused on walking as an experimental intervention, there is relatively little evidence at the population level, most likely due to the poor reliability of self-reported walking habits. In contrast, neighbourhood walkability is an objective measure based on geographic factors. People living in walkable neighbourhoods have shown higher daily step counts, as assessed using pedometry, than people living in car-dependent neighbourhoods [11]. Additionally, the mean duration of walking was longer and the likelihood of daily walking was higher among residents living in walkable neighbourhoods than among those living in rural areas [12]. Thus, the more walkable a neighbourhood environment, the greater the tendency for transport-related, utilitarian walking [13,14].

As it is well established that a physically inactive lifestyle is a risk factor for chronic back pain [15], lower neighbourhood walkability, acting as a surrogate measure of physical fitness, could be associated with chronic diseases in the same patient population. The objective of this study was to determine whether there was a relationship between neighbourhood walkability and the presence of chronic disease in a convenience sample of patients with chronic back pain, after adjustments for confounding factors. We hypothesized that if there is an association between living in a car-dependent neighbourhood and chronic disease, then this would provide initial support for a potential causal relationship. If such a relationship exists in a population with chronic back pain, this relationship may also apply to other populations, in which fear avoidance and pain with activity are less of a concern.

METHODS

Study Sample

We conducted a cross-sectional study of prospectively collected data from a prior randomized study, which served as a convenience cohort for exploration of our hypothesis [16]. Consecutive adult patients aged 18-80 years referred between 2011 and 2014 by their primary care provider to a regional academic tertiary health center in Ottawa, ON, Canada for specialist surgical consultation for chronic (>3 months symptomology) lumbar spinal conditions were considered eligible. Patients were considered ineligible if they met any of the following criteria: cervical pathologies, adult spinal deformities (e.g., scoliosis), or urgent spinal referrals (including fractures, infections, or suspected cancers). Ethics approval was granted by the institutional research ethics board (OHSN-REB protocol no. 2011204-01H).

Measures

After referral receipt by the surgeon's office, questionnaires were sent directly to the patient by mail. The questionnaires included a numerical pain rating scale (score 0-10), the Oswestry Disability Index (ODI) (score out of 50), and a healthcare use survey [16]. Supplementary information pertaining to patients' demographics (e.g., postal codes) and their medical history of comorbidities was extracted from their hospital medical records. The Charlson Comorbidity Index (CCI) [17], modified to eliminate the age scoring system so as to remove age as a confounder, was calculated using the collected data. The CCI is a commonly used comorbidity index, and is predictive of hospital costs, health care utilization, and 1-year mortality [18,19]. Patients with ≥1 medical comorbidity on the CCI were classified as having ≥1 chronic disease.

Using patient postal codes, neighbourhood walkability was determined using the Walk Score [20], which was obtained from a valid and reliable web site [21,22]. The algorithm used to calculate the Walk Score functions by measuring the accessibility of proximate amenities within the radius of the built environment of a particular neighbourhood, based on the distance of the shortest calculated route. Amenities include stores, schools, parks, restaurants, retail, and recreational and community centers. The Walk Score, placed on a normalized scale from 0-100, is computed electronically as follows: amenities within a 0.4 km radius (5-minute walk) from the domicile are awarded the greatest value, with the more amenities, the higher the score; distant amenities within a radius of 2.4 km

(<30-minute walk) are scored with a decaying function. Neighbourhoods with Walk Scores <50 are classified as car-dependent, while neighbourhoods with scores ≥50 are considered increasingly more walkable. A high Walk Score is equivalent to a shorter distance from the place of residence to nearby amenities. Additionally, the Walk Score uses a pedestrian-friendliness variable, representing the population density and road metrics (e.g., average city-block length, intersection density, compact vs. sprawling neighbourhood, etc.) [22,23]. The algorithm compiles data from numerous sources such as Google, Open Street Map, Localeze, Education.com, and places added by the Walk Score user community [24].

In addition to the Walk Score, socioeconomic information regarding patients' neighbourhoods was obtained from the 2011 City of Ottawa Census and the 2011 Canadian National Household Survey [25,26]. The neighbourhoods were analyzed on the level of city wards, otherwise known as census subdivisions. The median before-tax total household income in 2010 of private households and the percent employment rate in each census subdivision was obtained.

Statistical Analysis

Statistical analysis was performed using the SAS version 9.3 (SAS Institute Inc., Cary, NC, USA). The significance of differences in the baseline features of patients living in car-dependent and walkable neighbourhoods was determined. Possible interactions between socioeconomic status and neighbourhood walkability were assessed by creating an interaction variable between car-dependent status and neighbourhood income above or below the median for the cohort. Univariate analysis was used to determine whether any significant associations existed between patients with or without a chronic disease. Any potential significant and near-significant ($p \leq 0.1$) associations or interactions were considered as possible confounding variables, as well as age and gender, and were then entered into a multivariate logistical regression analysis. Backwards stepwise logistic regression was used to reduce the non-significant variables ($p > 0.1$), provided that the final adjusted R-square did not change by more than 10% [27].

RESULTS

A total of 227 patients were included; their mean age was 55.9 (standard deviation [SD], 14.4) years and 126 (55.5%) were men. Thirty-four distinct neighbourhoods were examined from 2 provinces (Ontario and Quebec) and 1 territory (Nunavut). The average Walk Score was 38.9 (SD, 30.9); 134 patients (59.0%) lived in a car-dependent neighbourhood while 93 (41.0%) lived in a walkable neighbourhood. Based on Statistics Canada's definitions, 161 (70.9%) households were classified as urban and 66 (29.1%) were classified as rural.

Table 1. Baseline characteristics of patients living in car-dependent or walkable neighbourhoods

Characteristics	Car-dependent (n=134)	Walkable (n=93)	*p*-value
Age (SD, y)	57.0 (13.6)	54.3 (15.4)	0.17
Men, n (%)	75 (56.0)	51 (54.8)	0.87
Rural households, n (%)	66 (49.3)	0 (0.0)	<0.001
Mean household income (SD)			
Canadian dollar	77 874 (23 520)	67 827 (18 024)	<0.001
US dollar[1]	76 581 (23 130)	66 701 (17 725)	<0.001
Mean percent employment, % (SD)	66.6 (4.7)	62.1 (5.2)	<0.001
BMI (SD, kg/m^2)	28.6 (4.9)	29.8 (5.9)	0.25
Smoking, n (%)			0.32
Non-smoker	58 (43.3)	42 (45.2)	
Ex-smoker	46 (34.3)	24 (25.8)	
Current smoker	30 (22.4)	27 (29.0)	
CCI points, n (%)			0.01
0	87 (64.9)	75 (80.7)	
1	37 (27.6)	14 (15.1)	
2	7 (5.2)	4 (4.3)	
3	3 (2.2)	0 (0.0)	
Mean worst numeric pain score, n (SD)	7.5 (1.6)	7.7 (2.0)	0.59
Mean ODI score, n (SD)	28.4 (7.8)	29.2 (8.0)	0.45

SD, standard deviation; BMI, body mass index; CCI, Charlson Comorbidity Index; ODI, Oswestry Disability Index.
[1]2011 conversion rate: 1 Canadian dollar=0.9834 US dollar.

Table 1 shows the characteristics of participants who lived in a walkable compared to a car-dependent neighbourhood. As expected, because all patients were referred with elective lumbar spinal conditions, there were no significant differences in back pain ($p=0.590$) or ODI scores ($p=0.469$). Car-dependent neighbourhoods showed a significantly higher median household income ($p<0.001$) and a higher percent employment ($p<0.001$). We were unable to detect a significant interaction between car-dependent neighbourhoods and high- or low-income neighbourhoods ($p=0.307$).

In the unadjusted univariate analyses of possible confounders for the 227 patients, having a chronic disease (CCI≥1) showed a significant relationship with older age ($p<0.001$), a higher BMI ($p<0.001$), being a current smoker ($p=0.013$), higher pain

Table 2. Multivariate adjusted[1] factors associated with chronic disease

	aOR (95% CI)	*p*-value
Age (per year)	1.07 (1.04, 1.10)	<0.001
BMI (per kg/m^2)	1.16 (1.06, 1.27)	0.001
Car-dependent neighbourhood	2.82 (1.38, 5.78)	0.004
Numeric pain score	1.26 (1.03, 1.54)	0.02

aOR, adjusted odds ratio; CI, confidence interval; BMI, body mass index.
[1]Multivariate adjusted statistics calculated using backwards stepwise logistic regression.

scores ($p=0.036$), and higher ODI scores ($p=0.045$). There was a non-significant trend towards higher levels of chronic disease in rural households ($p=0.185$). There were no associations ($p>0.2$) with gender, household income, or percent employment.

In the unadjusted univariate analysis, the odds of having a chronic disease (CCI ≥ 1) was 2.25 (95% confidence interval [CI], 1.21 to 4.21; $p=0.01$) times higher for individuals living in a car-dependent neighbourhood, and there was also a significant dose-related association ($p=0.01$; Mantel-Haenszel chi-square=6.4) between living in car-dependent neighbourhoods and more severe CCI scores.

Multivariate logistic regression modelling was performed to assess the odds of having at least 1 chronic disease when living in a car-dependent neighbourhood, adjusting for the potential confounding factors of age, gender, BMI, rural postal code, smoking status, median household income, percent employment, and pain and disability scores. The adjusted R-square for this model was 0.304 and the Hosmer and Lemeshow goodness of fit was non-significant (chi-square=5.4; $p=0.715$), thereby suggesting a reasonable and good fit for a biological model. This model demonstrated an adjusted odds ratio of 2.75 (95% CI, 1.16 to 6.53; $p=0.022$) times greater chance of having a chronic disease (CCI ≥ 1) for patients living in a car-dependent neighbourhood. A backwards stepwise approach was used to reduce non-significant variables ($p \leq 0.1$). This model had a similar goodness of fit to the previous model (R-square=0.288; Hosmer and Lemeshow chi-square=6.3; $p=0.607$). The results from the reduced multivariate model of significant predictors for chronic disease are shown in Table 2.

DISCUSSION

This cross-sectional analysis demonstrated that, for a cohort of patients with back pain, living in a car-dependent neighbourhood was significantly associated with a higher prevalence of chronic disease. This value was independent of potential risk factors for chronic diseases, including gender, age, BMI, smoking status, socioeconomic status, pain, and disability.

Physical inactivity is closely related to chronic disease. Many studies have demonstrated that interventions that promote increased physical activity are beneficial and equivocal in efficacy to pharmaceutical mediation [28]. Walking is one of the simplest methods to improve physical activity. However, there is currently little evidence to support the notion that there is an association between walking and reduced chronic disease at the population level. Furthermore, such studies often use self-reported physical activity levels, which may be inaccurate [29], while interventions that promote physical activity directed at individuals may be expensive and unsustainable, with poor long-term compliance. As the Walk Score is based on the geographic proximity of fixed neighbourhood amenities, it is static, sustainable, and objective, as well as potentially modifiable. Additionally, the Walk Score has been shown to be relatively accurate at predicting the time that people spend walking in the neighbourhoods where they live [11-14,21,22]. For these reasons, we decided to evaluate neighbourhood walkability (measured by the Walk Score) as a surrogate measure of physical fitness.

To date, little evidence has assessed whether neighbourhood walkability is correlated with health outcomes. Although there are over 500 published studies in PubMed related to neighbourhood walkability, at present only a handful have addressed its association with chronic diseases. Studies using administrative databases have demonstrated an association between lower neighbourhood walkability and increased risk of diabetes [30,31], hypertension [32], and higher hospital costs [33]. Two other studies have demonstrated a relationship between neighbourhood walkability and the prevalence of pain in youth [34] and low back pain [35]. Our study is the first to utilize prospectively collected individual patient-level data to assess the relationship between neighbourhood walkability and chronic diseases.

As in other studies [36], we noted a significant association between higher socioeconomic status and increased dependence on cars. However, as socioeconomic status may also be a risk factor for chronic disease, we evaluated whether there was an interaction with car-dependence. The results of our study confirm previous findings in that the effects of neighbourhood walkability applied similarly in high- and low-socioeconomic-status neighbourhoods [33,37]. Alas, because our population size was relatively small, we cannot conclude that the effect of neighbourhood walkability applies across all subpopulations.

The strong association between car-dependent neighbourhoods and the prevalence of chronic disease should be interpreted with caution. We studied a convenience sample of chronic back pain patients in a region of North America that has cold, snowy winters. This factor may have actually reduced a source of confounding, but further studies in different populations should be performed to assess the generalizability of our results. We also acknowledge that there may be other confounding factors that we did not consider that could have affected the results. It is unclear whether the specific health benefits of living in a walkable neighbourhood are due to increased physical activity; the Walk Score may be a surrogate measure for another health-promoting activity, such as increased social support due to population density or the propensity for people with a predisposition to healthy lifestyles to choose a walkable neighbourhood. Since the Walk Score is derived from a number of factors, including proximity to amenities and pedestrian-friendliness, we can only speculate which of these factors are associated with improved health outcomes. Finally, given the cross-sectional nature of our study, we cannot make any conclusions regarding causal relationships.

In conclusion, the strong association that we demonstrated between car-dependence and chronic disease suggests a possible effect of neighbourhood walkability, which is modifiable through better urban planning and interventions to improve health outcomes at a population level. Given the reduced odds of the prevalence of chronic disease in back pain patients living in a walkable neighbourhood, potentially significant health care cost savings may be realized through public policy changes that promote neighbourhood walkability.

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CONFLICT OF INTEREST

The authors have no conflicts of interest associated with the material presented in this paper.

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