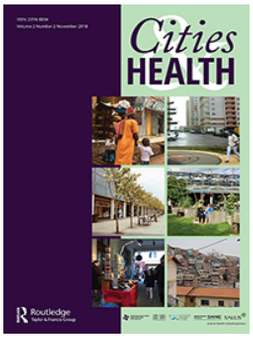

Cities & Health

ISSN: 2374-8834 (Print) 2374-8842 (Online) Journal homepage: https://www.tandfonline.com/loi/rcah20

Environmental health assessment of communities across Canada: contextual factors study of the Canadian Alliance for Healthy Hearts and Minds

R. J. de Souza, L. Gauvin, N. C. Williams, S. A. Lear, A. P. Oliveira, D. Desai, D. J. Corsi, S. V. Subramanian, A. Rana, R. Arora, G. L. Booth, F. Razak, J. R. Brook, J. V. Tu & S. S. Anandon behalf of The Canadian Alliance for Healthy Hearts Minds Study Investigators

To cite this article: R. J. de Souza, L. Gauvin, N. C. Williams, S. A. Lear, A. P. Oliveira, D. Desai, D. J. Corsi, S. V. Subramanian, A. Rana, R. Arora, G. L. Booth, F. Razak, J. R. Brook, J. V. Tu & S. S. Anandon behalf of The Canadian Alliance for Healthy Hearts Minds Study Investigators (2018) Environmental health assessment of communities across Canada: contextual factors study of the Canadian Alliance for Healthy Hearts and Minds, Cities & Health, 2:2, 163-180, DOI: 10.1080/23748834.2018.1548071

To link to this article: https://doi.org/10.1080/23748834.2018.1548071

CITIES & HEALTH
2018, VOL. 2, NO. 2, 163–180
https://doi.org/10.1080/23748834.2018.1548071

Routledge
Taylor & Francis Group

ORIGINAL SCHOLARSHIP

Environmental health assessment of communities across Canada: contextual factors study of the Canadian Alliance for Healthy Hearts and Minds

R. J. de Souza[a,b], L. Gauvin[c,d], N. C. Williams[e], S. A. Lear[f], A. P. Oliveira[e], D. Desai[b,g], D. J. Corsi[h], S. V. Subramanian[i,j], A. Rana[k], R. Arora[l], G. L. Booth[m,n,o], F. Razak[m], J. R. Brook[p], J. V. Tu[†k,o,q] and S. S. Anand on behalf of The Canadian Alliance for Healthy Hearts Minds Study Investigators[a,b,e]

[a]Department of Health Research Methods, Evidence, and Impact, Faculty of Health Sciences, McMaster University, Hamilton, Canada; [b]Population Health Research Institute, Hamilton, Canada; [c]Centre de recherche du Centre hospitalier de l'Université de Montréal, Montreal, Canada; [d]Département de médecine sociale et préventive, École de santé publique de l'université de Montréal, Montreal, Canada; [e]Department of Medicine, McMaster University, Hamilton, Canada; [f]Faculty of Health Sciences, Simon Fraser University, Burnaby, Canada; [g]Hamilton Health Sciences Corporation, Hamilton, Canada; [h]Ottawa Hospital Research Institute, Ottawa, Canada; [i]Department of Social and Behavioral Sciences, Harvard T.H. Chan School of Public Health, Boston, MA, USA; [j]Harvard Center for Population and Development Studies, Harvard University, Cambridge, MA, USA; [k]Faculty of Medicine, University of Toronto, Toronto, Canada; [l]Faculty of Health Sciences, McMaster University, Hamilton, Canada; [m]Li Ka Shing Knowledge Institute, St. Michael's Hospital, Toronto, Canada; [n]Institute of Health Policy, Management and Evaluation, University of Toronto, Toronto, Canada; [o]Institute for Clinical Evaluative Sciences, Toronto, Canada; [p]Dalla Lana School of Public Health, University of Toronto, Toronto, Canada; [q]Sunnybrook Research Institute Toronto, Canada

ABSTRACT

Rationale: Cardiovascular risk varies across communities in Canada. Community-level differences in contextual factors may influence risk factor development.

Methods: We audited urban and rural Canadian communities using a standardized instrument to collect objective measures of demographic, public transport, tobacco, grocery, alcohol, and healthful restaurant options. We duplicated 209 audits to assess reliability.

Results: Of 2074 communities audited between 2014 and 2016, 83.5% were urban. Provincial and urban-rural differences exist in fruit and vegetable availability. Rural communities face higher food prices, are subject to more seasonal variation in fruit and vegetable selection, and generally see less promotion of healthy choices and nutritional information in restaurants than urban communities. In-store advertising for sweet drinks and junk food is more frequent than advertisements for tobacco products. Cigarette prices are lower and variety higher in urban than rural communities, and lowest in central Canada. Alcohol prices are lowest in Quebec. The intra-rater reliability of the audits was high. We created an on-line map for public use.

Conclusions: Provincial and urban-rural differences exist for contextual determinants of health. Public health and built environment professionals and government officials should use these data to develop unified federal and provincial strategies to reduce Canada's chronic disease burden.

ARTICLE HISTORY
Received 15 June 2018
Accepted 8 October 2018

KEYWORDS
Contextual factors; cardiovascular risk; urban; rural; Canada; built environment

Introduction

Cardiovascular disease (CVD) rates vary considerably across geographic regions, and over time (Keys *et al.* 1984, Menotti *et al.* 2003). The built environment in which a person lives strongly influences the development of risk factors for CVD and other chronic diseases, and varies across populations, geography, and over time. Features of the built environment, known as 'contextual factors', may be viewed as primordial causes of CVD risk factors, because the environment affects health through physical (e.g. community resources, built environment), and social (e.g. social support, norms) dimensions, which influence health-related behaviors such as smoking, food consumption, and physical activity (Sallis and Owens 2002). These behaviors may influence the risk of CVD through promoting or preventing intermediate conditions such as obesity, hypertension, dyslipidemia, and hyperglycemia.

Many tools have been developed to capture individuals' perceptions of their built environment (Reimers *et al.* 2013), but fewer tools exist to capture direct observations of multiple features of the built environment (Cunningham *et al.* 2005, Day *et al.* 2006, Pikora *et al.* 2006, Glanz *et al.* 2007, Chow *et al.* 2009, Gasevic *et al.* 2011, Wong *et al.* 2011, Pomerleau *et al.* 2013, Rahmanian *et al.* 2014). The Prospective Urban and Rural Epidemiological (PURE) study developed and validated an objective audit tool that simultaneously assesses multiple contextual factors within communities (Chow *et al.*

CONTACT S. S. Anand anands@mcmaster.ca Population Health Research Institute, 237 Barton St East, Hamilton, ON L8L 2X2, Canada
[†]Deceased 30 May 2018
Supplementary material for this article can be accessed here

2010), and implemented it internationally. We adapted this assessment tool for use in Canada as part of the Canadian Alliance for Healthy Hearts and Minds (CAHHM), a pan-Canadian, prospective, multi-ethnic cohort study of 9000 people (Anand *et al.* 2016, 2018).The objective of the contextual factors component of the CAHHM is to understand the role of the activity, nutrition, social, and tobacco environments on CV risk factors, subclinical vascular disease, and clinical cardiovascular (CV) events at the individual and population levels. The specific aims of this paper are to report on the assessment methodology and summarize the characteristics of communities in Canada. In this paper, we report national-level community characteristics and their interprovincial, urban/rural, and Cartesian coordinate differences.

Methods

Below, we briefly describe the assessment tool, selection of communities, and country-coverage. Appendix 1 within the Supplementary material presents detailed methods, and Appendix 2 within the Supplementary material presents the audit protocol.

Assessment tool

We conducted contextual audits using a modified version of the Environmental Profile of a Community's Health (EPOCH-1) instrument (Chow *et al.* 2010). This audit was developed and validated in 93 rural and urban communities in 5 countries (Canada, Colombia, Brazil, China and India) participating in the PURE study, a large-scale epidemiological study of the relationship of societal influences on human lifestyle behaviors, cardiovascular risk factors, and incidence of chronic diseases in >600 communities in 17 low-, middle-, and high-income countries around the world (Teo *et al.* 2009). This tool was modified slightly for the Canadian context (e.g. the food list), reviewed for face validity by an expert panel (SA, SL, LG, GB, SS, DC) and pilot tested in 2 urban and 2 rural communities in Southern Ontario prior to widespread use.

The modified EPOCH-1 assesses 5 contextual domains: i) community characteristics (i.e. demographics, infrastructure, and services); ii) tobacco environment (i.e. availability, access, and pricing of tobacco products); iii) alcohol environment (i.e. the prices of beer and wine); iv) retail grocery environment (i.e. prices and availability of foods, and advertising); and v) restaurant environment (i.e. healthfulness of offerings and nutritional information available).

Selection of communities and locations

The forward sortation area (FSA) was deemed to be the optimal community unit. FSAs are a geographical unit based on the first three characters of the 6-character Canadian postal code, which is roughly equivalent to the first two digits of a U.S. zip code. Each audited community represented a median of 323 postal codes (IQR: 9 to 668), with at least 1 audit conducted at the FSA or postal-code level for 97.2% of Canadian postal codes, representing 96.7% of the population (32,362,892 people). We classified communities as rural or urban using prespecified definitions (Appendix 1 within Supplementary material), and as northern or southern using median latitude values by province (**Table S1**). Two audits were conducted in areas with highly variable household incomes, which were treated as two distinct communities. All data were collected by centrally-trained auditors in each province and deposited into a central database at the Population Health Research Institute (Hamilton, ON). The closest tobacco store, grocery store, and local restaurant to the center of the community were selected for the detailed assessments. In a minority of communities (<21%), a grocery store (33%), tobacco retail (26%), alcohol retail (33%), or restaurant (28%) could not be found. No food, tobacco, or alcohol data were collected when there was no store within the designated community.

Statistical approaches

Data were analyzed using SAS (version 9.4, Cary, NC) and differences or associations were declared significant where $p < 0.05$. Descriptive data are presented as mean ± standard deviations or median (interquartile range [IQR]) for continuous variables, and as counts (percent) for categorical or dichotomous variables. Between-groups comparisons of means of continuous variables were assessed with independent-samples t-tests (2 categories) or one-way analysis of variance (ANOVA; >2 categories). Between-groups comparisons of medians of continuous variables were conducted using Wilcoxon rank-sum test (2 categories) or the Kruskal-Wallis test (>2 categories). Between-groups comparisons of proportions were assessed using the exact binomial test. A previous Canadian study (CANHEART) (Maclagan *et al.* 2014) showed that cardiovascular health generally decreases from western to eastern provinces; we therefore investigated the presence of an east-west gradient of the distribution of the contextual factors measured in our study, by regressing the outcome against the continuous longitude using linear regression for continuous outcomes and logistic regression for dichotomous outcomes. We used the same approach to assess the presence of a north-south gradient.

Measurement error assessment

We assessed both intra-rater and inter-rater reliability of measures collected during the audit in a sample of

209 communities in Alberta, Ontario, Quebec, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador. Reliability was quantified with the intra-class correlation coefficient:

$$ICC = \frac{\hat{\rho}^2 s}{\hat{\rho}^2 y} = \frac{n(SMS - EMS)}{nSMS + kMMS + (nk - n - k)EMS}$$

where SMS (mean square between subjects), MMS (mean square between measures), and EMS (random error) are the mean squares for community-level characteristics, audits, and error, respectively, obtained from the two-way random-effects ANOVA design. This method has been described previously (Chow *et al.* 2010). We classified ICC between 0 and 0.44 as low, 0.45 and 0.74 as acceptable, and >0.75 as excellent. Negative values represent agreement *worse* than expected, or disagreement.

Results

A total of 2074 community audits were undertaken by trained auditors between 2014 and 2016: 14% in eastern provinces (New Brunswick, Nova Scotia, Newfoundland/Labrador, and Prince Edward Island), 58% in central provinces (Ontario and Quebec), and 27% in Western provinces (British Columbia, Alberta, Saskatchewan, and Manitoba). A total of 1544 tobacco stores, 1392 major chain grocery stores, 1381 alcohol stores, and 1501 restaurants were audited.

Community demographics

About 83.5% of Canadian communities are classified as urban, and 16.5% as rural (Table 1). The most urban province is Ontario (92.1% of 696 communities were urban) and the most rural province is Newfoundland/Labrador (50.0% of 44). The median number of households in a community is 7,210 (IQR: 3,647.5 to 11,867.5), which contain 17,435 (IQR: 8,624 to 28,144) people (and **Tables S2-S5** for Census and National Household Survey data). The median distance from the community center to a major city center is 8.7 (IQR: 1.1 to 23.2) km, and the median distance to a major highway is 3.1 (IQR: 1.4 to 6.8) km. In total, 69% of communities are serviced by a bus at least once per day, and 10% are serviced by a train or subway at least once per day.

The median number of households (7975 [IQR: 4370 to 12,280] vs. 4055 [IQR: 2,100 to 7,205]), population (19,153 [IQR: 10,484 to 29,085] vs. 9,702 [IQR: 5,324 to 17,493]), and household income ($78,629.50 [IQR: $61,747.50 to $99,810.50] vs. $64,181 [$55,455.00 to $76,389.00]) are higher in urban than in rural communities (Table 1). The mean ratio of the highest to the lowest median income in a community is higher in urban areas (ratio = 7.1 ± 14.7) than rural areas (4.0 ± 2.0). Rural communities are further from the nearest urban center (median distance: 61.2 [IQR: 32.1 to 103.0] vs. 6.3 [IQR: 0 to 15.4] km; $p < 0.0001$) but the median distance to major highways does not differ between urban and rural communities (3.1 [IQR: 1.4 to 6.3] vs 3.5 [IQR: 0.5 to 19.2] km; $p = 0.37$). In urban centers, 78.5% of communities are serviced at least once per day by a bus and 12.0% are serviced at least once per day by a train. In rural centers, 20.9% of communities are serviced at least once per day by a bus and none are serviced at least once per day by train. **Table S6** presents comparisons between northern and southern communities by province. **Table S11** presents continuous regression models by latitude and **Table S12** presents continuous regression models by longitude.

Tobacco store assessments

Out of the 2074 communities, 74.5% contain a tobacco store, being more common in rural than in urban communities (Table 2). The price of the lowest price pack of cigarettes is $1.07 lower (per 20-pack) in urban than in rural environments ($p < 0.001$) (Table 2). The median number of brands available is higher ($p < 0.0001$) in urban (25, IQR: 20 to 30) than in rural regions (20, IQR: 14 to 25) ($p < 0.0001$). In other respects, urban and rural stores were similar.

The mean price of a 20-pack (the most common size) of Marlboro (or another international brand) is $11.30 ± 1.74, and the least expensive pack of 20 cigarettes is $7.80 ± 1.70. Tobacco is rarely openly displayed (3.5% of 1,535 stores), and mainly reported in Alberta (19.9% of 146 stores) and Quebec (4.6% of 392 stores). Advertising for tobacco products is visible at the point-of-sale in 21.4% of stores. Signs warning of the harmful effects of smoking are present in 32.6% of stores, signs prohibiting smoking are observed in 66.8% (e.g., please see Figure 1), and 8.3% of stores sell smoking cessation aids. The presence of point-of-sale cigarette advertising is highest in Alberta (56.9% of 146 stores) and Quebec (54.1% of 392 stores).

Some interprovincial differences were observed including wide ranges in the per-pack price of 20 cigarettes. The lowest price for a 20-pack of Marlboro (or equivalent international brand) cigarettes was found in Quebec ($10.51 ± 1.10) and the highest in Manitoba ($14.00 ± 0.93). The lowest price for the cheapest 20-pack of cigarettes was found in Quebec ($6.49 ± 0.38) and the highest in New Brunswick ($10.85 ± 0.21). Marlboro cigarettes were 49% (95% CI: 48% to 50%; $p < 0.0001$) more expensive than the cheapest pack of the same size but this ranged from 24% (Manitoba) to 62% more expensive (Quebec).

Table 1. Community Demographics. (U = urban; R = rural). BC = British Columbia; AB = Alberta; SK = Saskatchewan; MB = Manitoba; ON = Ontario; QC = Quebec; NB = New Brunswick; NS = Nova Scotia; PE = Prince Edward Island; NL = Newfoundland and Labrador CAN = Canada).

Province		BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	CAN
Number of Communities	U	208 (87.4)	159 (80.7)	41 (71.9)	56 (72.7)	641 (92.1)	450 (87.0)	66 (48.5)	81 (78.6)	7 (77.8)	22 (50.0)	1731 (83.5)
	R	30 (12.6)	38 (19.3)	16 (28.1)	21 (27.3)	55 (7.9)	67 (13.0)	70 (51.5)	22 (21.4)	2 (22.2)	22 (50.0)	343 (16.5)
Number of households Median (IQR)[a]	U	8,670 (7,390)	8,720 (8,615)	6,652.5 (11,075)	6,917.5 (7,335)	9,270 (7,335)	7,730 (7,305)	2,460 (4,150)	4,070 (4,960)	3,715 (3,680)	4,562.5 (6,960)	**7,975 (7,910)**
	R	5,155 (7,935)	4,365 (2,935)	12,530 (7,965)	7,840 (7,460)	5,380 (3,275)	4,105 (4,315)	1,417.5 (935)	4,385 (6,375)	14,227.5 (5,535)	3,957.5 (6,155)	**4,055 (5,105)**
Population Median (IQR)	U	21,830 (16,963)	22,151.5 (21,574.5)	13,092 (25,899)	17,622 (20,106)	22,862 (19,436)	17,899 (15,765)	6,123.5 (10,196)	10,232 (11,982)	10,122 (7,819)	12,254 (16,939)	**19,153 (18,601)**
	R	12,169 (19.865)	11,341 (7775.5)	30,995 (27,484)	19,792 (19,033)	13,341 (9,861)	9,509.5 (10,759.5)	3,172 (2,113)	9,172 (13,743)	36,605 (14,374)	9,579 (14,446)	**9,702 (12,168)**
Household Income $ '000s	U	79.6 (24.7)	94.6 (40.8)	91.4 (39.8)	78.0 (32.9)	83.9 (45.4)	71.6 (30.5)	65.7 (23.0)	71.0 (33.3)	68.3 (21.5)	74.9 (29.7)	**78.6 (38.0)**
Median (IQR)[a]	R	67.5 (19.7)	83.8 (23.6)	68.3 (21.6)	66.4 (19.9)	72.1 (12.8)	60.7 (9.2)	57.5 (12.7)	57.4 (8.0)	66.6 (1.4)	55.2 (34.3)	**64.2 (20.9)**
Number of Postal Codes	U	533.0 (698.5)	395.0 (815.0)	142.0 (900.0)	385.5 (576.8)	341.0 (693.0)	370.0 (648.0)	354.5 (709.0)	161.0 (502.0)	584.0 (741.0)	312.0 (689.5)	**368.0 (717.0)**
Median (IQR)	R	29.5 (112.5)	158.0 (184.5)	49.0 (63.5)	42.0 (39.0)	41.0 (389.0)	262.0 (436.5)	345.0 (340.3)	32.5 (272.3)	27.0 (5.0)	21.5 (67.3)	**91.0 (379.5)**
Distance to City Centre km	U	5.3 (7.6)	8.8 (14.1)	5.6 (6.1)	8.4 (9.8)	11.1 (13.8)	0.0 (0.0)	12.7 (30.0)	7.2 (16.6)	5.1 (2.8)	5.8 (14.9)	**6.3 (15.4)**
Median (IQR)	R	39.6 (116.9)	91.6 (54.6)	70.2 (68.9)	48.7 (78.9)	72.4 (100.7)	42.3 (44.6)	70.0 (39.8)	46.7 (51.0)	18.3 (7.9)	80.7 (132.6)	**61.2 (70.7)**
Distance to Major Highway km	U	1.3 (2.6)	2.4 (4.2)	1.7 (2.0)	5.6 (4.7)	4.8 (6.4)	2.5 (3.2)	1.5 (5.0)	2.9 (5.2)	1.1 (1.9)	14.2 (15.3)	**3.1 (4.9)**
Median (IQR)	R	2.2 (16.0)	0.5 (1.6)	1.0 (1.2)	4.0 (6.5)	3.5 (18.2)	15.3 (60.4)	1.0 (7.1)	17.3 (20.4)	0.0 (0.0)	21.0 (94.1)	**3.5 (18.7)**
Regular bus?	U	196 (95.1)	118 (74.7)	32 (80.0)	46 (82.1)	524 (81.7)	341 (76.3)	19 (28.8)	56 (69.1)	4 (57.1)	17 (77.3)	**1353 (78.5)**
Yes (n, %)	R	16 (55.2)	2 (5.6)	0 (0.0)	0 (0.0)	3 (5.5)	32 (47.8)	0 (0.0)	11 (50.0)	0 (0.0)	7 (31.8)	**71 (20.9)**
Regular train?	U	28 (13.7)	31 (19.6)	0 (0.0)	0 (0.0)	102 (15.9)	45 (10.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	**206 (12.0)**
Yes (n, %)	R	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	**0 (0.0)**

[a] Number of communities (Province;U/R): (BC: 165/23; *AB*: 121/28; SK: 36/11; MB: 46/17; ON: 430/51; QC: 342/64; NB: 49/58; NS: 57/19; PEI: 5/2; NL: 18/14)

Table 2. Tobacco store characteristics. (U = urban; R = rural). BC = British Columbia; AB = Alberta; SK = Saskatchwean; MB = Manitoba; ON = Ontario; QC = Quebec; NB = New Brunswick; NS = Nova Scotia; PE = Prince Edward Island; NL = Newfoundland and Labrador CAN = Canada.

Province		BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	CAN
Number of Communities with Tobacco Outlets	U	151 (72.6)	122 (76.7)	32 (78.0)	38 (67.9)	435 (67.9)	329 (73.1)	42 (63.6)	73 (90.1)	7 (100.0)	21 (95.5)	**1250 (72.2)**
N (%)	R	27 (90.0)	28 (73.7)	12 (75.0)	17 (81.0)	51 (92.7)	64 (95.5)	52 (74.3)	19 (86.4)	2 (100.0)	22 (100.0)	**294 (85.7)**
Tobacco Openly Displayed	U	2 (1.3)	28 (23.3)	0 (0.0)	0 (0.0)	0 (0.0)	17 (5.2)	1 (2.4)	1 (1.4)	0 (0.0)	0 (0.0)	**49 (3.9)**
N (%)	R	2 (7.4)	1 (3.6)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.6)	0 (0.0)	1 (5.3)	0 (0.0)	0 (0.0)	**5 (1.7)**
Point-of-sale tobacco advertising?	U	2 (1.3)	64 (53.3)	0 (0.0)	0 (0.0)	25 (5.8)	172 (52.4)	0 (0.0)	1 (1.4)	0 (0.0)	0 (0.0)	**264 (21.2)**
N (%)	R	0 (0.0)	19 (67.9)	0 (0.0)	0 (0.0)	5 (10.0)	40 (62.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	**64 (21.8)**
Signs to Prohibit Smoking	U	81 (53.6)	57 (47.5)	0 (0.0)	4 (10.5)	406 (95.8)	245 (74.7)	37 (88.1)	6 (8.2)	0 (0.0)	4 (19.0)	**840 (68.0)**
N (%)	R	10 (38.5)	14 (50.0)	0 (0.0)	2 (11.8)	50 (100.0)	52 (81.3)	49 (94.2)	1 (5.3)	0 (0.0)	1 (4.5)	**179 (61.3)**
Signs of Harmful Effects of Smoking	U	40 (26.7)	0 (0.0)	0 (0.0)	0 (0.0)	243 (56.4)	54 (16.5)	19 (45.2)	31 (42.5)	5 (71.4)	2 (9.5)	**394 (31.8)**
N (%)	R	9 (34.6)	1 (3.6)	0 (0.0)	0 (0.0)	36 (72.0)	18 (28.1)	21 (41.2)	13 (68.4)	2 (100.0)	5 (22.7)	**105 (36.1)**
Smoking Cessation Aids Sold	U	9 (6.0)	6 (5.1)	16 (51.6)	0 (0.0)	51 (12.2)	3 (0.9)	0 (0.0)	14 (19.4)	1 (14.3)	0 (0.0)	**100 (8.3)**
N (%)	R	3 (11.5)	1 (3.6)	7 (58.3)	0 (0.0)	10 (19.6)	0 (0.0)	0 (0.0)	0 (0.0)	1 (50.0)	2 (9.1)	**24 (8.3)**
Lowest Price of a 20 Pack of Cigarettes $	U	9.37 (0.67)	9.14 (1.01)	9.79 (0.65)	10.61 (1.31)	6.81 (0.77)	6.50 (0.40)	10.82 (0.18)	9.79 (1.09)	9.70 (–)	9.68 (0.63)	**7.62 (1.58)**
Mean (SD)	R	9.47 (1.57)	9.51 (1.02)	10.14 (1.93)	10.55 (0.75)	7.02 (0.68)	6.46 (0.27)	10.88 (0.24)	9.36 (1.27)	–	9.86 (0.81)	**8.69 (1.95)**
Price of a 20 Pack of Marlboro Cigarettes $	U	12.66 (0.99)	12.22 (1.52)	13.24 (1.43)	14.09 (0.99)	10.10 (1.07)	10.53 (1.15)	13.49 (0.59)	13.73 (1.18)	13.53 (–)	12.96 (2.34)	**11.21 (1.72)**
Mean (SD)	R	12.86 (1.22)	12.83 (1.10)	12.74 (–)	13.62 (0.47)	11.15 (1.48)	10.36 (0.65)	13.60 (–)	14.10 (2.25)	–	12.82 (0.95)	**12.00 (1.72)**
Number of Cigarette Brands	U	24 (8)	32 (45)	20 (13)	26 (27)	32 (29)	28 (11)	13 (4)	28 (13)	29 (7)	30 (15)	**28 (24)**
Mean (SD)	R	22 (13)	26 (10)	19 (6)	13 (6)	22 (9)	25 (9)	10 (3)	27 (9)	33 (4)	25 (10)	**21 (10)**
Number of Cigarette Brands	U	25 (10)	26 (12)	20 (7)	20 (10)	25 (15)	25 (11)	12 (3)	25 (10)	30 (8)	30 (10)	**25 (10)**
Median (IQR)	R	23 (15)	25 (10)	18 (5)	14 (5)	20 (6)	23 (10)	10 (4)	25 (15)	33 (3)	20 (11)	**20 (11)**
<20 Packs Sold	U	3 (2.0)	65 (53.3)	3 (9.4)	2 (5.3)	4 (0.9)	22 (6.7)	1 (2.4)	1 (1.4)	0 (0.0)	1 (4.8)	**102 (8.2)**
N (%)	R	2 (7.4)	12 (42.9)	1 (8.3)	0 (0.0)	0 (0.0)	6 (9.4)	0 (0.0)	0 (0.0)	0 (0.0)	1 (4.5)	**22 (7.5)**
20–24 Packs Sold	U	150 (100.0)	118 (97.5)	27 (84.4)	32 (84.2)	425 (97.7)	326 (99.4)	42 (100.0)	71 (97.3)	7 (100.0)	21 (100.0)	**1219 (97.8)**
N (%)	R	26 (96.3)	28 (100.0)	11 (91.7)	14 (82.4)	50 (98.0)	64 (100.0)	52 (100.0)	17 (89.5)	2 (100.0)	22 (100.0)	**286 (97.3)**
25–30 Packs Sold	U	14 (9.3)	117 (96.7)	29 (90.6)	38 (100.0)	429 (98.6)	325 (99.1)	42 (100.0)	72 (98.6)	7 (100.0)	17 (81.0)	**1090 (87.4)**
N (%)	R	14 (51.9)	27 (96.4)	12 (100.0)	17 (100.0)	50 (98.0)	63 (98.4)	52 (100.0)	19 (100.0)	2 (100.0)	16 (72.7)	**272 (92.5)**
>30 or Multi-packs Sold	U	2 (1.3)	76 (62.8)	0 (0.0)	29 (76.3)	141 (32.4)	166 (50.6)	28 (66.7)	3 (4.1)	0 (0.0)	0 (0.0)	**445 (35.7)**
N (%)	R	5 (18.5)	13 (46.4)	0 (0.0)	11 (64.7)	5 (9.8)	38 (59.4)	23 (44.2)	0 (0.0)	0 (0.0)	2 (9.1)	**97 (33.0)**

Figure 1. Examples of signs prohibiting smoking and alcohol advertisements. Examples of cigarette signs in Alberta (left smaller panels), and cigarette and alcohol advertisements in Quebec (right larger panels).

Figure 2. Examples of fruit and vegetable, and 'junk food' advertising. Clockwise from top left: Signs promoting green vegetables (Ontario), a grocery store offering fruit for children to snack on while their parents shop (Alberta), a chocolate bar display (Nova Scotia), and a sugar-sweetened beverage display (Ontario).

Point-of-sale tobacco advertisements were more common in northern stores (24.1%) than in southern stores (18.6%); mainly in Alberta (28.2% vs. 8.2%; n = 146 stores) and Quebec (8.9% vs. 1.3%; n = 392 stores). Openly displayed tobacco was seen more often in southern (5.5%) than in northern (1.6%) stores. Signs warning of the dangers of smoking (45.4% vs. 19.7%) and prohibiting smoking (71.7% vs. 61.8%), and smoking cessation aids (10.5% vs. 5.9%) were more common in northern than in southern stores. **Table S7** presents comparisons between northern and southern communities by province. Table S11 presents continuous regression models by latitude and Table S12 presents continuous regression models by longitude.

Grocery store assessments

Out of the 2074 communities, 67.1% contain a major chain grocery store (Table 3). A greater percentage of rural (77.6%) than urban communities (65.0%) had a major chain grocery store within the community boundary. A median of 25 (IQR: 22 to 27) out of 35 fruits and 31 (IQR: 27 to 34) out of 42 vegetables surveyed were available for purchase. **Tables S13** and **S14** list the relative availability of each fruit and vegetable. The price of a nutritious food basket is \$66.92 ± 9.56 and of a 'junk food' combination is \$1.97 ± 0.68 (Please see Appendix 3 within the Supplementary material for the components of each). Purchasing these foods once per week would

account for 5.0 ± 2.0% of annual household income (or $3577.50 ± 507.52 per year). At least one organic option was available in 48.8% of stores. Overall, 77.2% of grocery stores have 'junk food' advertisements, 73.9% have sweet drink advertisements, 59.2% have fruits and vegetable advertisements, 23.6% of stores have advertisements for alcohol, and 1.4% have advertisements for cigarettes (For examples, please see Figures 1 and 2). At least three damaged or bruised fruits were noted in 29.2% of grocery stores; and 83.0% of stores had fruits/vegetables specially packaged for sale.

Interprovincial comparisons show that the number of fruits (median = 14; IQR: 12 to 20) and vegetables (median = 21; IQR: 19 to 25) available is lowest New Brunswick, and the number of fruits available is highest in Prince Edward Island (median = 28; IQR: 24 to 28), and the number of vegetables available is highest in British Columbia (median = 34; IQR: 31 to 36) (Table 5). The price of the nutritious food basket is highest in New Brunswick ($87.54 ± 1.89) and lowest in Ontario ($60.92 ± 9.70). Junk food advertising is most common in New Brunswick (at least one advertisement was observed in 100% of 54 stores) and least common in Manitoba (at least one advertisement was observed in 5.6% of 54 stores). Sweet drink advertising is highest in New Brunswick (100% of 54 stores) and lowest in Prince Edward Island (0.0% of 6 grocery stores) and Manitoba (5.6% of 54 stores). Advertisements for fruits and/or vegetables were highest in New Brunswick (98.2% of 54 stores) and lowest in Manitoba (5.6% of 54 stores) and Saskatchewan (6.5% of 46 stores). Alcohol advertisements were most common in Quebec (82.1% of 358 stores), which has been selling alcohol in grocery stores and *depanneurs* since 1978. (Mailloux 2013) Alcohol was not widely sold in grocery stores in other provinces. Other than Quebec, only Newfoundland (9.1% of 33 stores), Ontario (5.5% of 419 stores), Saskatchewan (2.2% of 46 stores), and Alberta (0.7% of 148 stores) reported any advertisements. For examples of these advertisements, please see Figures 1 (alcohol, cigarettes) and **2** (fruits, vegetables, sweet drinks, and candy).

More fruit and vegetable varieties are available for purchase in urban than in rural communities (median = 25 [IQR: 22 to 27] vs. 23 [IQR: 19 to 26] fruits and 32 [IQR: 28 to 34] vs. 28 [IQR: 22 to 32] vegetables; both $p < 0.0001$ for urban vs. rural difference) (Table 3). The price of food is lower in urban than in rural communities (by $4.56, or 6.4%, for the nutritious food basket, and by $0.31, or 13.8%, for the junk food combination) and purchasing these items weekly would cost 4.8 ± 2.0% of annual household income in urban compared to 5.8 ± 1.7% in rural households; at these mean values, rural households spend an additional $249 per year (95% CI: $165 to $334) on these food items compared with urban households.

The presence of advertisements promoting junk food is higher in urban (78.5%) than rural (71.5%) communities ($p < 0.018$). The presence of advertisements promoting sweet drinks, fruits and/or vegetables, and alcohol and tobacco advertising is similar between urban and rural communities (Table 3). When stratified by season of audit, in urban areas there is little seasonal variability in the number of fruits or vegetables available but rural areas are more affected by seasonal availability. The lower variety numbers are also observed in rural communities in eastern and western Canada in the winter.

No differences in availability of fruits or vegetables, food prices, the availability or organic foods, or the presence of damaged fruits were noted between northern and southern communities. However, advertising of sweet drinks fruits and vegetables, alcohol, and tobacco were more common in northern than in southern stores. The number of fruits and vegetables available increased from north to south. The price of the food basket decreased from north to south (-$0.90 per 200 km, the approximate difference between a typical northern and southern community; 95% CI: −1.24 to −0.56; $p < 0.0001$). This was driven by a decrease in price of the nutritious food items (-$0.87 per 200 km; 95% CI: −1.20 to −0.53; $p < 0.0001$) (Table 3). Advertisements for junk food, sweet drinks, alcohol, tobacco, and fruits and vegetables were more commonly observed moving from west to east. The price of the food basket increased from west to east (+$0.46 per 800 km, the typical between-province distance; 95% CI: −0.05 to 0.88; $p = 0.027$). The cost of this food basket represented an increasing proportion of household income from west-to-east. **Table S8** presents comparisons between northern and southern communities by province. Table S11 presents continuous regression models by latitude and Table S12 presents continuous regression models by longitude.

Alcohol store assessments

Out of the 2074 communities, 66.6% contained a store that sold alcohol. The average price of a 750-mL bottle of wine was $11.32 ± 3.33, and the price of 24-cans of beer was $34.38 ± 13.59 (Table 4). The price of a 750-mL bottle of wine was lowest in Quebec ($9.75 ± 1.81), and highest in Prince Edward Island ($13.99). The price of a case of 24-cans of beer was lowest in Quebec ($19.39 ± 11.33) and highest in Newfoundland ($50.85 ± 9.05). Alcohol outlets are present more frequently in rural (77.0%) than in urban (64.5%) communities, but the prices of beer and wine are not significantly different (Table 4). Alcohol outlets are present equally in

Table 3. Grocery store characteristics. (U = urban; R = rural). BC = British Columbia; AB = Alberta; SK = Saskatchwean; MB = Manitoba; ON = Ontario; QC = Quebec; NB = New Brunswick; NS = Nova Scotia; PE = Prince Edward Island; NL = Newfoundland and Labrador CAN = Canada.

Province		BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	CAN
Number of Communities with chain Grocery Stores	U	151 (72.6)	124 (78.0)	33 (80.5)	38 (67.9)	383 (59.8)	295 (65.6)	23 (34.8)	58 (71.6)	4 (57.1)	17 (77.3)	**1126 (65.0)**
N (%)	R	27 (90.0)	28 (73.7)	13 (81.3)	16 (76.2)	49 (89.1)	64 (95.5)	33 (47.1)	17 (77.3)	2 (100.0)	17 (77.3)	**266 (77.6)**
Number of fruits available	U	24 (6)	24 (7)	21 (8)	20 (7)	25 (4)	25 (5)	18 (7)	23 (5)	27 (3)	23 (6)	**24 (5)**
Mean (SD)	R	19 (8)	25 (4)	21 (3)	21 (6)	22 (6)	25 (4)	13 (3)	22 (8)	26 (2)	22 (6)	**22 (6)**
Number of fruits available Median (IQR)	U	25 (5)	25 (5)	24 (6)	21 (8)	25 (4)	26 (5)	20 (6)	25 (8)	28 (2)	25 (3)	**25 (5)**
	R	22 (10)	25 (3)	21 (3)	22 (4)	23 (6)	26 (5)	13 (2)	27 (12)	26 (2)	25 (6)	**23 (7)**
Number of vegetables available	U	32 (8)	29 (9)	24 (11)	26 (8)	31 (5)	30 (6)	24 (8)	25 (6)	27 (4)	30 (8)	**30 (7)**
Mean (SD)	R	26 (11)	30 (4)	24 (5)	24 (6)	28 (7)	30 (5)	20 (3)	23 (9)	28 (5)	24 (7)	**27 (7)**
Number of vegetables available	U	34 (4)	32 (7)	27 (13)	29 (8)	32 (4)	32 (6)	25 (6)	26 (7)	28 (4)	32 (6)	**32 (6)**
Median (IQR)	R	31 (14)	30 (5)	25 (7)	26 (8)	29 (7)	31 (6)	20 (3)	25 (10)	28 (4)	24 (6)	**28 (10)**
Price of groceries $												
Nutritious food basket[a]	U	69.71 (7.96)	65.22 (9.05)	64.00 (9.27)	66.30 (7.55)	62.45 (9.50)	66.91 (6.86)	91.40 (1.82)	76.09 (6.78)	82.38 (4.08)	80.40 (6.87)	**66.17 (9.47)**
Mean (SD)	R	75.80 (4.87)	64.76 (8.56)	68.06 (2.83)	70.38 (8.89)	69.59 (7.51)	67.38 (6.48)	90.85 (7.15)	78.47 (6.27)	79.15 (7.91)	82.09 (2.27)	**70.73 (9.14)**
Junk food combination items[b]	U	1.88 (0.42)	1.49 (0.35)	2.15 (0.49)	1.48 (0.28)	1.56 (0.54)	2.52 (0.52)	1.72 (0.31)	2.22 (0.92)	2.45 (1.03)	2.65 (0.23)	**1.91 (0.67)**
Mean (SD)	R	2.04 (0.46)	1.38 (0.31)	2.08 (0.32)	1.55 (0.30)	2.28 (0.67)	2.64 (0.50)	1.90 (0.49)	2.89 (0.58)	2.71 (0.29)	2.85 (0.44)	**2.23 (0.68)**
Total food basket[c]	U	71.52 (8.03)	66.66 (9.36)	67.81 (6.66)	67.76 (7.66)	63.90 (9.66)	69.24 (7.10)	92.65 (1.34)	78.20 (6.95)	84.83 (5.08)	83.02 (6.97)	**68.01 (9.67)**
Mean (SD)	R	77.63 (4.93)	66.19 (8.76)	70.13 (2.88)	71.85 (9.15)	71.77 (8.04)	70.01 (6.77)	91.48 (6.96)	81.55 (6.14)	81.85 (8.19)	84.82 (1.66)	**72.81 (9.18)**
Purchasing Power[d]	U	4.9 (1.0)	3.9 (1.8)	4.0 (0.8)	4.6 (1.3)	4.5 (2.1)	5.3 (1.2)	7.0 (2.5)	7.0 (4.3)	6.0 (0.9)	4.9 (1.9)	**4.8 (2.0)**
Mean (SD)	R	5.9 (1.0)	4.3 (1.2)	5.4 (0.6)	5.8 (1.3)	5.0 (0.9)	6.0 (0.8)	8.4 (0.9)	7.5 (1.1)	6.4 (0.5)	7.9 (5.3)	**5.8 (1.7)**
Advertisements												
Junk food	U	111 (75.0)	96 (82.1)	13 (39.4)	3 (7.9)	335 (88.6)	259 (88.1)	21 (100.0)	18 (31.0)	2 (50.0)	12 (70.6)	**870 (78.5)**
N (%)	R	15 (55.6)	25 (89.3)	5 (38.5)	0 (0.0)	43 (93.5)	60 (93.8)	33 (100.0)	3 (17.6)	0 (0.0)	4 (23.5)	**188 (71.5)**
Sweet drink	U	109 (73.2)	98 (83.8)	5 (15.2)	3 (7.9)	300 (79.2)	263 (89.5)	21 (100.0)	10 (17.2)	0 (0.0)	13 (76.5)	**822 (74.1)**
N (%)	R	17 (63.0)	24 (85.7)	4 (30.8)	0 (0.0)	44 (95.7)	58 (90.6)	33 (100.0)	3 (17.6)	0 (0.0)	9 (52.9)	**192 (73.0)**
Fruits or Vegetables	U	26 (17.4)	96 (80.0)	2 (6.1)	2 (5.3)	240 (63.5)	227 (77.2)	21 (100.0)	26 (44.8)	4 (100.0)	10 (62.5)	**654 (58.9)**
N (%)	R	9 (33.3)	18 (64.3)	1 (7.7)	1 (6.3)	29 (63.0)	56 (87.5)	32 (97.0)	7 (41.2)	1 (50.0)	5 (29.4)	**159 (60.5)**
Cigarettes or tobacco	U	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.3)	12 (4.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	**13 (1.2)**
N (%)	R	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	6 (9.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	**6 (2.3)**
Alcohol	U	0 (0.0)	1 (0.8)	0 (0.0)	1 (2.7)	22 (5.9)	236 (80.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	**260 (23.5)**
N (%)	R	0 (0.0)	0 (0.0)	1 (7.7)	0 (0.0)	1 (2.2)	58 (90.6)	0 (0.0)	0 (0.0)	0 (0.0)	3 (17.6)	**63 (24.0)**

[a]The nutritious food basket consists of 15 food items (2% milk, eggs, chicken drumsticks, pork loin chops, carrots, lettuce, apples, bananas, grapes, oranges, pears, tomatoes, white bread, white rice, brown rice) that correspond to a food item in the Ontario Nutritious Food Basket.
[b]The junk food combination consists of two items: a can of cola, and a chocolate bar
[c]The total food basket consists of the health food basket and the junk food combination items.
[d]Purchasing power is the percent of the community's median household income that would be spent purchasing the items of the total food basket each week.

Table 4. Alcohol store characteristics. (U = urban; R = rural). BC = British Columbia; *AB* = Alberta; SK = Saskatchwean; MB = Manitoba; ON = Ontario; QC = Quebec; NB = New Brunswick; NS = Nova Scotia; PE = Prince Edward Island; NL = Newfoundland and Labrador CAN = Canada.

Alcohol		BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	CAN
Number of Communities with	U	140 (67.3)	127 (79.9)	27 (65.9)	27 (48.2)	365 (56.9)	332 (73.8)	29 (43.9)	50 (61.7)	3 (42.9)	17 (77.3)	**1117 (64.5)**
Alcohol Stores N (%)	R	22 (73.3)	27 (71.1)	13 (81.3)	14 (66.7)	47 (85.5)	64 (95.5)	38 (54.3)	16 (72.7)	2 (100.0)	21 (95.5)	**264 (77.0)**
Price of Wine $	U	13.41 (3.91)	12.18 (3.14)	10.98 (2.68)	10.56 (1.75)	10.97 (3.08)	9.80 (1.88)	11.09 (0.67)	12.85 (1.70)	13.99 (0.00)	14.42 (1.89)	**11.20 (3.03)**
750 mL Mean (SD)	R	12.41 (3.90)	12.47 (2.76)	12.54 (3.69)	10.92 (2.34)	9.90 (2.36)	9.47 (1.35)	11.19 (0.79)	12.55 (0.17)	13.99 (0.00)	12.81 (1.47)	**11.06 (2.50)**
Price of Beer $	U	37.64 (4.97)	46.06 (7.02)	42.93 (6.87)	40.41 (0.51)	40.40 (4.49)	19.55 (8.67)	26.65 (5.28)	44.49 (3.71)	42.99 (0.01)	53.22 (4.04)	**34.13 (12.43)**
24 cans Mean (SD)	R	35.40 (6.41)	49.32 (7.30)	44.99 (3.04)	40.27 (0.15)	38.84 (2.56)	15.65 (4.82)	25.22 (2.92)	45.08 (1.19)	42.98 (0.00)	47.65 (9.50)	**33.26 (13.42)**

northern and southern communities. The price of a case of 24-beer and 750-mL bottle of wine are, on average, lower in northern than in southern communities. However, when both price and latitude were measured as continuous variables in the regression model, moving from north to south the prices of a 24-case of beer (−$1.69 per 200 km [95% CI: −2.10 to −1.28]; $p < 0.0001$) and 750-mL bottle of wine (-$0.35 per 200 km [95% CI: −0.45 to −0.25]; $p < 0.0001$) both decreased (Table S10). Moving from west to east the prices of a 24-case of beer (−$3.15 per 800 km; 95% CI: −3.59 to −2.71) and 750-mL of wine (−$0.59 per 800 km; 95% CI: −0.69 to −0.48) both decreased. **Table S9** presents comparisons between northern and southern communities by province. Table S11 presents continuous regression models by latitude and Table S12 presents continuous regression models by longitude.

Restaurant assessments

Out of the 2074 communities, 72.3% contain a family restaurant, as defined for our audits. Rural communities are more likely to have a restaurant within the community boundary than urban communities (79.0% vs. 71.1%). Canada-wide, 9.1% of restaurants had at least 1 menu item that carried a major health claim (Table 5). The most common was 'low-calorie' (11.5%), followed by 'low-fat' (7.0%), and 'low-sodium' (4.9%). A total of 23.4% of restaurants had nutrition information available, either on-site or via web link, and 24.2% (including 24.6% of 224 restaurants audited before 17 June 2014, the end-date of the program (Macdonald and Weeeks 2014)) had at least 1 item with the Heart and Stroke Foundation's 'health check'. Only 4.4% of restaurants across the country had a smoking section, all of which were in Quebec (63 out of 383 restaurants; 16.5%).

Urban restaurants and rural restaurants are similarly likely to provide at least 1 item with a major health claim (12.4% vs. 12.9%), with no urban-rural difference in the frequency of low-calorie items (Table 5). Low-fat (7.8% vs. 3.3%) and low-sodium (5.8% vs. 1.1%) items were observed more often in urban than in rural restaurants. Urban restaurants are also more likely to have nutrition information available than rural restaurants (24.6% vs. 17.8%). There is no difference in the frequency of presence of smoking sections between urban and rural restaurants in Quebec.

Southern restaurants are also more likely to highlight low-sodium, low-calorie, and low-fat options, and more likely to have nutrition information available. The odds of a restaurant offering at least one low-fat option (OR = 0.88, 95% CI: 0.78 to 0.998; $p = 0.047$) or a health-check item (OR = 0.90, 95% CI: 0.83 to 0.98; $p = 0.011$) decrease with each 800 km moved from

west to east. The odds of a restaurant having nutritional information available increase with each 800 km moved from west to east (OR = 1.12, 95% CI: 1.04 to 1.21; $p < 0.004$) (Table S10, S11). There is no clear evidence that moving from south to north results in a difference in restaurant options. **Table S10** presents comparisons between northern and southern communities by province. Table S11 presents continuous regression models by latitude and Table S12 presents continuous regression models by longitude.

Reliability of audits

For 209 repeated audits, both audits agreed with respect to the presence or absence of an auditable store between 86.8% (grocery stores) and 91.6% (tobacco store) of the time. The overall intra-rater reliability of the audits (i.e. when the same auditor surveyed the same location on two separate occasions an average of 43 days apart) was 0.90 (0.88 to 0.92) (0.92 for tobacco stores; 0.90 for grocery stores; 0.84 for alcohol stores; and 0.84 for restaurants). In addition, 64% of domains had excellent, 28% had fair to good, and 11% had low intra-rater reliability. The inter-rater reliability (i.e. when two different auditors surveyed the same location on two separate occasions an average of 290 days apart) was 0.43 (0.39 to 0.47) with 11% of domains having excellent inter-rater reliability; 36% fair to good; and 52% poor (**Tables S15** and **S16**). The most reliable items were those that could be objectively counted or measured (e.g. presence or absence, number of advertisements or warnings, and distances). The least reliable items were those which could be truly expected to vary over time (e.g. prices of fruits and vegetables, the number of damaged fruits, restaurant menu items) or were dependent on a shopkeeper's response (e.g. number of cigarette brands sold). A summary of feedback provided by our auditors appears as Appendix 4 within the Supplementary material.

On-line map

The results of the CAHHM community audits are displayed as an on-line map, which is available at: http://cvcdcontextual.mcmaster.ca for public use (Figures 3 and 4; for documentation, refer to **the accompanying paper**). Here, interested users can view contextual factors assessments for any audited community (or postal code), with the ability to compare with nearby communities, and with other communities in the province, and country averages.

Discussion

The CAHHM cohort study seeks to understand the individual and contextual origins of CVD risk and

Table 5. Restaurant characteristics. (U = urban; R = rural). BC = British Columbia; AB = Alberta; SK = Saskatchewan; MB = Manitoba; ON = Ontario; QC = Quebec; NB = New Brunswick; NS = Nova Scotia; PE = Prince Edward Island; NL = Newfoundland and Labrador CAN = Canada.

Restaurant		BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	CAN
Number of Communities with family Restaurants	U	161 (77.4)	126 (79.2)	32 (78.0)	24 (42.9)	445 (69.4)	321 (71.3)	36 (54.5)	65 (80.2)	4 (57.1)	16 (72.7)	**1230 (71.1)**
N (%)	R	23 (76.7)	28 (73.7)	11 (68.8)	12 (57.1)	45 (81.8)	63 (94.0)	46 (65.7)	19 (86.4)	2 (100.0)	22 (100.0)	**271 (79.0)**
Nutritional Information Available	U	31 (19.3)	49 (38.9)	16 (50.0)	12 (50.0)	103 (23.2)	58 (18.2)	8 (22.2)	16 (25.0)	2 (50.0)	6 (37.5)	**301 (24.6)**
N (%)	R	1 (4.3)	14 (50.0)	2 (18.2)	1 (8.3)	6 (13.3)	6 (9.5)	7 (15.2)	5 (26.3)	1 (50.0)	5 (23.8)	**48 (17.8)**
Health-Check Available	U	19 (11.8)	33 (26.2)	14 (43.8)	12 (50.0)	90 (20.3)	93 (29.2)	10 (27.8)	16 (24.6)	2 (50.0)	9 (56.3)	**298 (24.3)**
N (%)	R	1 (4.3)	13 (46.4)	2 (18.2)	1 (8.3)	8 (17.8)	12 (19.0)	8 (17.4)	6 (31.6)	1 (50.0)	11 (50.0)	**63 (23.2)**
Smoking permitted in Restaurant	U	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	49 (15.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	**50 (4.1)**
N (%)	R	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	14 (22.2)	0 (0.0)	1 (5.3)	0 (0.0)	0 (0.0)	**15 (5.5)**
Healthy Options												
Low Sodium	U	13 (8.1)	0 (0.0)	13 (40.6)	0 (0.0)	40 (9.0)	1 (0.3)	0 (0.0)	0 (0.0)	0 (0.0)	4 (25.0)	**71 (5.8)**
N (%)	R	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (13.6)	**3 (1.1)**
Low Calorie	U	14 (8.7)	8 (6.3)	13 (40.6)	12 (50.0)	58 (13.0)	4 (1.2)	5 (13.9)	15 (23.1)	2 (50.0)	8 (50.0)	**139 (11.3)**
N (%)	R	0 (0.0)	6 (21.4)	1 (9.1)	1 (8.3)	5 (11.1)	0 (0.0)	6 (13.0)	3 (15.8)	1 (50.0)	10 (45.5)	**33 (12.2)**
Low Fat	U	15 (9.3)	3 (2.4)	13 (40.6)	5 (20.8)	50 (11.2)	2 (0.6)	0 (0.0)	1 (1.5)	0 (0.0)	7 (43.8)	**96 (7.8)**
N (%)	R	0 (0.0)	2 (7.1)	1 (9.1)	0 (0.0)	1 (2.2)	1 (1.6)	0 (0.0)	0 (0.0)	0 (0.0)	4 (18.2)	**9 (3.3)**

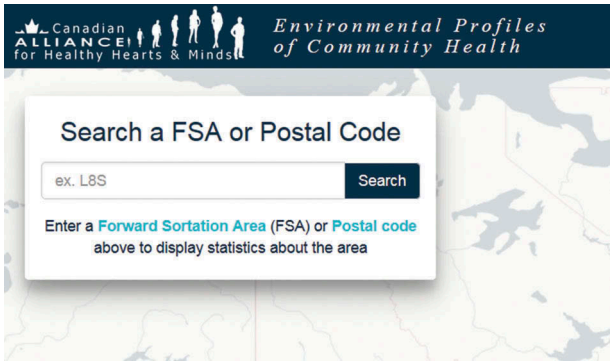

Figure 3. On-line map landing screen. We have created an on-line, interactive map to display the community audits for public use. For more information, please see the accompanying paper (de Souza et al., xxx; http://cvcdcontextual.mcmaster.ca/).

will aid in the design of effective policy and health interventions aimed at reducing population levels of risk factors in Canada. We objectively assessed multiple domains of the built environment of >2000 neighborhoods in Canada with a valid and reliable instrument and identified several important differences across Canadian communities that have important policy implications.

The main findings of our study are: i) provincial and urban-rural differences exist in availability of fruits and vegetables, and advertising differs between provinces more so than between urban and rural communities; ii) rural communities face higher food prices, are subject to more seasonal variation in fruit and vegetable selection, and generally see less promotion of healthy restaurant options and availability of nutritional information at restaurants than urban communities; iii) in-store advertising for sweet drinks and junk food are more frequent than in-store advertisements for tobacco products; iv) cigarette prices are lower and the variety of brands is greater in urban than in rural tobacco stores; and are lowest in central Canada, where there is both more in-store advertising for cigarettes and signage prohibiting smoking in stores; and v) alcohol prices are lowest in Quebec.

Consistency with previous research

Access to healthful and affordable food from neighbourhood retail food sources support individuals' ability to adopt a healthful diet (Kirkpatrick and Tarasuk 2003, Afshin *et al.* 2017, Ferdinand *et al.* 2017, Pearson-Stuttard *et al.* 2017a, Li *et al.* 2018). Our study finds several notable regional differences in food availability and accessibility. On average, 25 fruits and 31 vegetables were available in grocery stores. This is consistent with the findings of the PURE study of other high-income countries using a similar instrument, and higher than estimates from upper-middle, lower-middle, and low-income countries (Miller *et al.* 2016). Like PURE, we found lower availability of fruits and vegetables in rural communities (Miller *et al.* 2016). Urban areas were less subject to seasonal trends in variety than rural areas. Despite this variation across geography, 9 varieties of fruits and 11 varieties of vegetables were ubiquitously available (approaching or exceeding 90%) across seasons and locations. Availability tended to vary most for fruits and vegetables that were less commonly available overall (i.e. in <50% of stores). Further, seasonal variation in availability may be

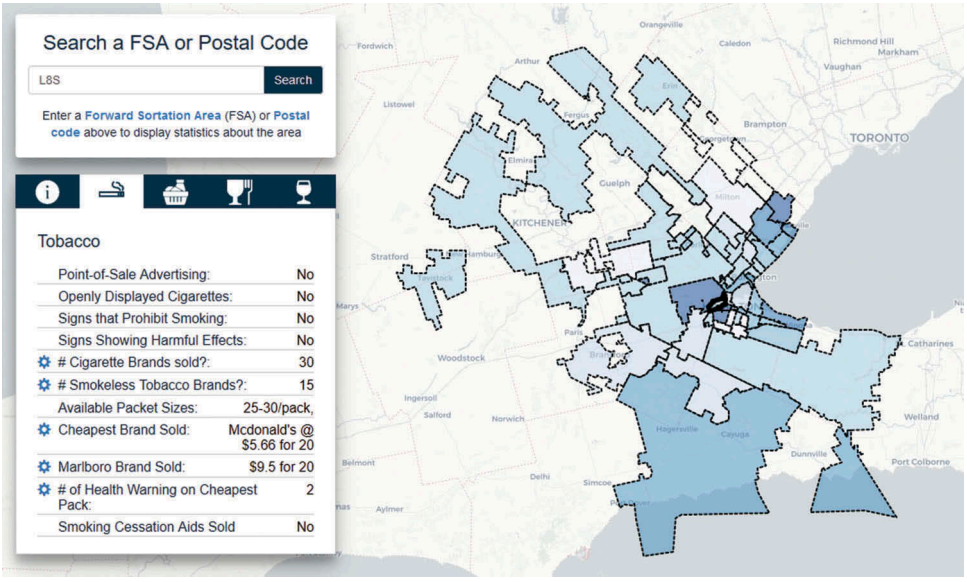

Figure 4. On-line map comparison feature. Display of a comparison of cigarette prices between a selected FSA with nearby communities. Darker shades represent the highest prices, lighter shades the lowest. White areas represent areas with no data (i.e. no tobacco store in the community). For more information, please see the accompanying paper (de Souza et al., 2018). http://cvcdcontextual.mcmaster.ca/.

expected for items with defined growing seasons, such as corn or strawberries.

The perception and relative importance of different indicators of quality differs across countries and fruit varieties. (Galmarini *et al.* 2013) The most common fruit quality problems cited in a previous study conducted in Oman included 'fruit immaturity', 'bruising', 'rot/decay', and 'bad taste' (Opara *et al.* 2007). In this study, 40% of those surveyed were willing to pay up to 25% more for good quality fruit (Opara *et al.* 2007). However, slight imperfections in the shapes of fruit and vegetables typically do not influence their nutritional content or taste; thus offering 'imperfect' fruits and vegetables for sale at a reduced price may reduce barriers to consumption. (Willimot 2016) In our study, poor quality fruit was seen in about 1 in 3 stores, and rural stores were no more likely to have >3 types of fruits that appeared damaged (our indicator of poor quality) than urban stores (32.0% vs. 28.6%; $p > 0.26$).

Good local availability of fruits and vegetables seem to be positively related to intake, although evidence is limited. (Kamphuis *et al.* 2006) In a previous study from Montreal, Canada (Mercille *et al.* 2012) the percentage of stores that sold healthful foods (i.e. grocery stores/supermarkets, fruit and vegetable stores, and specialty food stores/all food stores including convenience stores) was associated with lower western (unhealthy) diet scores (standardized $\beta = -0.124$; $p < 0.01$), but this did not hold after adjustment for residential neighborhood characteristics—income, language fluency, and education. In a previous study in the same location, distributions of healthful food stores were correlated with the sociodemographic characteristics of the population in the participants' neighborhood (Mercille *et al.* 2013), which underlies the complexity of linking food availability with consumption. Mediation analyses could determine whether area-level composition might fully or partially explain the relationship between the food store environment and diet.

In PURE, increased costs of fruits and vegetables relative to household income were associated with reduced consumption (Miller *et al.* 2016). Higher fruit, vegetable, and legume consumption was associated with a lower risk of non-cardiovascular and total mortality, with the greatest benefits seen for both non-cardiovascular mortality and total mortality at 3–4 servings/d (375–500 g/d). (Miller *et al.* 2017) A large simulation study in the United states finds that a 10% national fruit and vegetable subsidy may result in up to 150,000 CVD deaths prevented or postponed by 2030 (Pearson-Stuttard *et al.* 2017b); and a 30% price decrease would increase fruits and vegetable consumption by 42% and prevent or postpone up to 450,000 CVD deaths (Pearson-Stuttard *et al.* 2017a).

Food prices were generally higher in eastern Canada than in central Canada. This is consistent with more rural communities existing in eastern Canada. These findings reflect the 2016 consumer price index of food (base 1986) which shows food is 4.9% higher than the Canadian average in eastern provinces, 0.5% higher in central provinces, and 1.0% lower in western provinces. (Statistics Canada 2017) These differences likely reflect differences in the underlying structure of the consumer markets between provinces (e.g. household income levels), government regulations that aim to protect local producers (e.g. dairy farmers), the relatively smaller size of the east coast markets, shipping/transportation costs which vary according to distance and fuel prices, the types and rates of grocery store expansions across provinces, and global agricultural production. Our finding that in addition to fruits and vegetables, foods in general tended to be more expensive in rural than in urban neighborhoods may translate into rural households spending an additional $249 per year on these food items compared with urban households. We were unable to adjust this value for household size, as these data were only available at the aggregate level for the communities. It is reasonable to hypothesize that lower access to and higher price of healthy foods in rural regions is associated with lower diet quality, which may contribute to the worse health outcomes experienced in rural than urban Canada. (Kondro 2006, Pong *et al.* 2009)

Urban restaurants are more likely to promote healthy options and provide nutritional information than rural restaurants. Few studies have directly measured the consumer nutrition environment within food outlets. Most have been cross-sectional and examined the number per capita, proximity, or density of food outlets indirectly identified through large databases (Holsten 2009). In surveys, most restaurant owners want their restaurant to be viewed as a place where customers can find healthy options (Benson 1995, Macaskill *et al.* 2003). Nutrition care providers often provide clients with strategies to improve food choices when eating in restaurants, such as choosing smaller portions or splitting entrees, declining higher fat extras such as cheese or bacon, and selecting broiled or baked meats instead of breaded or fried versions. Whether increased availability and promotion of healthier restaurant options results in desired behavior changes is not established (Green *et al.* 1993, Fitzgerald *et al.* 2004, Chu *et al.* 2009). However, differential availability of nutritional information or promotion of healthy options may make this advice harder to follow for rural than urban clients.

Restaurant smoking sections are almost exclusively seen in the province of Quebec. Smoking is prohibited in restaurants and restaurant patios in Manitoba,

Saskatchewan, Newfoundland and Labrador, Nova Scotia, New Brunswick, British Columbia, and Ontario (in some cities, smoking rooms are permitted in restaurants), and allowed in special rooms or sections in Prince Edward Island (but food cannot be served in these rooms) and Alberta (where those <18 years old are not permitted). In Quebec, smoking is prohibited inside restaurants but was allowed on restaurant patios, through 26 May 2016, when all commercial patios became smoke-free. Strong local restaurant smoking regulations are associated with reduced environmental tobacco smoke exposure among youth (Siegel *et al.* 2004), and in the 25-year follow-up of the Coronary Artery Risk Development in Young Adults (CARDIA) study, smoking bans in bars and restaurants were associated with reduced rates of current smoking and smoking intensity, and an increased likelihood of a quitting attempt. (Mayne *et al.* 2018)

Our cigarette price per-pack data are consistent with the findings of the non-smokers' rights association, which find carton prices lowest in the 'urban' provinces of Quebec, Ontario, Alberta, and BC; and higher in 'rural' provinces Saskatchewan, Manitoba, and the Maritime provinces (Smoking and Health Action Foundation 2017). An International Agency for Research on Cancer (IARC) report concluded that there was a causal relationship between increasing taxes and reducing tobacco use among adults and young people and that such taxes have a larger impact with lower income populations. However, for most Canadians, especially those living in the most populated provinces (e.g. Ontario and Quebec), tobacco taxes are too low to impact smoking behavior throughout the population, though some groups (e.g. youth and low-income individuals) may be more affected than others. (Azagba and Sharaf 2011, Manivong *et al.* 2017) Tobacco advertising was rarely seen, as most provinces have banned retail advertisements, but in Alberta, cigarette manufacturers are allowed to advertise in adult-only locations but cannot create ads that can be 'construed' as appealing to youths. (International Tobacco Control Policy Evaluation Project 2017) As of 1 July 2008, Alberta implemented a tobacco display ban (or 'power wall') law requiring shop owners to keep tobacco sales out of sight.

Lower alcohol prices in central Canada are largely influenced by policy, as the province of Quebec levies a lower provincial tax on alcohol (6.5%) compared with Ontario (13%). Additional important differences in alcohol distribution practices between provinces likely affect prices. In Ontario, the Beer Store conducts >80% of beer sales in the province (Morrow 2015); in Quebec, sales of specific types of alcoholic beverages, including beer and wine, are through *depanneurs* (convenience stores) and grocery stores. Ontario has winery-owned wine stores, as well as Liquor Control Board of Ontario (LCBO) locations. In 2016, after our audits had been completed, beer, cider, and wine were eligible to be sold in over 450 grocery stores in Ontario (Ministry of Finance 2017). Differences in prices and accessibility may influence consumption (Chaloupka *et al.* 2002, Jiang and Livingston 2015, Sherk *et al.* 2018), particularly among youth and young adults (Jiang and Livingston 2015). Increases in the total price of alcohol can lower the frequency of diseases, injuries, and deaths related to alcohol use and abuse; and reduce alcohol-related violence and other crime (Chaloupka *et al.* 2002).

Implications for policy and practice

The information gathered through our study can be used to foster collaboration between public health and built environment professionals, and legislators around the common aim of improving community health (Pilkington *et al.* 2008). Strategic environmental assessments, sustainability appraisals, and health impact assessments provide a new imperative for planners and public health professionals to work in collaboration. Planners have expertise in the use of these tools, and public health professionals possess knowledge of the wider determinants of health, health needs assessment, setting objectives for health, and monitoring and interpreting health information (Rao *et al.* 2007). Careful urban design can encourage sustainable and health-promoting modes of travel, through providing safe routes to schools and work, or space for community gardens. Examples of such collaborations to bring regional public health and built environment professionals together include the South West Public Health Teaching Network (Bristol, UK), the Harlem Children's Zone Project (Harlem, U.S.A.), and the AFOOT project (Germany) (Northridge *et al.* 2002, Pilkington *et al.* 2008, Brüchert *et al.* 2017).

The Global Burden of Disease (GBD) study estimates the total worldwide mortality currently attributable to inadequate consumption of fruit and vegetables at up to 2.6 million deaths per year. Increasing individual fruit and vegetable consumption to up to 600 g per day could reduce the total worldwide burden of disease by 1.8%, and the burden of ischaemic heart disease by 31% and ischaemic stroke by 19%. (Lock *et al.* 2005) Policies that reduce and stabilize the prices of fruits and vegetables across rural and urban communities are likely to increase purchase and consumption. Several examples in the literature have shown that reducing the prices of healthy foods is likely to increase consumption (Afshin *et al.* 2017, Cobiac *et al.* 2017, Ferdinand *et al.* 2017, Pearson-Stuttard *et al.* 2017a, Li *et al.* 2018). When the primary grocery stores in four Kentucky

counties (two rural, two urban) were surveyed over a 10-month period, more nutritious food items were less expensive in urban areas. (Hardin-Fanning and Rayens 2015) However, addressing the differences in food prices and availability between urban and rural communities in Canada requires a multi-factorial solution that addresses several challenges, including the lack of population density (i.e. less demand), and greater isolation, longer distances to travel under poor road conditions, a lack of storage and/or processing facilities. The influence of nutrition labeling and calorie information in restaurants on purchasing behavior will be an important area of future study. There is limited evidence that menu labeling affects calories purchased at fast-food restaurants, but some evidence that it lowers calories purchased at certain types of restaurants and in cafeteria settings (Bleich *et al.* 2017).

There is consensus among public health experts that reducing the influence of advertising is an important step in reducing obesity, most specifically, childhood obesity (Raine *et al.* 2013). While the public health threat posed by tobacco is reflected in stringently regulated tobacco advertising in Canada (CBC News 2011, International Tobacco Control Policy Evaluation Project 2017), an enforceable federal strategy for food advertising has been lacking in Canada. Several jurisdictions have introduced legislation to ban or restrict the manner in which processed foods can be advertised (Anonymous 2007, Oommen and Anderson 2008, Monteiro 2009). These appear to have had only a modest impact on marketing practices (Hawkes 2004). In 2017, Health Canada outlined a new Healthy Eating Strategy to 'support Canadians to make healthier choices by improving the food environment through several linked and complementary initiatives'; part of this strategy includes restricting marketing of unhealthy food and beverages to children (Government of Canada 2017). The Heart and Stroke Foundation of Canada has also recommended restricting marketing of all foods and beverages to children, and adopting a tax on beverages high in free sugars (i.e. sugar-sweetened beverages) (Heart & Stroke Foundation 2017).

In 2015, 11.5% of global deaths (6.4 million) were attributable to smoking worldwide, 52.2% of which were in four countries (China, India, the U.S., and Russia). Smoking was among the five leading risk factors by disability-adjusted life years (DALYs) in 109 countries and territories in 2015, rising from 88 geographies in 1990 (G. B. D. Tobacco Collaborators 2017). Higher prices of cigarettes are likely to be an effective strategy to prevent new smokers and increase cessation in existing smokers. Globally, cigarette smokers are price-sensitive and seek out measures to purchase less expensive cigarettes, which may decrease future cessation efforts (Hyland *et al.* 2005), and lower levels of attempting to quit smoking were observed among purchasers of low-priced (or untaxed) cigarettes compared to purchasers of full-priced cigarettes (Hyland *et al.* 2006). In a Canadian cohort of 51 high schools in 2004 and 2007, higher cigarette prices were predictive of lower smoking rates (Lovato *et al.* 2013).

Alcohol use is a leading risk factor for death and disability but its overall association with health remains complex given the possible protective effects of moderate alcohol consumption on some conditions. Globally, alcohol use was the seventh leading risk factor for both deaths and DALYs in 2016, accounting for 2.2% of female deaths and 6.8% of male deaths, adjusted for age. Among those aged 15–49 years, alcohol use was the leading risk factor globally: 3.8% of female deaths and 12.2% of male deaths were attributable to alcohol use. In this age group, female attributable DALYs were 2.3% and male attributable DALYs were 8.9% (G. B. D. Alcohol Collaborators 2018). Higher alcohol prices may represent an effective strategy to deter teenage and young adult drinking but this has not been routinely implemented (Chaloupka *et al.* 2002). Increases in the purchase price of alcohol has been suggested as an effective deterrent to drinking and driving and its consequences among all age groups (Chaloupka *et al.* 1993), as well as a means to reduce violent incidents on college campuses (Grossman and Markowitz 2001).

Our data may be linked with population-based data on other exposures (e.g. eating patterns) and outcomes (e.g. disease rates), which we plan to do in future studies. Finally, we have partnered with The Canadian Urban Environmental Health Research Consortium (http://www.canue.ca) to help build capacity to study how these multiple environmental factors are linked to a wide range of health outcomes (Brook *et al.* 2018). This work will enable effective, evidence-based strategies for planning healthy cities and towns, today and in the future.

Strengths and limitations

Strengths of our study include complete coverage of over 2000 neighborhoods in Canada, the use of a standardized, multi-faceted, previously validated tool to assess multiple domains of the contextual environment. Limitations include the selection of a single retail location or major chain grocery store to represent an entire neighborhood, which may not be representative, especially in rural FSAs with larger areas, and variable access to stores (e.g. local non-chain grocery stores or farmers' markets may provide higher variety than chain stores, and several of these may be present in a large FSA);

lower instrument reliability than has previously been reported (Chow *et al.* 2010); and failure to capture several relevant contextual determinants of health, such as traffic, pollution, walkability, or greenspace. However, these may be obtained from other sources (e.g. CANUE (Brook *et al.* 2018)) and 'layered' on top of each community.

Conclusions

Key differences between urban and rural settings and across provinces exist with respect to several contextual determinants of health. Our study has collected extensive data on contextual factors that may influence chronic disease risk at the community level, and these data should be considered jointly by public health and built environment professionals, and government officials to develop unified federal and provincial strategies to reduce the burden of chronic diseases across Canada.

Acknowledgments

We acknowledge the dedication of our community auditors: Hannah Albani, Connor Arnott, Sukhmeet Bedi, Annie Bernatchez-Côté, Erin Bethune, Erica Corber, Veronica de Jong, Shira Gerstein, Neil Gandhi, Aditi Gupta, Vavandeep Kandola, Delia Lin, Lauren Lumsden, Matthew Madill, Adriana Maroleanu, Gift Madojemu, Crystal Narten, Sungpyo Park, Timothy Park, Anne-Marie Poirier, Tayler Poscai, Emma Price, Anjali Sergeant, and Geoffrey Thompson. We acknowledge Dr. Geoff Fong (University of Waterloo) for his assistance with the International Tobacco Control Policy Evaluation Project reports, and Sujane Kandasamy, M.Sc., for her assistance with preparing the 'City Know-how' summary. We thank the peer reviewers of this manuscript for their constructive suggestions.

Availability of data and material

An interactive map will be published on-line containing the data used to produce this paper. Requests for data can be addressed to Dr. Sonia S. Anand (anands@mcmaster.ca).

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors

R. J. de Souza is an Assistant Professor in the Department of Health Research Methods, Evidence, and Impact at McMaster University. He is a registered dietitian, and his research focuses on dietary patterns, health, and how the food environment shapes food choice and risk of cardiovascular disease.

Lise Gauvin is a principal scientist at Centre de recherche du Centre hospitalier de l'Université de Montréal . Her work focuses on how different neighbourhood characteristics can influence people's lifestyle choices, what neighbourhood features can become the target of public health interventions, and on how these interventions can successfully shape urban residential areas.

Natalie Williams is a data manager working with the Alliance for Healthy Hearts and Minds.

Scott Lear is a Professor in the Faculty of Health Sciences at Simon Fraser University and the inaugural Pfizer/Heart and Stroke Foundation Chair in Cardiovascular Prevention.

A. P. Oliveira does not wish to have is biography printed.

Dipika Desai is a senior project manager with the Alliance for Healthy Hearts and Minds.

Danel Corsi works with the OMNI Research Group at the Ottawa Hospital Research Institute.

S. V. Subramanian is a Professor of Population Health and Geography at Harvard University, and Director of a University-wide Initiative on Applied Quantitative Methods in Social Sciences.

Ayesha Rana was a M.Sc. student with Dr. Anand at the time of data collection and worked on developing and testing the audit plan. She is now a family medicine resident.

Rishi Arora is an undergraduate research student in the Faculty of Health Sciences, McMaster University.

Gillian Booth is an Endocrinologist and Scientist at the Li Ka Shing Knowledge Institute at St. Michael's Hospital, Toornto. She leads the the "Healthy Cities, Healthier Lives" Research Program.

Fahad Razak an Internist and Scientist at the Li Ka Shing Knowledge Institute at St. Michael's Hospital, Toornto. His research is focused on health interventions in low-income settings, and big data development and analytics.

Jeff Brook is the Principal Investigator and Scientific Director of the Canadian urban environmental health research consortium (CANUE). He has 25 years of experience as an Environment Canada scientist working at the science-policy interface.

Jack Tu was a senior scientist with the Institute for Clinical Evaluative Sciences in Torotno. He was an internationally recognized health services researcher, who published over 350 peer-reviewed journal articles.

Sonia S. Anand is a Professor Medicine and Epidemiology at McMaster University and a senior scientist at the Population Health Research Institute. Her research focuses on understanding the environmental and genetic causes of cardiovascular risk factors among women, and diverse ethnic groups, and clinical-population health interventions.

Ethics approval and consent to participate

The project has been approved by Hamilton Integrated Research Ethics Board: Project# 13–255. Some participating research centers also obtained secondary approval for data collection.

Funding

Canadian Partnership Against Cancer (CPAC), Heart and Stroke Foundation of Canada (HSF-Canada), Canadian Institutes of Health Research (CIHR) through the Canadian Urban Environmental Health Research Consortium (CANUE). Anand is supported by a Tier 1 Canada Research Chair in Ethnicity and Cardiovascular Disease and Heart and Stroke Foundation Chair in Population Health. Tu was supported by a Tier 1 Canada Research Chair in Health Services Research and an Eaton Scholar award. Lear is supported by a Pfizer/Heart and Stroke Foundation and a Chair in Cardiovascular Prevention Research at St. Paul's Hospital. Booth is supported by the Li Ka Shing Knowledge Institute of St Michael's Hospital and a Department of Medicine Merit Award at the University of Toronto; Heart and Stroke Foundation of Canada; Canadian Institutes of Health Research (CA); Canadian Institutes of Health Research (through CANUE); Canadian Partnership Against Cancer.

ORCID

R. J. de Souza http://orcid.org/0000-0001-8945-513X
S. S. Anand http://orcid.org/0000-0003-3692-7441

References

Afshin, A., *et al.*, 2017. The prospective impact of food pricing on improving dietary consumption: a systematic review and meta-analysis. *PLoS one*, 12 (3), e0172277. doi:10.1371/journal.pone.0172277.

Anand, S.S., *et al.*, 2016. Rationale, design, and methods for Canadian alliance for healthy hearts and minds cohort study (CAHHM) - a Pan Canadian cohort study. *BMC public health*, 16, 650. doi:10.1186/s12889-016-3310-8.

Anand, S.S., *et al.*, 2018. Canadian alliance for healthy hearts and minds: first nations cohort study rationale and design. *Progress in Community Health Partnerships*, 12 (1): 55-64. doi:10.1353/cpr.2018.0006.

Anonymous, 2007. Nutritional health warnings: just for show. *Prescrire international*, 16 (92), 261.

Azagba, S. and Sharaf, M., 2011. Cigarette taxes and smoking participation: evidence from recent tax increases in Canada. *International journal of environmental research and public health*, 8 (5), 1583–1600. doi:10.3390/ijerph8051583.

Benson, W., 1995. Strategies and willingness of rural restaurateurs to promote healthy foods. *Canadian journal of public health*, 86 (3), 181–184.

Bleich, S.N., *et al.*, 2017. A systematic review of calorie labeling and modified calorie labeling interventions: impact on consumer and restaurant behavior. *Obesity (Silver Spring, Md.)*, 25 (12), 2018–2044. doi:10.1002/oby.21940.

Brook, J.R., *et al.*, 2018. The Canadian Urban Environmental Health Research Consortium - a protocol for building a national environmental exposure data platform for integrated analyses of urban form and health. *BMC public health*, 18 (1), 114. [published Online First: 2018/01/10]. doi:10.1186/s12889-017-5001-5

Brüchert, T., *et al.*, 2017. Intersectoral collaboration of public health and urban planning for promotion of mobility and healthy ageing: protocol of the AFOOT project. *Cities & health*, 1 (1), 83–88. doi:10.1080/23748834.2017.1312086.

CBC News, 2011. *A legal history of smoking in Canada*. Availabe from: http://www.cbc.ca/news/health/a-legal-history-of-smoking-in-canada-1.982213 [Accessed 1 October 2017].

Chaloupka, F.J., Grossman, M., and Saffer, H., 2002. The effects of price on alcohol consumption and alcohol related problems. *Alcohol research and health*, 26 (1), 22–34.

Chaloupka, F.J., Saffer, H., and Grossman, M., 1993. Alcohol-control policies and moter-vehicle fatalities. *The journal of legal studies*, 22 (1), 161–186. doi:10.1086/468161.

Chow, C.K., *et al.*, 2009. Environmental and societal influences acting on cardiovascular risk factors and disease at a population level: a review. *International journal of epidemiology*, 38 (6), 1580–1594. doi:10.1093/ije/dyn258.

Chow, C.K., *et al.*, 2010. Environmental profile of a community's health (EPOCH): an instrument to measure environmental determinants of cardiovascular health in five countries. *PLoS one*, 5 (12), e14294. doi:10.1371/journal.pone.0014294.

Chu, Y.H., *et al.*, 2009. Improving patrons' meal selections through the use of point-of-selection nutrition labels. *American journal of public health*, 99 (11), 2001–2005. doi:10.2105/AJPH.2008.153205.

Cobiac, L.J., *et al.*, 2017. Taxes and subsidies for improving diet and population health in Australia: a cost-effectiveness modelling study. *PLoS medicine*, 14 (2), e1002232. doi:10.1371/journal.pmed.1002232.

Cunningham, G.O., *et al.*, 2005. Developing a reliable senior walking environmental assessment tool. *American journal of preventive medicine*, 29 (3), 215–217. doi:10.1016/j.amepre.2005.05.002.

Day, K., *et al.*, 2006. The Irvine-Minnesota inventory to measure built environments: development. *American journal of preventive medicine*, 30 (2), 144–152. doi:10.1016/j.amepre.2005.09.017.

de Souza, R.J., *et al.*, 2018. Development of an on-line interactive map to display environmental health assessments of Canadian communities: knowledge-translation to support collaborations for health. *Cities & health*, doi:10.1080/23748834.2018.1546560.

Ferdinand, R., *et al.*, 2017. Incentivizing fruit and vegetable purchasers at fresh markets in lower 9th Ward, New Orleans. *Ethnicity & disease*, 27 (Suppl 1), 287–294. doi:10.18865/ed.27.S1.287.

Fitzgerald, C.M., *et al.*, 2004. Effect of a promotional campaign on heart-healthy menu choices in community restaurants. *Journal of the American dietetic association*, 104 (3), 429–432. doi:10.1016/j.jada.2003.12.019.

G. B. D. Alcohol Collaborators, 2018. Alcohol use and burden for 195 countries and territories, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet*, 392 (10152), 1015–1035. [published Online First: 2018/08/28]. doi: 10.1016/S0140-6736(18)31310-2

G. B. D. Tobacco Collaborators, 2017. Smoking prevalence and attributable disease burden in 195 countries and territories, 1990–2015: a systematic analysis from the Global Burden of Disease Study 2015. *Lancet*, 389 (10082), 1885–1906. [published Online First: 2017/04/10]. doi: 10.1016/S0140-6736(17)30819-X

Galmarini, M.V., *et al.*, 2013. Understanding apple consumers' expectations in terms of likes and dislikes. Use of comment analysis in a cross-cultural study. *Appetite*, 62, 27–36. [published Online First: 2012/11/29]. doi:10.1016/j.appet.2012.11.006

Gasevic, D., *et al.*, 2011. A direct assessment of "obesogenic" built environments: challenges and recommendations. *Journal of environmental and public health*, 2011, 161574. doi:10.1155/2011/161574.

Glanz, K., *et al.*, 2007. Nutrition environment measures survey in stores (NEMS-S): development and evaluation. *American journal of preventive medicine*, 32 (4), 282–289. doi:10.1016/j.amepre.2006.12.019.

Government of Canada, 2017. *Health Canada's healthy eating strategy*. Ottawa, ON: Government of Canada. [updated 06 October 2017]. Available from: https://www.canada.ca/en/services/health/campaigns/vision-healthy-canada/healthy-eating.html [accessed 9 October 2017].

Green, K.L., *et al.*, 1993. Evaluation of the heart smart restaurant program in Saskatoon and Regina, Saskatchewan. *Canadian journal of public health*, 84 (6), 399–402.

Grossman, M. and Markowitz, S., 2001. Alcohol regulation and violence on college campuses. *In*: M. Grossman and C.R. Hsieh, eds. *Economic analysis of substance use and abuse: the experience of developed countries and lessons for developing countries*. Cheltenham, UK: Edward Elgar, 257–289.

Hardin-Fanning, F. and Rayens, M.K., 2015. Food cost disparities in rural communities. *Health promotion practice*, 16 (3), 383–391. [published Online First: 2014/10/12]. doi:10.1177/1524839914554454

Hawkes, C., 2004. *Marketing food to children: the global regulatory environment*. Geneva: World Health Organization.

Heart & Stroke Foundation, 2017. *Position statement: sugar, heart diseaes and stroke*. Available form: https://www.heartandstroke.ca/-/media/pdf-files/canada/2017-position-statements/sugar-ps-eng.ashx [Accessed 19 October 2017].

Holsten, J.E., 2009. Obesity and the community food environment: a systematic review. *Public health nutrition*, 12 (3), 397–405. [published Online First: 2008/05/15] doi:10.1017/S1368980008002267

Hyland, A., *et al.*, 2005. Higher cigarette prices influence cigarette purchase patterns. *Tobacco control*, 14 (2), 86–92. doi:10.1136/tc.2004.008730.

Hyland, A., *et al.*, 2006. Cigarette purchase patterns in four countries and the relationship with cessation: findings from the International Tobacco Control (ITC) four country survey. *Tobacco control*, 15 (Suppl 3), iii59–64. doi:10.1136/tc.2005.012203.

International Tobacco Control Policy Evaluation Project, 2017. ITC Country Tobacco Policy Report: Canada Tobacco Control Acts.

Jiang, H. and Livingston, M., 2015. The dynamic effects of changes in prices and affordability on alcohol consumption: an impulse response analysis. *Alcohol and alcoholism*, 50 (6), 631–638. doi:10.1093/alcalc/agv064.

Kamphuis, C.B., *et al.*, 2006. Environmental determinants of fruit and vegetable consumption among adults: a systematic review. *The British journal of nutrition*, 96 (4), 620–635. [[published Online First: 2006/10/03]].

Keys, A., *et al.*, 1984. The seven countries study: 2,289 deaths in 15 years. *Preventive medicine*, 13 (2), 141–154.

Kirkpatrick, S. and Tarasuk, V., 2003. The relationship between low income and household food expenditure patterns in Canada. *Public health nutrition*, 6 (6), 589–597. [published Online First: 2003/12/24].

Kondro, W., 2006. Health of rural Canadians lags behind urban counterparts. *CMAJ: Canadian Medical Association journal = journal de l'Association medicale canadienne*, 175 (10), 1195. [published Online First: 2006/11/14]. doi:10.1503/cmaj.061306

Li, Y., *et al.*, 2018. Assessing the role of access and price on the consumption of fruits and vegetables across New York City using agent-based modeling. *Preventive medicine*, 106, 73–78. doi:10.1016/j.ypmed.2017.10.014.

Lock, K., *et al.*, 2005. The global burden of disease attributable to low consumption of fruit and vegetables: implications for the global strategy on diet. *Bulletin of the World Health Organization*, 83 (2), 100–108. [published Online First: 2005/03/04].

Lovato, C., *et al.*, 2013. School and community predictors of smoking: a longitudinal study of Canadian high schools. *American journal of public health*, 103 (2), 362–368. doi:10.2105/AJPH.2012.300922.

Macaskill, L.A., *et al.*, 2003. Eat smart! Ontario's healthy restaurant program: a survey of participating restaurant operators. *Canadian journal of dietetic practice and research*, 64 (4), 202–207. doi:10.3148/64.4.2003.202.

Macdonald, G. and Weeeks, C., 2014. Heart and stroke foundation ends health check program. *The Globe and Mail*, 18 June.

Maclagan, L.C., *et al.*, 2014. The CANHEART health index: a tool for monitoring the cardiovascular health of the Canadian population. *CMAJ: Canadian Medical Association journal = journal de l'Association medicale canadienne*, 186 (3), 180–187. doi:10.1503/cmaj.131358.

Mailloux, Y., 2013. Toute la verite sur les vins vendu dans les epiceries et les depanneurs. *Huff Post Quebec*, 9 May. Available from: http://quebec.huffingtonpost.ca/yves-mailloux/verite-vins-vendus-epiceries-depanneurs_b_3857374.html [Accessed 9 October 2017].

Manivong, P., Harper, S., and Strumpf, E., 2017. The contribution of excise cigarette taxes on the decline in youth smoking in Canada during the time of the Federal Tobacco Control Strategy (2002–2012). *Canadian journal of public health*, 108 (2), e117–e23. doi:10.17269/cjph.108.5705.

Mayne, S.L., *et al.*, 2018. Associations of bar and restaurant smoking bans with smoking behavior in the CARDIA study: A 25-year study. *American journal of epidemiology*, 187 (6), 1250–1258. doi:10.1093/aje/kwx372.

Menotti, A., *et al.*, 2003. Twenty-five-year coronary mortality trends in the seven countries study using the accelerated failure time model. *European journal of epidemiology*, 18 (2), 113–122.

Mercille, G., *et al.*, 2012. Associations between residential food environment and dietary patterns in urban-dwelling older adults: results from the VoisiNuAge study. *Public health nutrition*, 15 (11), 2026–2039. doi:10.1017/S136898001200273X.

Mercille, G., *et al.*, 2013. Comparison of two indices of availability of fruits/vegetable and fast food outlets. *Journal of urban health : bulletin of the New York academy of medicine*, 90 (2), 240–245. [published Online First: 2012/06/28]. doi:10.1007/s11524-012-9722-6

Miller, V., *et al.*, 2016. Availability, affordability, and consumption of fruits and vegetables in 18 countries across income levels: findings from the Prospective Urban Rural Epidemiology (PURE) study. *The lancet global health*, 4 (10), e695–e703. doi:10.1016/S2214-109X(16)30186-3.

Miller, V., *et al.*, 2017. Fruit, vegetable, and legume intake, and cardiovascular disease and deaths in 18 countries (PURE): a prospective cohort study. *Lancet*, 390 (10107), 2037–2049. [published Online First: 2017/09/03]. doi:10.1016/S0140-6736(17)32253-5

Ministry of Finance, 2017. *Beer, wine and cider sales in grocery stores: queen's printer for Ontario*. Available from: https://www.ontario.ca/page/beer-wine-cider-sales-grocery-stores [Accessed 9 September 2017].

Monteiro, C.A., 2009. Nutrition and health. The issue is not food, nor nutrients, so much as processing. *Public health nutrition*, 12 (5), 729–731. doi:10.1017/S1368980009005291.

Morrow, A., 2015. The beer store: everything you need to know about Ontario's lucrative monopoly. *The Globe and Mail*, 3 March.

Northridge, M.E., *et al*., 2002. Advancing population health in the Harlem Children's Zone Project. *Sozial- und Praventivmedizin*, 47 (4), 201–202. [published Online First: 2002/11/06].

Oommen, V.G. and Anderson, P.J., 2008. Policies on restriction of food advertising during children's television viewing times: an international perspective. *In*: *Australian College of Health Service Executives 2008 QLD State Conference*, 29–30 May, Gold Coast, Australia.

Opara, L.U., Al-Said, F.A., and Al-Abri, A., 2007. Assessment of what the consumer values in fresh fruit quality: case study of Oman. *New Zealand journal of crop and horticultural science*, 35, 235–243. doi:10.1080/01140670709510190

Pearson-Stuttard, J., *et al*., 2017a. Comparing effectiveness of mass media campaigns with price reductions targeting fruit and vegetable intake on US cardiovascular disease mortality and race disparities. *The American journal of clinical nutrition*, 106 (1), 199–206. doi:10.3945/ajcn.116.143925.

Pearson-Stuttard, J., *et al*., 2017b. Reducing US cardiovascular disease burden and disparities through national and targeted dietary policies: A modelling study. *PLoS medicine*, 14 (6), e1002311. [published Online First: 2017/06/07]. doi:10.1371/journal.pmed.1002311

Pikora, T.J., *et al*., 2006. Neighborhood environmental factors correlated with walking near home: using SPACES. *Medicine and science in sports and exercise*, 38 (4), 708–714. doi:10.1249/01.mss.0000210189.64458.f3.

Pilkington, P., Grant, M., and Orme, J., 2008. Promoting integration of the health and built environment agendas through a workforce development initiative. *Public health*, 122 (6), 545–551. [published Online First: 2008/05/09]. doi:10.1016/j.puhe.2008.03.004

Pomerleau, J., *et al*., 2013. Measuring the food and built environments in urban centres: reliability and validity of the EURO-PREVOB community questionnaire. *Public health*, 127 (3), 259–267. doi:10.1016/j.puhe.2012.12.025.

Pong, R.W., Desmeules, M., and Lagace, C., 2009. Rural-urban disparities in health: how does Canada fare and how does Canada compare with Australia? *The Australian journal of rural health*, 17 (1), 58–64. [published Online First: 2009/01/24]. doi:10.1111/j.1440-1584.2008.01039.x

Rahmanian, E., *et al*., 2014. The association between the built environment and dietary intake - a systematic review. *Asia Pacific journal of clinical nutrition*, 23 (2), 183–196. doi:10.6133/apjcn.2014.23.2.08.

Raine, K.D., *et al*., 2013. Restricting marketing to children: consensus on policy interventions to address obesity. *Journal of public health policy*, 34 (2), 239–253. doi:10.1057/jphp.2013.9.

Rao, M., *et al*., 2007. The built environment and health. *The Lancet*, 370 (9593), 111–113.

Reimers, A.K., *et al*., 2013. Systematic review on measurement properties of questionnaires assessing the neighbourhood environment in the context of youth physical activity behaviour. *BMC public health*, 13, 461. doi:10.1186/1471-2458-13-461.

Sallis, J.F. and Owens, N., 2002. Ecological models of health behaviour. *In*: K. Glanz, B.K. Rimer, and F.M. Lewis, eds. *Health behavior and health education*. 3rd ed. San Francisco: Jossey-Bass, 462–468.

Sherk, A., *et al*., 2018. Alcohol consumption and the physical availability of take-away alcohol: systematic reviews and meta-analyses of the days and hours of sale and outlet density. *Journal of studies on alcohol and drugs*, 79 (1), 58–67.

Siegel, M., *et al*., 2004. Effect of local restaurant smoking regulations on environmental tobacco smoke exposure among youths. *American journal of public health*, 94 (2), 321–325.

Smoking and Health Action Foundation, 2017. Cigarette prices in Canada. Available from: https://nsra-adnf.ca/wp-content/uploads/2017/04/170427_map_and_table.pdf [Accessed 9 September 2017].

Statistics Canada, 2017. *Consumer price index, by province (monthly)*, Ottawa, ON: Government of Canada. [updated 21 December 2017]. Available from: http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/cpis01d-eng.htm [Accessed 18 January 2018].

Teo, K., *et al*., 2009. The Prospective Urban Rural Epidemiology (PURE) study: examining the impact of societal influences on chronic noncommunicable diseases in low-, middle-, and high-income countries. *American heart journal*, 158 (1), 1–7 e1. doi:10.1016/j.ahj.2009.04.019.

Willimot, R., 2016. Wonky veg and ugly fruit are making a comeback- here's why. *The Conversation*.

Wong, F., *et al*., 2011. Community Health Environment Scan Survey (CHESS): a novel tool that captures the impact of the built environment on lifestyle factors. *Global health action*, 4, 5276. doi:10.3402/gha.v4i0.5276.