CANADIAN JOURNAL of
URBAN RESEARCH
REVUE CANADIENNE de RECHERCHE URBAINE

Sustainable cities: Examining the relationship between neighbourhood composition and recycling patterns in Canadian cities

Junghoon (Dennis) Lee
Department of Sociology and Department of Geography
University of Calgary

Jenny Godley
Department of Sociology
University of Calgary

Abstract
This paper explores the relationship between urban design and household recycling practices in Canadian cities. A growing body of research links urban design with residents' transportation behaviour, such as rates of driving and use of public transportation. However, the effect of urban design on other forms of environmentally sustainable behaviour has not been as widely explored. Recycling is an important aspect of sustainability and the recycling activities of urban residents require further attention. We examine the relationship between urban design and recycling practices at the census metropolitan area (CMA) level in Canada using aggregated data merged from three secondary sources: the 2005–2006 Household and the Environment Survey conducted by Statistics Canada; the 2006 Census; and Gordon and Shirokoff's (2014) classification of Canada's urban neighbourhoods. The results demonstrate that there is a significant relationship between urban development patterns and household recycling practices at the CMA-level, when controlling for demographic factors. We conclude that urban design is related to residents' sustainability behaviours in multiple, complex ways.

Keywords: sustainability, recycling, urban sociology, Canada

Résumé
Cet article explore la relation entre la conception des villes et les pratiques de recyclage des ménages dans les villes canadiennes. Un nombre croissant de recherches a lié la conception des villes au comportement des résidents en matière de transport, comme les taux de conduite et l'utilisation des transports en commun. Cependant, l'effet de la conception des villes sur d'autres formes de comportement écologiquement durable n'a pas été aussi largement exploré. Le recyclage est un aspect important de la durabilité et les activités de recyclage des résidents urbains nécessitent une plus grande attention. Nous examinons la relation entre la conception des villes et les pratiques de recyclage au niveau des régions métropolitaines de recensement (RMR) au Canada à l'aide de données agrégées fusionnées à partir de trois sources secondaires : l'Enquête sur les ménages et l'environnement de 2005–2006 menée par Statistique Canada; le recensement de 2006; et la classification de Gordon et Shirokoff (2014) des quartiers urbains du Canada. Les résultats démontrent qu'il existe une relation significative entre les modèles de développement urbain et les pratiques

Canadian Journal of Urban Research, Winter 2020, Volume 29, Issue 2, pages 18–31.

ISSN: 2371-0292

de recyclage des ménages au niveau des RMR, lorsque l'on tient compte des facteurs démographiques. Nous concluons que la conception urbaine est liée aux comportements de durabilité des résidents de multiples façons complexes.

Mots-clés : durabilité, recyclage, sociologie urbaine, Canada.

Introduction

Urban dwellers account for just over half the world's population, yet they are responsible for over 70% of fossil fuel related carbon emissions (WWF 2012, 58). As the world continues to urbanize—two-thirds of the world's population is predicted to be urban by the year 2050 (UN 2014)—urban planners and policy makers need to think of a variety of ways to reduce the ecological footprints of cities. One important aspect of this project is promoting more environmentally sustainable behaviours among urban residents.

Sustainable consumption can be defined as behaviours that aim to reduce one's ecological footprint, including activities such as purchasing environmentally friendly products and consciously trying to minimize material consumption (Niemi and Hubacek 2007). There is evidence to suggest that the type of neighbourhood you live in can influence certain types of sustainable consumption practices, especially in terms of transportation. For example, it has been widely established that sprawling, low-density development patterns—generally referred to as *urban sprawl* or *suburbanization*—have led to increasing rates of automobile usage due to the greater distances between destinations and lack of public transportation (Ewing 1997; Frank and Kavage 2008; Kennedy, Krogman, and Krahn 2013; Ewing and Hamidi 2015; Moos et al. 2015). In terms of the environmental impact, this leads to greater energy consumption and a reduction in air quality (Ewing 1997; Frank and Kavage 2008; Ewing and Hamidi 2015).

Critics of urban sprawl have instead promoted the development of more compact, walkable communities which offer a wider range of sustainable transportation options, as well as opportunities for residents to interact and engage with their communities (Jacobs 1961; Ewing 1997; Leyden 2003; Bay and Lehmann 2017). However, there has been less focus on the relationship between neighbourhood residence and forms of sustainable practices other than transportation. The aim of this study is to further investigate this topic by examining the relationship between the different types of residential neighbourhoods that make up a city and recycling practices across Canadian cities.

Using data aggregated and merged at the census metropolitan area (CMA) level, we pose the following research questions:

1. To what extent is the design of a city (measured by the composition of types of neighborhoods) related to the accessibility and usage of recycling programs at the CMA-level?
2. How does the varying demographic composition of cities affect the relationship between neighbourhood composition and accessibility and usage of recycling programs?

Literature review

(Sub)Urbanization in Canada

Canadian urbanization has been predominantly characterized by urban sprawl and suburbanization. It has been estimated that over 80% of Canada's metropolitan population lives in suburban areas, or two-thirds of the country's total population (Gordon and Janzen 2013; Gordon and Shirokoff 2014). There are several reasons for the rise and continuing popularity of suburban developments. The emergence of the automobile and its mass production "created new options for urban spatial growth and ultimately supported the need for high-speed urban freeways… perhaps the most important consequence was the *suburbanization of residence*… and eventually even the *suburbanization of industry*" (Hiller 2014, 29, italics original). As it became easier to travel farther distances, people were able to live far from their places of work and shopping, and modern communications made clustering of businesses unnecessary (Gordon and Richardson 1997). Gordon and Richardson (1997) therefore argued that sprawl was a reflection of market forces and consumer preferences.

A growing body of evidence has linked urban sprawl to a variety of negative outcomes, not only related to sustainable consumption practices, but also physical health, strength of social ties, civic and political participation. Frank and Kavage (2013, 214) argued that "Sprawl, now the dominant development paradigm, may actually be undermining our health in a number of ways—decreased physical activity levels, and less access to healthy food associated with increases in obesity; increased rates of asthma and other respiratory illnesses from ozone; higher rates of traffic-related injuries; and to say nothing of the stress of long commutes".

Urban sprawl has also been argued to weaken social ties. Robert Putnam (2000), pointed to suburbanization as one of the major causes for the decline in social capital (social networks and interactions that inspire trust and reciprocity among citizens) in the US. According to John Helliwell (2002), social capital has also been declining in Canada. Jane Jacobs (1961) asserted that compact developments provide better walkability and therefore increase the likeliness of social interaction and civic activity. Although some studies who have refuted these claims (Brueckner and Largey 2008; Glaeser and Gottlieb 2006), others have provided evidence to suggest that there is indeed a link between neighbourhood design and social capital/civic participation (Freeman 2001; Leyden 2003; Nguyen 2010).

Hopkins and Williamson (2012) found that certain design aspects common in suburban neighbourhoods are powerful predictors of reduced political activity. Other researchers have also drawn attention to the importance of neighbourhoods in voting behavior and political preferences (Gainsborough 2001; Walks 2005a; Walks 2005b; Williamson 2008). Despite the growing criticisms directed towards urban sprawl, cities in Canada and the US have continued to develop in this fashion. "The 2006–2011 findings show that the population of Canadian auto-dependent communities are growing much faster than the national growth rate, which is significant to note when implementing policies guiding public health, transportation, political decisions, and community design" (Gordon and Shirokoff 2014, 2).

Sustainable consumption and neighbourhood design

There is much research to show that the physical design of suburban neighbourhoods leads to higher rates of driving, which not only leads to increased energy consumption and emissions, but also a variety of negative social outcomes (Frank and Kavage 2013). There is also evidence to suggest that neighbourhoods can influence other forms of sustainable consumption practices as well. According to Kennedy, Krogman, and Krahn (2013), neighbourhood of residence is linked to environmental attitudes—which are both powerful predictors of sustainable consumption practices. In their study, in which they compared a central and suburban neighbourhood, they found that households labelled as *sustainable consumers*—consumers who purchase environmentally friendly products and consciously try to keep their consumption of material goods to a minimum (Niemi and Hubacek 2007, 4)—were more heavily clustered in the central neighbourhood (Kennedy, Krogman, and Krahn 2013, 375). In contrast, *mainstream consumers*—people who show no interest in reducing their material consumption and seldom if ever purchase green products (Niemi and Hubacek 2007, 4)—were more than twice as heavily concentrated in the suburban neighbourhood (Kennedy, Krogman, and Krahn 2013, 375).

By contrast, most of the research on urban waste management concludes that residents of multi-family dwellings—which tend to be concentrated in central neighbourhoods—recycle less than residents of single-family homes, which tend to be concentrated in suburban neighbourhoods. Evidence from several countries, including Sweden, Korea, and the UK, demonstrates higher levels of recycling among residents of single-family homes than multi-family dwellings (Abbott et al. 2011; Lee and Paik 2010; Fallde 2015). Most researchers blame the reduced levels of recycling among residents of multi-family dwellings on a lack of adequate interior space for sorting recyclable materials, as well as the increased distance to recycling bins, or in other words, a lack of convenience (Ando and Gosselin 2005). By comparison, single-family homes are often much more spacious and have access to curbside recycling services.

In Canada, both convenience and visibility appear to be key to encouraging residents in multi-family residences to recycle more. An experiment conducted in Vancouver found that convenience greatly increased recycling and composting in high density buildings. Having recycling and composting containers on every floor in a high-rise building (rather than just on the ground floor) greatly increased residents' rates of recycling and composting (DiGiacomo et al. 2018). Another experiment conducted in Toronto illustrated that while convenience (having recycling chutes on each floor) was important, visibility (having recycling bins positioned prominently in the building lobby) was what really lead to increased rates of recycling in high density buildings.

Based on past findings, therefore, we expect to find that Canadian cities with a higher proportion of people living in central neighbourhoods will have lower rates of access to, and usage of, recycling programs. We also expect to find that cities with a higher proportion of people living in car-dependent, suburban neighbourhoods will have higher rates of recycling.

Individual-level demographic factors associated with sustainable consumption practices

Research on the individual-level determinants of recycling behaviour indicates that both intrinsic and extrinsic incentives contribute to recycling habits and patterns. Extrinsic incentives include things like monetary incentives, laws and regulations, and social pressure. Intrinsic incentives include attitudes, knowledge, and motivation.

Several individual factors have been found to be associated with sustainable consumption practices, including age, income and education. In Korea, both income and age were found to be positively related to recycling (Lee and Paik 2010). In Canada, by contrast, income was found to be negatively associated with several types of recycling. The conclusion being that, "as income increases, the value of time tends to increase, making recycling more costly" (Ferrara and Missios 2005, 231).

According to Kennedy et al. (2013, 373), sustainable consumers have slightly more years of education than other types of consumers, on average. They also found that mainstream consumers are typically younger than *low-level consumers*—people who live relatively simple lifestyles in terms of material consumption (Kennedy et al. 2013, 373). Additionally, they found that *material greens*—people who often buy green products, but who still continue to live relatively materialistic lives (Niemi and Hubacek 2007, 4)—are more likely to be born outside of Canada than low-level consumers (Kennedy et al. 2013, 373).

In order to measure and account for these individual-level factors that may affect rates of recycling, we gathered relevant aggregate demographic information for each CMA and controlled for these variables at the CMA level in our regression model.

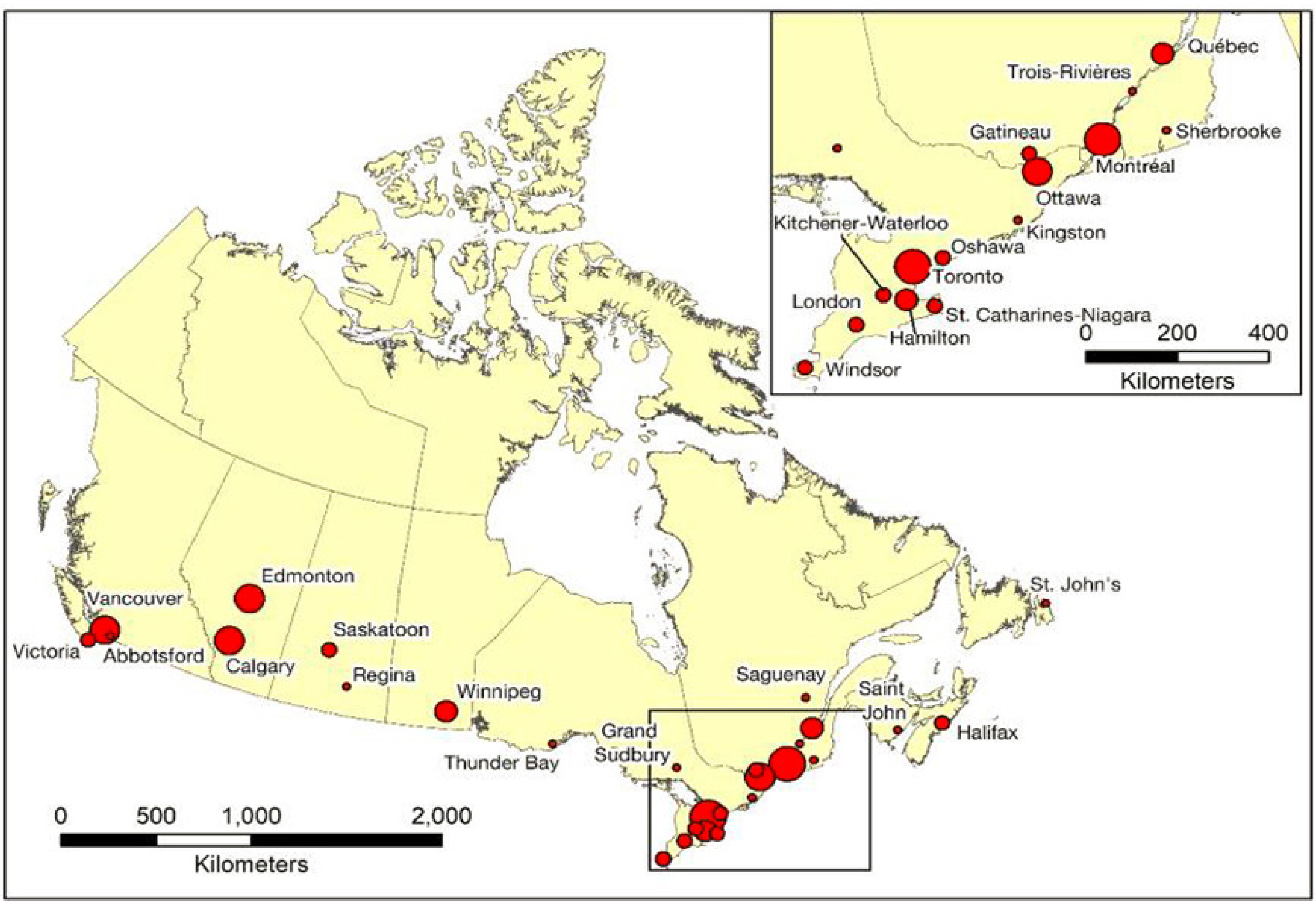

Figure 1
Location of CMAs in Canada

Data and methods

To examine the relationship between neighborhood composition and recycling practices in Canadian cities, we aggregated and merged data from three secondary sources at the CMA-level. These data are described in the next three sections. For readers not familiar with Canada, we include a map which indicates the location of all of the CMAs (Figure 1).

Recycling variables

The Households and the Environment Survey (HES) is a national household survey conducted by Statistics Canada which gathers information on the practices and behaviours of Canadian households that relate to the environment. This study provided the two dependent variables for this study: *access to recycling programs* and *usage of recycling programs*. The 2005–2006 survey was the third of its kind, and the survey has been administered five additional times since (2007, 2009, 2011, 2013, and 2015). We utilized data from the 2005–2006 cycle because it includes the most detailed information related to household recycling practices.

The target population for the HES consists of households in Canada excluding households in which no member is 18 years old or more. Also excluded are households located in the Yukon, Northwest Territories and Nunavut, households located on First Nations, military bases, and households consisting entirely of full-time members of the Canadian Armed Forces. The survey was conducted through telephone interviews. The initial sample size consisted of 36,431 households with a response rate of 77.8%, yielding an effective sample of 28,334. We aggregated the responses to the recycling variables to the CMA-level and removed all respondents living in non-CMAs. This reduced the sample size to 15,362.

In the HES, there were four questions which asked if the respondent has access to different types of recycling programs (paper, plastic, metal cans, and glass), as well as four follow-up questions which asked whether they used each respective program. For example, the survey would ask the respondent if they have access to a recycling program for plastics. Their response categories included "yes", "no", "don't know", and "refusal". The follow-up questions then asked if they use this specific program with the same response categories. To operationalize these survey responses, we re-coded them into binary variables for each response (where 1=yes, 0=else) and then aggregated them to the CMA-level so that the value would measure the proportion of respondents who answered "yes" to the question in each CMA.

In order to see the overall effects of CMA composition on recycling access and usage, we combined each set of variables to form two new dependent variables, *average levels of access to recycling programs* and *average levels of use of recycling programs*, for our analysis. These variables thus measure the average access to recycling programs (including paper, plastic, metal cans and glass) at the city level, and average usage of recycling programs (including paper, plastic, metal cans and glass), respectively. We concluded this method was appropriate since these materials tend to be recycled together with the same type of collection service; meaning that decisions about recycling different materials are positively correlated (Ferrara and Missios 2012, 718).

As shown in Table 1 (next page), average access to recycling programs and average usage of recycling programs are highly correlated. Interestingly, average rates of access and use vary considerably across Canadian CMAs, with a range of 0.64 to 0.97, and 0.55 to 0.95 respectively. CMAs from Ontario and British Columbia appear to show higher rates of both access and usage. A few CMAs are also noticeable for their relatively large gap between access and usage, such as Saguenay, QB and Thunder Bay, ON.

Neighbourhood composition variables

The first set of independent variables were derived from a study conducted by Gordon and Shirokoff (2014). This study was an update to an earlier study by Gordon and Janzen (2013), in which they tested 12 different models to define and measure different types of inner-city and suburban neighborhoods in Canadian CMAs. Using a combination of population density and journey to work data in their model, they came up with four classifications for neighbourhoods within Canadian CMAs: *active cores, transit suburbs, auto suburbs,* and *exurbs* (Gordon and Janzen 2013; Gordon and Shirokoff 2014), and calculated the number of residents living in each type of neighbourhood, by CMA.

Table 1
Mean access and usage of recycling programs, Canadian CMAs (N = 28)

City	% Access Mean (95% CI)	% Use Mean (95% CI)	Gap (A-U)	N
Kingston, ON	97 (96-99)	95 (93-97)	2	416
Victoria, BC	96 (95-98	95 (93-96)	1	576
St. Catharines-Niagara, ON	96 (94-97)	94 (92-96)	2	449
Oshawa, ON	95 (94-97)	93 (91-95)	2	409
Hamilton, ON	95 (93-97)	93 (91-95)	2	400
Sudbury, ON	95 (93-97)	91 (88-93)	4	445
Kitchener - Waterloo, ON	94 (92-96)	92 (89-94)	2	391
Ottawa, ON	94 (92-96)	90 (88-93)	4	494
Toronto, ON	93 (92-94)	91 (90-93)	2	1358
London, ON	93 (91-95)	89 (87-91)	4	543
Vancouver, BC	92 (91-93)	89 (88-91)	3	1164
Winnipeg, MB	91 (89-93)	82 (79-84)	9	703
Halifax, NS	91 (88-93)	87 (84-89)	4	580
Abbotsford, BC	90 (88-93)	87 (84-90)	3	389
Sherbrooke, QB	90 (88-93)	86 (83-88)	4	525
Gatineau, QB	90 (88-93)	84 (81-87)	6	465
Windsor, ON	90 (88-93)	85 (82-88)	5	427
Montréal, QB	87 (85-90)	81 (78-84)	6	514
Thunder Bay, ON	86 (83-89)	74 (70-77)	12	426
Saguenay, QB	85 (82-88)	71 (67-75)	14	438
Trois-Rivières, QB	84 (81-87)	75 (71-78)	9	483
Edmonton, AB	83 (81-85)	78 (75-80)	5	749
Regina, SK	83 (80-85)	72 (69-75)	11	555
Saskatoon, SK	77 (75-80)	68 (65-71)	9	529
Québec, QB	77 (73-80)	69 (65-73)	8	487
Calgary, AB	75 (73-78)	65 (62-68)	10	736
Saint John, NB	72 (68-75)	60 (56-64)	12	278
St. John's, NL	64 (61-68)	55 (51-58)	9	433
AVERAGE	88 (88-89)	82 (82-83)	6	15362

Source(s): 2006 Households and the Environment Survey (Statistics Canada 2007b)

Active core neighbourhoods are defined as census tracts that have levels of active transportation (walk/cycle) greater than 150% of the overall average for the CMA and greater than 50% of the national average (Gordon and Shirokoff 2014, 11). These neighbourhoods are generally in central areas and the downtowns of cities; however, they have also begun to form in secondary centres in some larger cities and metropolitan areas.

Transit suburbs are neighbourhoods where a higher proportion of people commute by transit. More specifically, they have transit use greater than 150% of the metro average for journey to work, active transit less than 150% of the metro average, and transit use greater than 50% of the national average (Gordon and Shirokoff 2014, 10).

Auto suburbs have a gross population density that is greater than 150 people per square kilometre, transit use less than 150% of the metro average, and active transit use less than 150% of the metro average. Almost all residents commute by automobile in these classic suburban neighborhoods (Gordon and Shirokoff 2014, 10).

Exurbs are rural areas on the edges of CMAs that have a gross population density less than 150 people per square kilometre, where more than 50% of workers commute into the metropolitan area (Gordon and Shirokoff

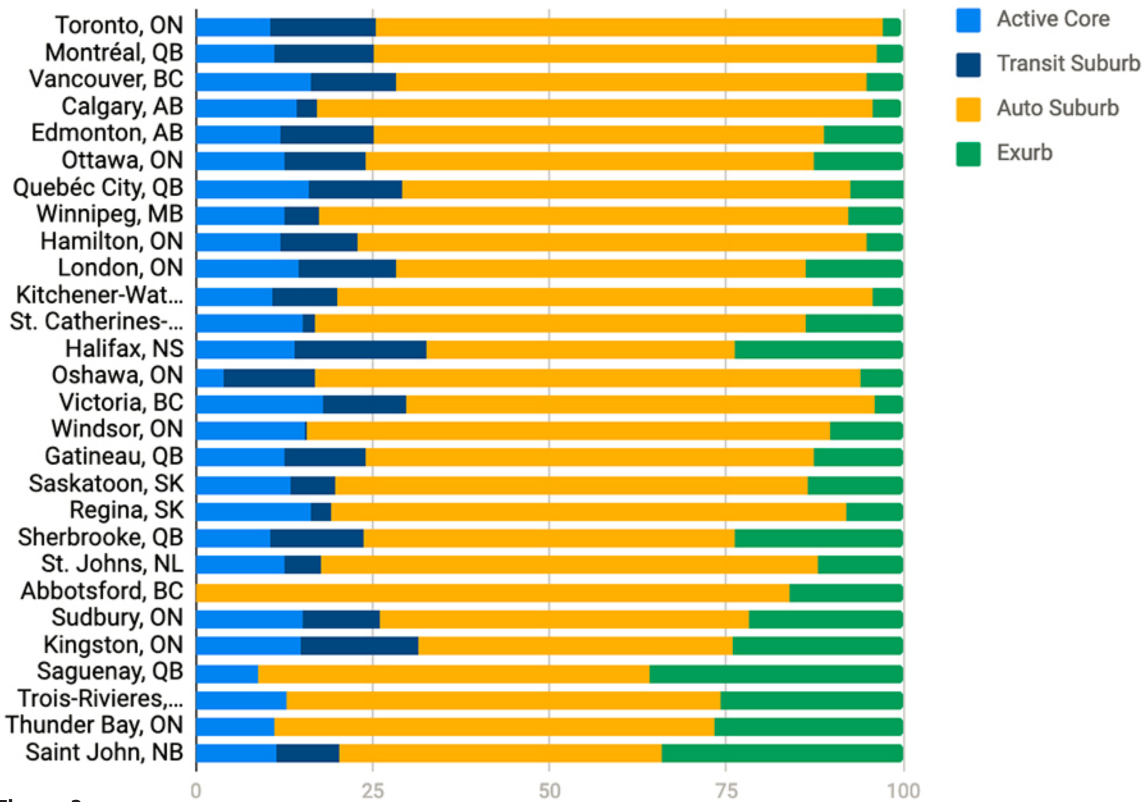

Figure 2
Percent of the population living in each type of neighbourhood

2014, 10). According to these findings, in 2006, 87% of Canada's total metropolitan residents lived in transit suburbs, auto suburbs or exurban areas, while only 12% lived in active core neighbourhoods (2014, 1).

Using the classifications and data provided in their study (Gordon and Shirokoff 2014, 23), we calculated the proportion of residents in each neighborhood classification for each CMA to create neighbourhood composition variables to utilize in our own study. These variables measure, at the CMA-level, the percent of the population living in each type of neighborhood: *active core, transit suburb, auto suburb,* and *exurb*. This information is illustrated in Figure 2.

The dataset provided by Gordon and Shirokoff (2014) contained information for 33 Canadian CMAs. However, the HES did not include respondents from Moncton, Brantford, Peterborough, Barrie, Guelph, and Kelowna in their sample, therefore these cities were left out of our analysis. In addition, Gordon and Shirokoff (2014) classified the CMA of Ottawa-Gatineau as a single CMA while the HES categorized them as separate CMAs. Thus, we applied the same values for the neighbourhood composition variables to both Gatineau and Ottawa for this study, while assigning the demographic variables based on provincial boundaries. This left us with a sample of 28 CMAs.

Figure 2 displays the proportions of neighbourhood types by CMA. Although there seems to be quite a bit of variation, auto suburbs are the predominant neighbourhood type across all Canadian CMAs. Interestingly, Abbotsford has neither transit suburbs nor active core neighbourhoods, while over 25% of the population in Kingston, Sudbury, Victoria, Halifax, London, Quebec City and Vancouver live in active core or transit suburb neighbourhoods. In addition, most of the smaller CMA's have substantial exurban populations. This may indicate that commuting from rural areas to employment in the central city is much easier in these places due to less traffic congestion (Gordon and Janzen 2013, 210).

In order to illustrate what the different neighbourhood compositions of the cities look like, we include a map of Victoria (Figure 3) and a map of Calgary (Figure 4) produced by Gordon and his colleagues and available on their research website (www.canadiansuburbs.ca). The maps illustrate the differences between the two cities, with Victoria have a higher percentage of active core and transit suburb neighbourhoods than Calgary, and Calgary having a higher proportion of auto suburb neighbourhoods.

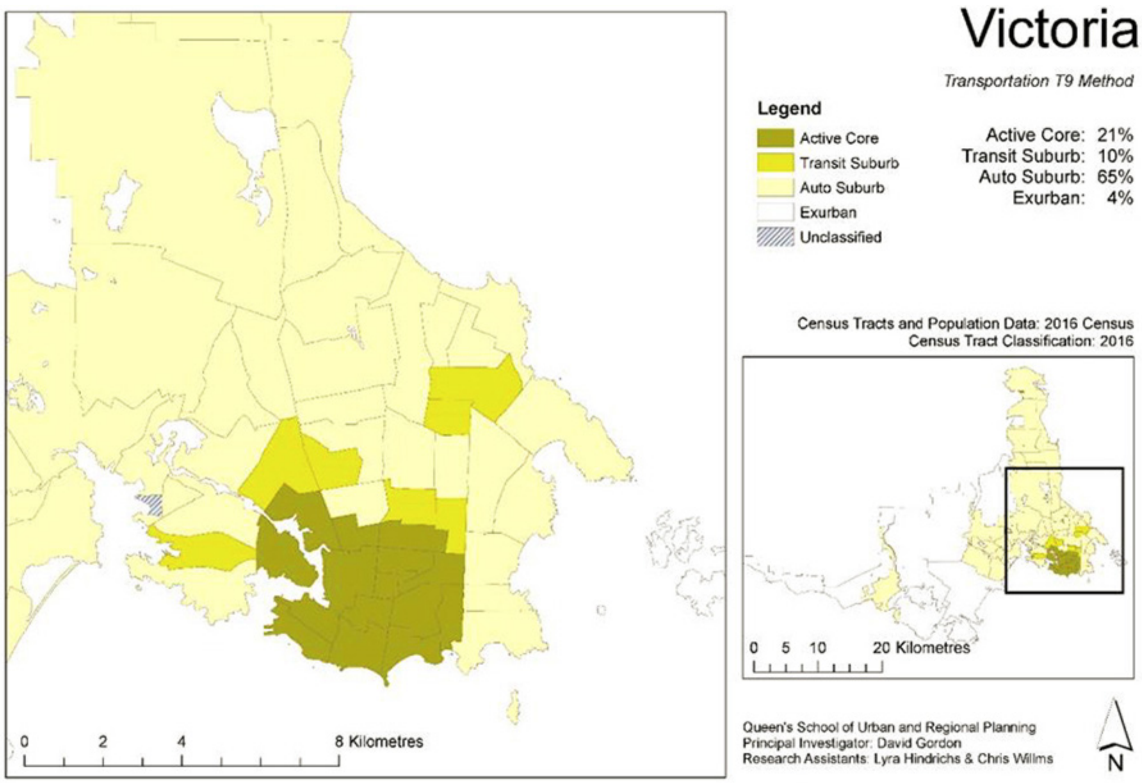

Figure 3
Neighbourhood compositions of Victoria

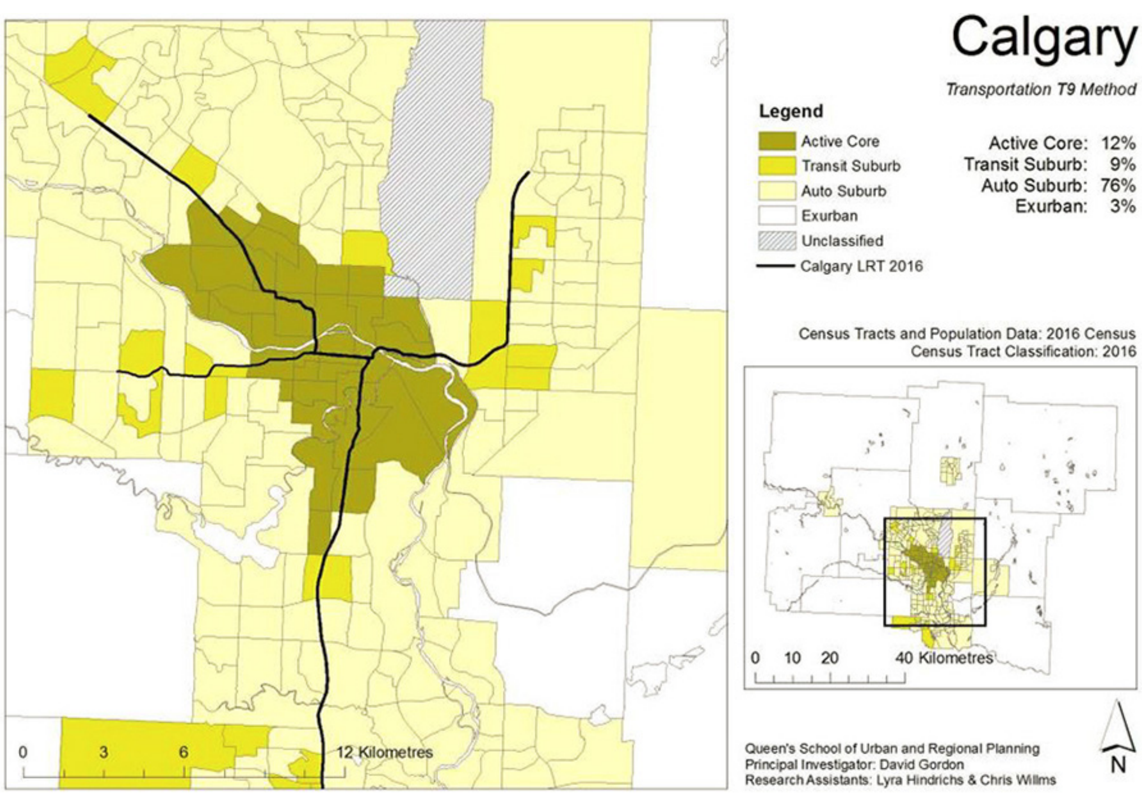

Figure 4
Neighbourhood compositions of Calgary

Demographic composition variables

To account for variations in the demographic composition of cities, we employed CMA-level demographic data from the Statistics Canada 2006 Population Census. The census was conducted on May 16, 2006, and counted a total population of 31,612,897 Canadians, with nearly 25 million living in urban areas (Statistics Canada 2007). The Community Profiles section, which can be accessed on the Statistics Canada website, provided relevant information on each CMA.

We included six demographic control variables into our regression model: *population size, median age, median household income, immigrants* (percent of total population), *education* (percent of total population aged 25–64 with a university certificate, diploma, or degree), and *low income* (percent of low-income persons—after tax). As the neighbourhood composition variables included population density as a factor (Gordon and Shirokoff 2014), this variable was not included as a demographic composition variable in our model.

While each demographic variable varies considerably across Canadian CMAs, the most significant differences are seen in population size as well as percentage of immigrants.

Table 2
Descriptive summary of neighbourhood and demographic composition variables, Canadian CMAs (N = 28)

	Mean	Min.	Max.	Std. Dev.
Percent population living in active cores	12.41	0.00	17.98	3.68
Percent population living in transit suburbs	8.62	0.00	18.77	5.79
Percent population living in auto suburbs	64.97	43.45	84.00	10.52
Percent population living in exurbs	13.75	2.79	35.96	9.64
Population size	737585	122389	5113149	1129395
Median age	39.28	35.70	43.80	2.32
Median household income	55799	40617	72329	8542
Percent of immigrants	15.56	1.17	45.74	10.87
Percent pop. aged 25-64 with a university certificate, diploma, or degree	23.49	14.11	39.08	5.96
Percent pop. low income - after tax	11.28	6.90	16.50	2.33

Source(s): Census of Population 2006 (Statistics Canada 2007a); Gordon and Shirokoff 2014

Statistical analyses

To conduct our statistical analysis, we merged the three datasets at the CMA-level. As mentioned, this included the aggregated data from the HES on recycling availability and usage, the neighborhood composition data from Gordon and Shirokoff (2014), and the socio-demographic data from the Census.

We began by identifying bivariate correlations between the dependent variables and the neighbourhood composition variables (Table 3). Afterwards, we ran linear regression models including both the neighbourhood composition variables and the demographic control variables to predict average recycling access and usage at the CMA-level (Table 4).

Results

Bivariate analysis between neighbourhood composition and recycling behaviour

The results presented in Table 3 (next page) allow us to address our first research question: Is the design of a city (measured by the percent of the population living in different types of neighbourhoods) related to the average accessibility and usage of recycling programs at the city-level? We find no significant relationship between neighbourhood composition and average levels of access to recycling programs across Canadian CMAs. However, we do find a relationship between the percentage of people living in different types of neighbourhoods and the average usage of recycling programs. CMAs which have a higher proportion of residents living in transit suburbs report higher

Table 3
Bivariate correlations between neighbourhood composition and aggregate recycling variables, Canadian CMAs (N=28)

	Average Access	Average Usage
Percent population living in active cores	-.046	-.036
Percent population living in transit suburbs	.312	.413**
Percent population living in auto suburbs	.005	.033
Percent population living in exurbs	-.230	-.326*

* Correlation is significant at the 0.10 level (2-tailed)
** Correlation is significant at the .05 level (2-tailed)
Source(s): Statistics Canada (2007b), Gordon and Shirokoff (2014)

Table 4
Linear regression results: Average access to recycling and average use of recycling, Canadian CMAs (N = 28)

		Access	Use
Constant		.298 (.529)	-.181 (.161)
Neighbourhood Composition (Ref = Active Core)	Transit Suburb	.007 (.004)	.004 (.001) **
	Auto Suburb	.001 (.003)	.000 (.001)
	Exurb	.001 (.003)	-.001 (.001)
Population		-.000 (.000)	-.000 (.000)
Median Age		.015 (.007) **	.001 (.002)
Median Household Income		-.000 (.000)	-.000 (.000)
Percent Immigrants		.007 (.002)**	.002 (.001) **
Percent Post-secondary		-.000 (.003)	-.001 (.001)
Percent Low Income		-.016 (.008) *	-.003 (.003)
Access to Recycling			1.130 (.071)**
Adjusted R^2		.642	.983

Note. $N = 28$. Reported as b (Standard Error), where b = unstandardized regression coefficient. $*p < 0.1$; $**p < .05$ (two-tailed tests).
Ref = Reference Group.

average use of recycling programs. In addition, CMAs which have a higher proportion of residents living in exurbs report lower average use of recycling programs.

Controlling for demographic factors

In the two linear regression models displayed in Table 4, we address the second research question: Does the relationship between urban design and the accessibility and usage of recycling programs remain once we account for the demographic composition of the CMAs? We included the demographic control variables to first examine the impact of neighbourhood composition on average access to recycling programs, controlling for population size, median age, median household income, percentage of immigrants, percentage of low income, and percent of the population aged 25–64 with a university certificate, diploma, or degree. We then examined the same model for average usage. We included average access to recycling programs as an additional control variable for the second model, since access significantly affects usage.

In the first column in Table 4, we see that average access to recycling programs in CMAs in Canada is positively associated with the median age and the percentage of immigrants in CMAs, and negatively associated with the percentage of the city population who are low income, controlling for all other variables in the model. As in the bivariate model, the neighbourhood composition variables have no significant relationship to average access, after controlling for the demographic composition variables.

In the second column in Table 4, average usage of recycling programs is significantly and positively associated with the percent of the population living in transit suburb, indicating that an increase in the proportion of the population living in transit suburbs (versus living in the active core) in a CMA leads to an increase in average recycling usage, controlling for access to recycling programs, population size, median age, median household income, percentage of immigrants, percentage of low income, and percent of the population aged 25–64 with a university certificate, diploma, or degree. Interestingly, the percentage of immigrants is also positively associated with average recycling usage, even when controlling for access.

Discussion and conclusion

The findings from this study provide some evidence of a link between the neighbourhood composition of a city and the recycling practices of its residents. In the bivariate analysis, we found that there was no relationship between the neighbourhood type composition of cities and the reported average levels of access to recycling programs. However, we did find a relationship between neighbourhood composition and recycling usage at the city level. Cities with a higher percentage of their population living in transit suburbs report higher average recycling usage, and cities with a higher percentage of their residents living in exurbs report lower average levels of recycling usage.

We next tested to see if these relationships held once we controlled for the demographic composition of the cities. The results indicated that the relationship between the percent of residents living in transit suburbs and average recycling usage remained positive and significant, controlling for average access to recycling, population size, median age, median household income, percentage of immigrants, percentage of low income, and the percent of the population aged 25–64 with a university certificate, diploma, or degree. However, the percent of residents living in exurbs was no longer significantly related to average recycling usage, suggesting that the initial bivariate relationship was explained by the demographic composition of the cities.

Our findings support those of previous studies which have shown that residents of multi-family dwellings (common in the active core) are less likely to recycle than residents of single-family homes (common in suburbs and exurbs) (Ando and Gosselin 2005; Bay and Lehmann 2017). We believe our findings illustrate some of the issues with city-level recycling initiatives. Many municipalities in Canada have worked hard to make recycling available to their residents, however accessibility does not translate directly to usage.

If residents in the active core have to travel to use recycling facilities, and their only form of transportation is walking or cycling, they may be less likely to use the facilities than residents in transit suburbs who often have access to both public transportation and a vehicle. In high-density buildings, both convenience and visibility appear to be key to encouraging recycling (DiGiacomo et al. 2018; Lakhan 2016). Recycling needs to be actively encouraged within the building, by building operators, not just by city authorities.

Several key limitations to this study are worth mentioning. First, conducting the study at the CMA level meant that we had a rather small sample size of 28, making it difficult to identify statistically significant findings. Second, we recognize that the use of aggregated and merged data made it impossible to establish direct causal relationships between these variables. As we did not have the neighbourhood location of the HES respondents, we do not know, in any given city, which neighbourhoods the respondants come. The third limitation is the potential presence of self-selection bias, where individuals and households might choose one type of neighbourhood (or a certain type of city) over another because of their values and practices, rather than be influenced by the neighbourhood itself. In other words, we cannot be sure whether certain types of cities and neighbourhoods attract certain types of residents who in turn establish more sustainable behavioural norms; or if collective, pre-existing features of neighbourhoods—their socio-demographic, market-oriented, structural, or politico-economic characteristics—shape incoming residents, regardless of background. It seems reasonable to conclude that both processes may be occurring simultaneously (Kennedy et al. 2013).

A multitude of studies have shown the powerful effect neighbourhood residence can have on sustainable consumption practices in a variety of ways. Perhaps recycling activities and sustainable consumption practices are better explained by individual differences, however, our findings provide some evidence of a statistically significant link between the neighbourhood composition of a city and recycling patterns in Canadian CMAs, net of the demographic composition of the cities. This leads to the conclusion that neighbourhood design can potentially influence the recycling behavior of residents. Importantly, while most studies have focused on the benefits of compact neighbourhoods in terms of sustainable transportation, our study highlights a different type of sustainable consumption behaviour that can be affected by the urban environment. Governments and urban planners need to address all aspects of sustainability, including both transportation and recycling, in order to move towards a more sustainable form of development that suits the needs of a new generation of urban residents.

Acknowledgements

The authors would like to thank the journal's reviewers for their helpful suggestions and feedback on this paper. We thank University of Calgary Data Librarian, Peter Peller, for providing assistance in locating relevant data for the purposes of this research, and for producing the map of Canada for us. Finally, we thank Dr. David L. A. Gordon of Queen's University for generously allowing us to use maps from his research website www.canadiansuburbs.ca

References

Abbott, A., N. Shasikanta, and L. O'Shea. 2011. Explaining the variation inhousehold recycling rates across the UK. *Ecological Economics* 11(15): 2214–2223. doi.org/10.1016/j.ecolecon.2011.06.028.

Ando, A. W., and A. Y. Gosselin. 2005. Recycling in multifamily dwellings: Does convenience matter? *Economic Inquiry* 43(2): 426–438. doi.org/10.1093/ei/cbi029.

Bay, J. H. P., and S. Lehmann. 2017. *Growing compact: Urban form, density and sustainability*. Abingdon, Oxon; New York, NY: Routledge.

Blasingame, L. 1998. Sustainable cities: Oxymoron, utopia, or inevitability? *The Social Science Journal* 35(1): 1–13. doi.org/10.1016/S0362-3319(98)90055-6.

Brueckner, J. K., and A. G. Largey. 2008. Social interaction and urban sprawl. *Journal of Urban Economics* 64(1): 18–34. doi.org/10.1016/j.jue.2007.08.002.

DiGiacomo, A., D. W-L. Wu, P. Lenkic, B. Fraser, J. Zhao, and A. Kingstone. 2018. Convenience improves composting and recycling rates in high-density residential buildings. *Journal of Environmental Planning and Management* 61(2): 309–331. doi.org/10.1080/09640568.2017.1305332.

Ewing, R. 1997. Is Los Angeles-style sprawl desirable? *Journal of the American Planning Association* 63(1): 107–126. doi.org/10.1080/01944369708975728.

Ewing, R., and S. Hamidi. 2015. Compactness versus sprawl: A review of recent evidence from the United States. *Journal of Planning Literature* 30(4): 413–432. doi.org/10.1177%2F0885412215595439.

Fallde, M. 2015. Can area managers connect policy and tenants? Implementation and diffusion of a new waste management system in Linköping, Sweden. *Journal of Environmental Planning and Management* 58(5): 932–947. doi.org/10.1080/09640568.2014.904769.

Ferrara, I., and P. Missios. 2005. Recycling and waste diversion effectiveness: Evidence from Canada. *Environmental and Resource Economics* 30(2): 221–238. doi.org/10.1007/s10640-004-1518-z.

Frank, L. D., and S. Kavage. 2008. Urban planning and public health: A story of separation and reconnection. *Journal of Public Health Management and Practice* 14(3): 214–220. doi.org/10.1097/01.PHH.0000316478.42264.a7.

Freeman, L. 2001. The effects of sprawl on neighborhood social ties: An explanatory analysis. *Journal of American Planning Association* 67(1): 69–77. doi.org/10.1080/01944360108976356.

Glaeser, E. L., and J. D. Gottlieb. 2006. Urban resurgence and the consumer city. *Urban Studies* 43(8): 1275–1299. doi.org/10.1080/00420980600775683.

Gainsborough, J. F. 2001. *Fenced off: The suburbanization of American politics*. Washington, DC.: Georgetown University Press.

Gordon, D. L. A., and M. Janzen. 2013. Suburban nation? Estimating the size of Canada's suburban population. *Journal of Architectural Planning Research* 30(3): 197–220. http://canadiansuburbs.ca/researchpapers.html.

Gordon, D. L. A., and I. Shirokoff. 2014. Suburban nation? Population growth in Canadian suburbs, 2006–2014. Council for Canadian Urbanism Working Paper #1. http://canadiansuburbs.ca/researchpapers.html.

Gordon, D. L. A., and I. Shirokoff. 2016. Still suburban? Population growth in Canadian suburbs, 2006–2016. Council for Canadian Urbanism Working Paper #2. http://canadiansuburbs.ca/researchpapers.html.

Gordon, P., and H. W. Richardson. 1997. Are compact cities a desirable planning goal? *Journal of the American Planning Association* 63(1): 95–106. doi.org/10.1080/01944369708975727.

Helliwell, J. F. 2002. *Globalization and well-being*. Vancouver, BC: UBC Press.

Hiller, H. H. 2014. *Urban Canada*. Don Mills, ON: Oxford University Press.

Hopkins, D. J., and T. Williamson. 2012. Inactive by design? Neighborhood design and political participation. *Political Behavior* 34(1): 79–101. doi.org/10.1007/s11109-010-9149-2.

Jacobs, J. 1961. *The death and life of great American cities*. New York, NY: Random House.

Kennedy, E. H. 2011. Reclaiming consumption: Sustainability, social networks, and urban context. PhD diss., University of Alberta. https://era.library.ualberta.ca/items/48efe875-8959-41a3-b34b-fdbe8c98bf78/view/757d1187-1588-41ad-b412-aee19825b894/Kennedy_Emily_Spring-202011.pdf.

——. 2011. Rethinking ecological citizenship: The role of neighbourhood networks in cultural change. *Environmental Politics* 20(6): 843–860. doi.org/10.1080/09644016.2011.617169.

Kennedy, E. H., N. Krogman, and H. Krahn. 2013. Sustainable consumption and the importance of neighbourhood: A central city/suburb comparison. *Canadian Journal of Sociology* 38(3): 359–382. doi.org/10.29173/cjs18028.

Lakhan, C. 2016. Out of sight, out of mind: Issues and obstacles to recycling in Ontario's multi residential buildings. *Resources Conservation and Recycling* 108: 1–9. doi.org/10.1016/j.resconrec.2016.01.005.

Lee, S., and H. S. Paik. 2010. Korean household waste management and recycling behavior. *Building and Environment* 46(5): 1159–1166. doi.org/10.1016/j.buildenv.2010.12.005.

Leyden, K. M. 2003. Social capital and the built environment: The importance of walkable neighborhoods. *American Journal of Public Health* 93(9): 1546–1551. doi.org/10.2105/AJPH.93.9.1546.

Moos, M., A. Kramer, L. McGuire, P. Mendez, R. Walter-Joseph, M. Williamson, and E. Wyly. 2015. More continuity than change? Re-evaluating the contemporary socio-economic and housing characteristics of suburbs. *Canadian Journal of Urban Research* 24(2): 64–90.

Nguyen, D. 2010. Evidence of the impacts of urban sprawl on social capital. *Environment and Planning B: Urban Analytics and City Science* 37(4): 610–627. doi.org/10.1068/b35120.

Niemi, C. J., and K. Hubacek. 2007. The role of social capital in sustainable consumption. *The International Journal of Interdisciplinary Social Sciences: Annual Review* 1(6): 1–10. doi.org/10.18848/1833-1882/CGP/v01i06/51762.

Putnam, R.. 2000. *Bowling alone: The collapse and revival of American community*. New York, NY: Simon and Schuster.

Statistics Canada. 2007. *Community profiles*. 2006 Census. Released March 13, 2007. http://www12.statcan.ca/census-recensement/2006/dp-pd/prof/92-591/index.cfm?Lang=E. Accessed November 12, 2017.

——. 2007. *Households and the environment survey (HES), 2005-2006.* SDA version. University of Toronto Data Library Service. http://sda.chass.utoronto.ca.ezproxy.lib.ucalgary.ca/sdaweb/html/misc_dli.htm#hes.

United Nations, Department of Economic and Social Affairs, Population Division. 2015. *World urbanization prospects: The 2014 revision.* New York.

Walks, A. 2005. The city-suburban cleavage in Canadian federal politics. *Canadian Journal of Political Science* 38(2): 383–413. doi.org/10.1017/S0008423905030842.

——. 2005. City-suburban electoral polarization in Great Britain, 1950–2001. Transactions of the *Institute of British Geographers* 30(4): 500–517. doi.org/10.1111/j.1475-5661.2005.00185.x.

Williamson, T. 2008. Sprawl, spatial location, and politics: How ideological identification tracks the environment. *American Politics Research* 36(6): 903–933. doi.org/10.1177/1532673X08318589.