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ABSTRACT

Background

An extensive literature documents substantial variations in life expectancy (LE) between countries and at various levels of subnational geography. These variations in LE are significantly correlated with socioeconomic covariates, though no analyses have been produced at the finest feasible census tract (CT) level of geographic disaggregation in Canada or designed to compare Canada with the United States.

Data and methods

Abridged life tables for each CT where robust estimates were feasible were estimated comparably with U.S. data. Cross-tabulations and graphical visualizations are used to explore patterns of LE across Canada, for Canada's 15 largest cities, and for the 6 largest U.S. cities.

Results

LE varies by as much as two decades across CTs in both countries' largest cities. There are notable differences in the strength of associations with socioeconomic status (SES) factors across Canada's largest cities, though these associations with income-poverty rates are noticeably weaker for Canada's largest cities than for the United States' largest cities.

Interpretation

Small area geographic variations in LE signal major health inequalities. The association of CT-level LE with SES factors supports and extends similar findings across many studies. The variability in these associations within Canada and compared with those in the United States reinforces the importance for population health of better understanding differences in social structures and public policies not only at the national and provincial or state levels, but also within municipalities to better inform interventions to ameliorate health inequalities.

Keywords

life expectancy, Canada - United States, socio-economic factors, small area estimation, cities and census tracts

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What is already known on this subject?

- There are very wide variations in life expectancy (LE) across small geographic areas.
- These variations are typically strongly correlated with socioeconomic status (SES) factors.
- Little is known about these variations at very small levels of geographic disaggregation in Canada.

What does this study add?

- This study provides the first analysis in Canada of LE for the smallest feasible geographic areas, census tracts (CTs), then nested within larger cities (known as census metropolitan areas, CMAs).
- The strength of SES correlations with LE varies across 15 of Canada's largest cities, suggesting that municipal factors as well as provincial and federal factors play a role.
- While CT-level variations in LE in the largest Canadian and U.S. cities are similarly wide, even though Canada is a more egalitarian society, the within-city correlations between SES and LE are weaker in Canada than in the United States. Some evidence suggests that differences in social stratification and municipal governance (more equitable distribution of local public goods) rather than racial segregation may be the most important factors.
- Comparable submunicipal data for Canadian and U.S. cities are needed to understand why the associations between CT-level LE and SES are weaker in Canada than in the United States.
- To the extent these study results are borne out in future research, emphasis on equitably distributed public education and other local services may be more critical for improved population health than is generally appreciated.

An extensive literature shows wide variations in life expectancy (LE) across various subnational geographic areas.[1-11] The most often found correlates of these often-dramatic variations are socioeconomic status (SES) factors.[5,7,12,13,14] However, little is known about these variations across very small levels of geographic disaggregation in Canada.

This study expands the boundaries for such analyses by focusing on metropolitan areas, allowing an examination of small area variations in LE that cannot be ascribed to provincial- or federal-level health, social, and other policies and programs, as more than one metropolitan area per province can be studied.

This study develops new estimates of LE at the finest feasible level of geography—the census tract (CT)—in a way that is highly comparable with existing U.S. data. Collections of CTs for Canada's largest cities (in all cases defined as census metropolitan areas [CMAs]) and for the counties in the United States containing its largest cities form the focus of this analysis. Key questions focus on how these more finely disaggregated geographies' LEs vary with SES measures and whether the patterns in Canada are similar to those in the United States.

Data and methods

This analysis involves only statistical analysis of already publicly available aggregated data.

Data and methods, Canadian census tract-level life expectancy

To produce robust and recent LE estimates at the CT level across Canada, death counts from vital statistics records for 11 years, centred on 2011, were summed from 2006 to 2016. The population counts for each CT came directly from the full population census. For each CT, an abridged life table was constructed, using five-year age groups starting at age 20, up to an open-ended age group of 85 and older.

In some instances, the CTs identified on death certificates changed physical boundaries over the 11-year period and did not match those in the 2011 Census. Where a 2011 CT subsequently split into two or more CTs, the daughter CTs were rejoined to match the 2011 Census CT. For CTs that were established during the 2011-to-2016 period and therefore did not exist in 2006, deaths were summed only over the six years from 2011 to 2016.

These summed CT death counts, produced in a Statistics Canada research data centre, were randomly rounded according to the Statistics Canada data release policy to prevent any identifiability. The 2011 Census population counts by five-year age group and CT were used.[15] The cell counts in the released death count table were all divided by 11 (or 6 where the CT had not existed in 2006) to provide annual averages. These two sets of counts were assembled in the usual manner into abridged life tables, one for each CT, with the widely used South East Public Health Observatory (SEPHO) tool[16,17] based on Chiang.[18]

Not all of the 5,438 CTs in the 2011 Census with any death counts had sufficient population or death counts to support construction of an adequate abridged life table. CTs with zero population in any of the age groups were considered non-robust and excluded, as were CTs with standard errors in LE greater than or equal to 1.5 years based on SEPHO, leaving 4,429 robust CTs overall, and 3,348 CTs in Canada's 15 largest cities.

The focus of this analysis is on LE at age 20. As mortality rates increase rapidly with age, most small area variations in LE are likely related to variations in mortality rates at higher ages. The decomposition displayed in Figure 1[19] indicates that these LEs reflect, albeit less strongly, small area variations in deaths at younger-adult and middle ages as well.

For each CT, its abridged life table was used to compute the average annual number of life-years lived in each of three age intervals (20 to 44, 45 to 64 and 65 to 84) as proportions of the population alive at the beginning of each of these broad age groups. These proportions are arrayed along the horizontal axis in Figure 1, with all the 4,249 CTs' full LEs arrayed vertically.

Table 1 shows the population sizes of the CTs included in the analysis, ranging from just under 1,000 to over 25,000. Table 2 further shows the populations included by city for the robust CTs. These proportions range from 59.9% in the city of Québec to 90.0% in Oshawa.

Data and methods, U.S. census tract-level life expectancy

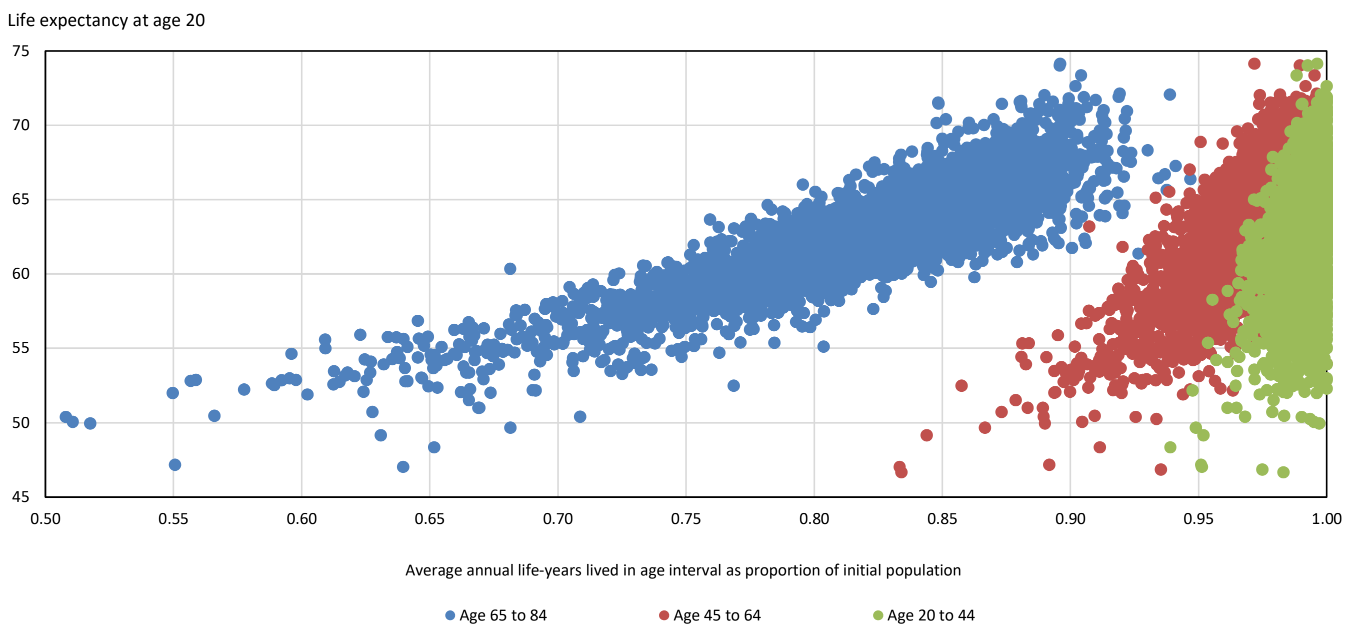
Parallel data were assembled for the U.S. counties with the six largest populations. These counties have been treated as "cities," therefore corresponding as closely as possible to the "city" (or CMA) definition for Canada. For New York City, it was necessary to combine five counties. The U.S. CT-level LEs were obtained directly from the National Center for Health Statistics,[6,20] all having standard errors less than or equal to 4.0 years. The underlying data were for the 15-to-24 age group. So as an approximation, five years were subtracted to provide LEs at age 20, yielding essentially comparable LEs to those for Canada, as U.S. mortality in the 15-to-19 age group is very small.

Finally, for comparability with the Canadian CTs, results for U.S. CTs with standard errors in LE below 1.5 years and below the 4.0-year cut-off based on SEPHO have been considered. About three-quarters of the six U.S. cities' CTs had standard errors greater than 1.5 years.

Data and methods, socioeconomic status factors

There is pervasive evidence for a broad range of SES factors as major determinants of population health, including LE. For this analysis, the focus is on the readily available CT-level data for 2011, downloaded from published National Household Survey tables.[21] Based on regressions of LE on each of eight SES variables, those with the largest R^2 and slope coefficients were income-poverty rates (percentages of households with incomes

Figure 1
Arriaga-style decomposition of life expectancy at age 20 for broad age groups across census tracts



Notes: Each dot represents one robust census tract (CT). The decomposition is based on an Arriaga-style decomposition, with the broad age intervals based on the South East Public Health Observatory abridged life tables combining results from four or five five-year age groups for the results between exact ages 20 and 44, 45 and 64, and 65 and 84 . Only CTs with summed 2006-to-2016 (or in some cases 2011 to 2016) death count data that are non-zero in all five-year age groups from 20 to 84, as well as 85 and older, and with 2011 National Household Survey data are included.
Source: Authors' calculations based on special tabulations of death counts and downloaded public census detailed census tract tables combined to estimate CT-level LE using the South East Public Health Observatory (2005) algorithm for abridged life tables.

Table 1
Population size distributions for Canadian census tracts, 2011

Statistics	All census tracts with data	Census tracts in 15 largest CMAs
Total	20,311,880	16,573,625
Minimum	780	850
1st percentile	1,534	1,617
5th percentile	2,275	2,347
1st quartile	3,585	3,669
Median	4,680	4,775
3rd quartile	5,955	6,028
95th percentile	7,727	7,815
99th percentile	10,345	10,695
Maximum	26,180	26,180

Notes: CMA = census metropolitan area. Only census tracts with summed 2006-to-2016 (or in some cases 2011 to 2016) death count data that are non-zero in all five-year age groups from 20 to 84, as well as 85 and older, and with 2011 National Household Survey data are included.
Source: Special tabluations of downloaded public 2011 Census of Population data.

Table 2
Populations of census tracts included, 2011

CMA	CMA population	Included CT population	Number of CTs included	CT population included (%)	Average CT population
Toronto	5,582,635	4,994,970	952	89.5	5,269
Montréal	3,824,285	2,572,185	550	67.3	4,711
Vancouver	2,309,515	2,004,465	380	86.8	5,331
Ottawa–Gatineau	1,235,265	994,405	213	80.5	4,758
Calgary	1,214,840	1,001,310	206	82.4	4,957
Edmonton	1,157,230	1,062,555	216	91.8	5,012
Québec	765,705	458,730	104	59.9	4,587
Winnipeg	728,835	644,975	143	88.5	4,640
Hamilton	720,960	658,810	164	91.4	4,118
Kitchener–Cambridge–Waterloo	477,140	430,475	88	90.2	5,125
London	474,795	441,185	99	92.9	4,644
St. Catharines–Niagara	392,210	368,970	87	94.1	4,445
Halifax	390,315	325,565	78	83.4	4,400
Oshawa	356,165	320,515	68	90.0	5,008
Victoria	344,620	294,510	60	85.5	5,259

Notes: CMA = census metropolitan area. CT = census tract. Only CTs with summed 2006-to-2016 (or in some cases 2011 to 2016) death count data that are non-zero in all five-year age groups from 20 to 84, as well as 85 and older, and with 2011 National Household Survey data are included.
Source: Special tabluations of downloaded public 2011 Census of Population data.

below the low-income measure, after-tax [LIM-AT]) and median household income. These SES variables were followed in descending order of quantitative importance by the proportions of individuals with at least some postsecondary educational attainment and the proportions who were renters. The proportions of individuals who were immigrants, who were aged 15 or older and employed, and whose language spoken at home and mother tongue were neither English nor French were not as quantitatively important (data not shown). As a result, the income-poverty (as measured by the LIM-AT) and median income variables were the primary indicators used in the analysis.

For the comparison with the United States, the official U.S. Census Bureau poverty rates[22] by CT were used as the primary SES factor.

Results

In accordance with broader results at the national and provincial or state levels, LE at age 20 was substantially higher in the 15 largest Canadian CMAs than in the 6 largest U.S. cities across the robust CTs studied. Table 3 shows the unweighted averages, medians, and distributions of CT-level LE. Median CT-level LE at age 20, depending on the cities being compared, ranges from three to almost eight years higher in Canada than in the United States.

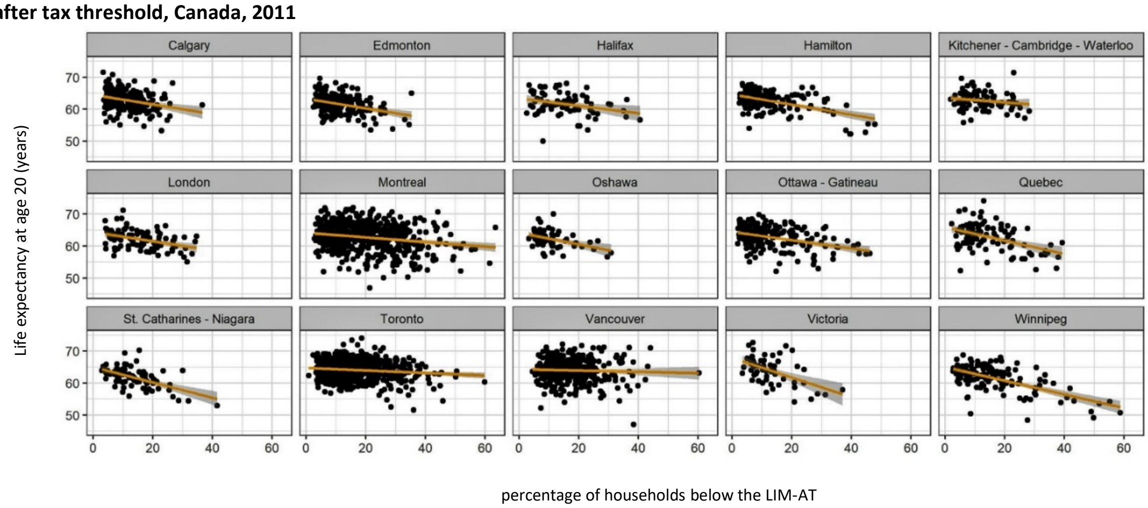
However, within Canadian and U.S. cities, there are very large differences in LE across each city's CTs. In fact, the interquartile and 95th-to-5th percentile ranges are generally wider in Canadian cities than in U.S. cities. Victoria, Montréal, and the city of Québec show the widest ranges, at around 14 years, while Toronto and Oshawa show the smallest ranges, at 8.5 and 8.1 years. By comparison, the 95th-to-5th percentile ranges in the six U.S. cities vary from 7.7 years in Los Angeles to 10.3 years in Houston (but see discussion of Figure 4 below).

Table 3
Life expectancy distributions for robust census tracts, 15 largest cities in Canada and 9 largest cities in the United States, 2011

		Life expectancy at age 20							
Cities	Number of census tracts	Mean	Median	25th percentile	75th percentile	5th percentile	95th percentile	75th to 25th	95th to 5th
Canada									
In top 15 CMAs	3,348	63.1	63.3	61.1	65.3	57.1	68.3	4.2	11.2
Not in top 15 CMAs	829	61.6	62.0	59.5	64.0	55.2	66.4	4.5	11.2
Toronto	948	64.1	64.2	62.6	65.9	59.8	68.2	3.3	8.5
Montréal	546	62.6	63.1	60.1	65.6	55.0	69.1	5.5	14.1
Vancouver	376	64.0	64.0	62.1	66.4	57.5	69.5	4.3	11.9
Ottawa–Gatineau	209	62.8	63.3	61.0	65.1	56.9	67.5	4.2	10.6
Calgary	202	62.8	62.9	60.9	64.9	57.5	67.4	4.0	9.9
Edmonton	212	61.6	61.7	59.8	63.2	56.9	66.5	3.4	9.6
Québec	100	62.8	63.5	60.3	65.6	56.0	69.1	5.3	13.2
Winnipeg	139	61.5	62.2	59.8	64.3	54.2	66.7	4.5	12.6
Hamilton	160	62.6	63.0	61.1	64.5	57.4	66.7	3.4	9.4
Kitchener–Cambridge–Waterloo	84	62.7	62.5	61.0	64.4	58.3	67.5	3.5	9.2
London	95	62.1	62.4	60.0	63.9	57.6	66.5	3.9	9.0
St. Catharines–Niagara	83	61.7	62.2	60.3	63.5	56.0	65.9	3.2	9.9
Halifax	74	61.6	61.5	59.7	64.0	56.0	67.2	4.4	11.2
Oshawa	64	62.2	62.3	60.8	63.6	57.6	65.7	2.7	8.1
Victoria	56	63.9	64.1	60.8	66.8	56.5	70.7	6.0	14.2
United States									
New York City	437	59.3	59.3	57.5	61.3	54.6	63.1	3.8	8.5
Los Angeles	541	60.0	60.2	58.1	61.7	56.1	63.8	3.6	7.7
Chicago	399	58.9	59.3	56.8	61.2	53.2	63.3	4.4	10.1
Houston	178	57.5	57.5	55.5	59.9	52.0	62.3	4.4	10.3
Phoenix	175	58.7	58.9	56.9	60.6	54.0	62.2	3.7	8.3
Philadelphia	112	56.0	56.3	53.9	58.0	51.3	60.9	4.1	9.6
San Antonio	119	57.6	57.5	55.7	59.1	54.1	62.1	3.4	8.0
San Diego	188	60.1	60.3	58.7	61.7	55.9	64.0	3.0	8.1
Dallas	133	57.5	57.7	55.8	59.4	52.6	62.1	3.6	9.5

Notes: CMA = census metropolitan area. For Canadian and U.S. census tracts (CTs), only those with life expectancy standard errors below 1.5 years are included. Canadian data are centred on 2011; U.S. data are centred on 2013. Only robust Canadian CTs with summed 2006-to-2016 (or in some cases 2011 to 2016) death count data that are non-zero in all five-year age groups from 20 to 84, as well as 85 and older, and with 2011 National Health Survey data are included.
Sources: South East Public Heath Observatory (2005), based on special tabluations of downloaded public 2011 Census of Population data, and National Center for Health Statistics (2018).

Figure 2
Life expectancy at age 20 in census tracts for 15 census metropolitan areas by prevalence of income below the low-income measure, after tax threshold, Canada, 2011



Notes: LIM-AT = low-income measure, after tax. Coloured lines represent linear regressions with bands indicating 95% confidence intervals. Only robust census tracts with summed 2006-to-2016 (or in some cases 2011 to 2016) death count data that are non-zero in all five-year age groups from 20 to 84, as well as 85 and older, and with 2011 National Household Survey data are included.
Sources: South East Public Health Observatory (2005), based on special tabluations of downloaded public 2011 Census of Population data; and Statistics Canada, 2011 National Household Survey.

LE is associated with SES factors in Canada and the United States, though the strengths of these associations were very different in Canada and the United States. To start, Figure 2 shows LE at age 20 for each of the 15 cities plotted against the income-poverty rate in each of its robust CTs. Little or no correlation is observed for Canada's three largest cities (Toronto, Montréal, and Vancouver), while several smaller cities (Winnipeg, Hamilton, and St. Catharines–Niagara) exhibit a noticeable gradient, with higher income-poverty rates in a given CT associated with lower LE.

Figure 3 shows somewhat stronger (positive) associations between median household income and LE among CTs, though the slopes of these relationships vary considerably across the cities. For figures 2 and 3, Victoria, British Columbia, shows the steepest slopes.

For comparisons with the largest cities in the United States, excluding CTs with a standard error greater than 1.5 years eliminates the majority of CTs. Therefore, Figure 4 juxtaposes scatterplots for CT-level LE and income-poverty rates first for Canada's six largest cities (leftmost column, all over 1 million population) and then for the six largest U.S. cities. For these six U.S. cities, two sets of scatterplots are shown: one for all CTs, with comparable LE standard errors less than 1.5 years (middle column), and one for all the available CTs where the standard errors in LE were less than 4.0 years (rightmost column).

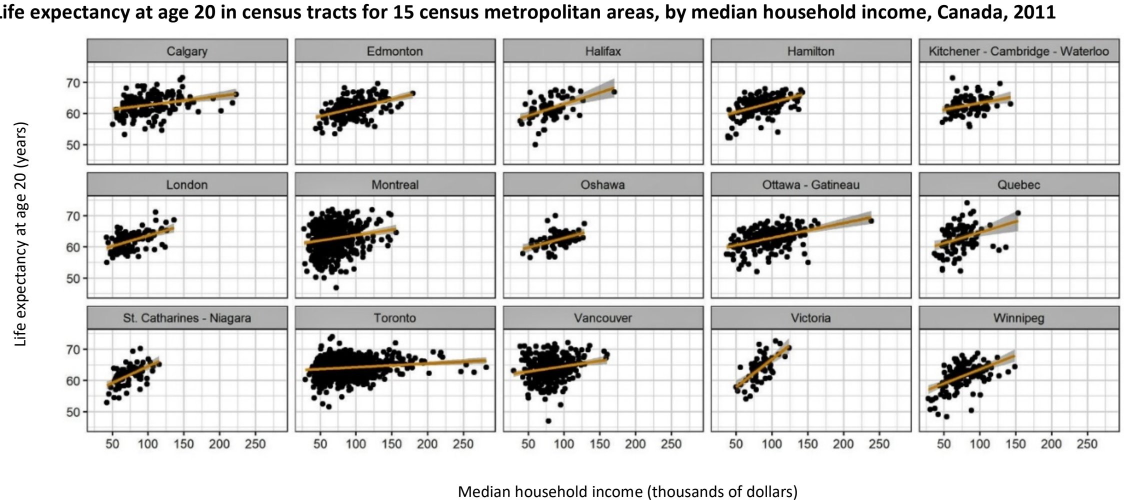
Figure 5 contrasts the slope coefficients and the strengths of the associations (R^2) between CT-level LE and income-poverty rates for the six Canadian cities and six U.S. cities. They are both considerably weaker in Canada.

Since these observations are at a subprovincial or substate level, the implication is that important factors influencing LE at finer levels of geography must be important. In Canada, the relevant factors cannot be national (such as the structures of unemployment insurance and old age pension programs) or provincial (such as access to health care and welfare benefit structures). Moreover, in Canada, the factors must not be as income-poverty related as in the United States.

Several points are notable in this juxtaposition, recalling that "city" in Canada refers to a CMA while in the United States it is defined by its county (except for New York City, which is a combination of five counties):

- As expected, when drawing on all the available U.S. CTs' data rather than those with standard errors less than 1.5 years for the six U.S. cities, there are many more CTs (dots) in the rightmost column than in the middle column of scatterplots shown in Figure 4.
- Based on this comparison showing the impacts of the exclusion of the non-robust U.S. CTs, the interquartile and 95th-to-5th percentile ranges in LE for the U.S. cities shown in Table 3 above are likely biased downward.
- The regression slopes plotted in the middle and rightmost columns are very similar; the restriction in the U.S. cities to CTs with standard errors in LE less than 1.5 years appears not to have had a notable effect.
- The slopes of the regression lines in the six U.S. cities are generally steeper than for the six largest Canadian cities.
- The U.S. cities have substantially more CTs with very high income-poverty rates than the Canadian cities

Figure 3
Life expectancy at age 20 in census tracts for 15 census metropolitan areas, by median household income, Canada, 2011



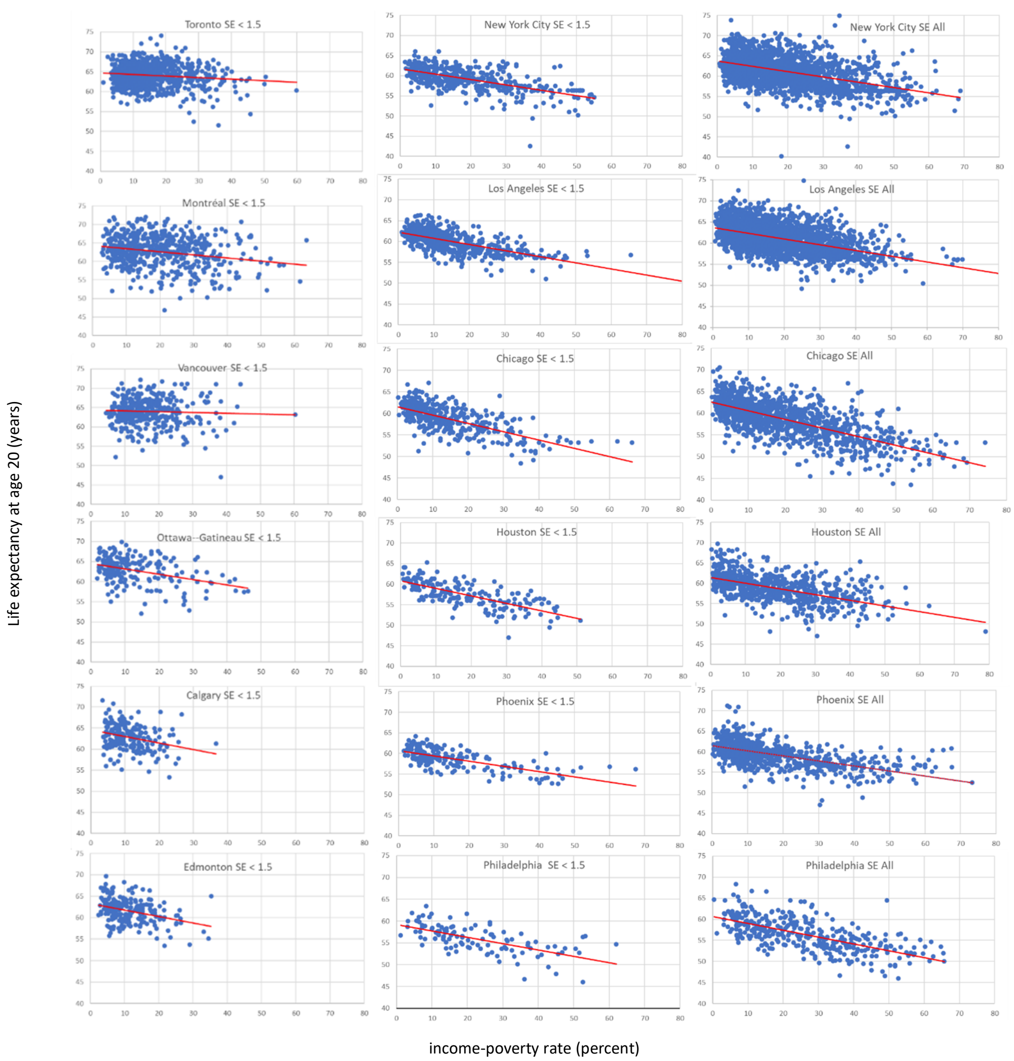
Notes: Coloured lines represent linear regressions with bands indicating 95% confidence intervals. Only robust census tracts with summed 2006-to-2016 (or in some cases 2011 to 2016) death count data that are non-zero in all five-year age groups from 20 to 84, as well as 85 and older, and with 2011 National Household Survey data are included.
Sources: South East Public Health Observatory (2005), based on special tabluations of downloaded public 2011 Census of Population data; and Statistics Canada, 2011 National Household Survey.

- The scatterplots of CT-level LEs within each city around the regression lines—especially comparing CTs with standard errors in LE less than 1.5 years (the first two columns)—are wider for Canada. The U.S. CT-level LEs are more tightly clustered around their regression lines and have higher R^2s, indicating that the extent to which the relationships in each city are explained by the income-poverty rate is considerably lower in Canada, as shown in Figure 5.

Discussion

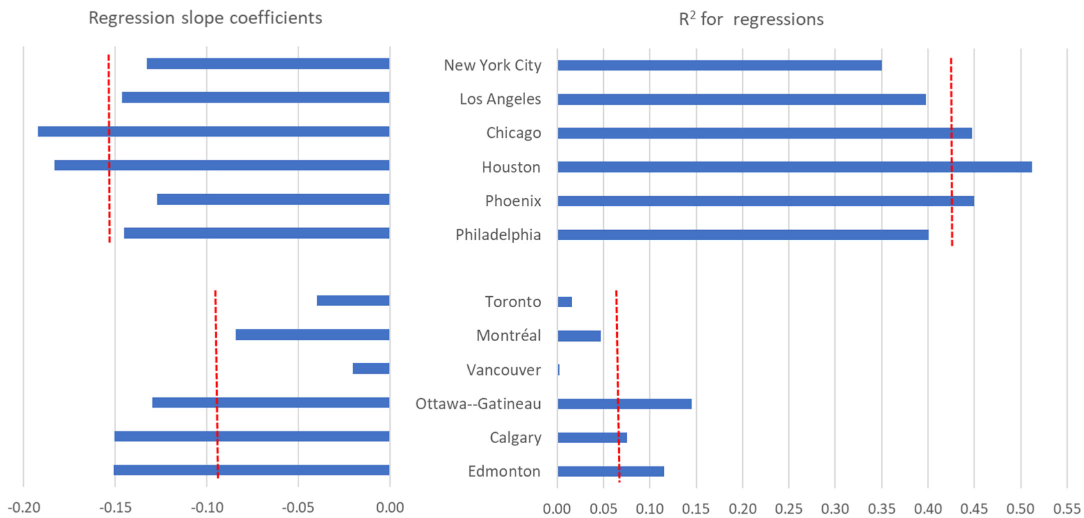
This analysis demonstrates large geographic variations in LE down to the smallest feasible level of geographic disaggregation, the CT. The variations in these CT-level LEs have been examined for each of Canada's 15 largest cities. These CT-level variations have also been compared with corresponding and highly comparable data for the U.S. counties containing the six largest U.S. cities. For the Canadian cities,

Figure 4
Census tract life expectancy at age 20 and income-poverty rates for the six largest cities in Canada and the United States



Notes: Los Angeles has one census tract (CT) with an income-poverty rate over 80%, which has been truncated. Canadian data are centred on 2011, whereas U.S. data are centred on 2013. Each dot represents one CT. The solid lines are regressions; their slopes and R^2s are shown in Figure 5. The first two columns show only CTs where the standard error (SE) of the life expectancy (LE) is less than 1.5 years; the rightmost column shows all U.S. CTs with available LEs, which have SEs up to 4.0 years. Only Canadian CTs with summed 2006-to-2016 (or in some cases 2011 to 2016) death count data that are non-zero in all five-year age groups from 20 to 84, as well as 85 and older, and with 2011 National Household Survey data are included.
Sources: South East Public Health Observatory (2005), based on special tabulations of 2011 Census of Population data; and National Center for Health Statistics (2018).

Figure 5
Regressions of census tract life expectancy (years) on poverty rates (%) for the six largest cities in Canada and the United States, 2011



Note: Vertical dashed lines indicate unweighted means.
Sources: South East Public Health Observatory (2005), based on special tabulations of 2011 Census of Population data; and National Center for Health Statistics (2018).

even within these subprovincial city-level geographies, there were significant variations in LE across their constituent CTs; LE varied by well over a decade (Table 3).

The results also extend findings of associations between LE and SES factors, where income-poverty as indicated by Statistics Canada's LIM-AT and median household income were found to have the strongest associations among the eight different SES factors examined (results not shown).

To provide a context for the Canadian city-level results, comparisons for the six largest Canadian cities (or CMAs) and six largest U.S. cities (or counties) have been shown. First, the **range** of LE across CTs is sometimes wider within Canadian cities than in the largest U.S. cities (Table 3), even though Canada is a significantly more egalitarian society—not only in terms of incomes,[23,24] but also in other domains such as education.[25] These Canada–United States differences are reminiscent of findings by Ross et al.,[26] who reported a very clear correlation between city-level income **inequality** and working age mortality in U.S. cities, but essentially none in Canadian cities. This older research, combined with the very distinct Canadian vs. U.S. patterns observed here (figures 4 and 5), suggests that a range of factors in Canada substantially weakens the strengths of the associations between LE and SES factors compared with the United States.

A more recent analysis by Wolfson et al.[27] sought to explain the earlier finding of a dramatic Canada–United States difference in the relationship between income inequality and mortality.[26] However, this analysis failed to support the hypothesis that the difference is related to neighbourhood segregation, especially racial segregation, which is far more evident in the United States. Instead, the authors pointed to the greater extent of social stratification in the United States. Corak's[28] "Great Gatsby Curve" shows almost twice the rate of intergenerational income mobility in Canada compared with the United States, notwithstanding the longstanding U.S. rhetoric about being the land of opportunity. This greater stratification is also indicated by comparisons of the gradient in educational attainment from the Organisation for Economic Co-operation and Development's Program for International Student Assessment study.[25] A further indication of this greater social stratification in the United States compared with Canada is the gradients for measures of children's math scores in relation to parental and neighbourhood SES. This gradient is significantly steeper (and lower) in the United States than in Canada.[25] Second, Wolfson et al.[27] point to a generally neglected factor, the distribution of local public goods, as indicated by the comparatively smaller extent of local government fragmentation (in municipal governments and school boards) in Canada compared with the United States. U.S. metropolitan areas (i.e., "cities" in this study) have many more school boards and municipal governments than their Canadian counterparts. Indeed, in Canada, municipal amalgamations may be seriously underrated regarding their public health benefits.

More definitive analyses of these potential factors, however, must await the development of adequately comparable Canada–United States data at the submunicipal level.

Limitations and strengths

While the associations between SES factors and CT-level LE are clear and pervasive, there are longstanding debates about the "true" causal factors, including whether these associations may be no more than statistical artifacts. Since the data used are all at the level of partially aggregated CT population groups, they are susceptible to an ecological fallacy. As Gravelle[29] has argued in the case of income inequality as the SES factor, these associations could be attributable to nothing more than the aggregation of individual-level **non-linear** associations. However, there is strong evidence that factors at various geographically aggregated levels are not merely statistical artifacts reflecting ecological fallacies, including evidence that controlled statistically for individual-level and aggregate-level factors.[30,31]

An important concern with the U.S. data is the substantially higher proportion of CTs with LE standard errors greater than 1.5 years. Such CTs were excluded from the Canadian portion of the analysis. However, as shown in Figure 4, considering all the available U.S. city CTs indicates that the key results were not highly sensitive to the exclusion. There is also a notable difference in the income-poverty measures used. The U.S. poverty line in dollar terms (including purchasing power parity adjustment) is considerably lower than the one used in Canada. A further limitation for the U.S. data is the approximation of LE at age 20 by using LE at age 15 minus five years.

An important limitation of this analysis, and virtually all other analyses of small area variations in LE, is a failure to account for geographic mobility, where the CT of usual residence may not be the CT where an individual's death is recorded. The abridged life tables at the foundation of the analysis are premised on no inter-CT migration—the death counts in the numerators of the mortality rates are geocoded to the individuals' residence at the time of death, not to where they may have lived previously.

Another possible form of confounding migration involves nursing homes, where age-specific mortality rates are significantly higher than for the household population. Such confounding would arise if moving to a nursing home involved crossing a CT boundary.

There have been only a few attempts to assess this "no mobility" assumption, and the general conclusion for U.S. states,[32] U.S. counties[4] and Vancouver[9] is that such migration is unlikely to have a meaningful effect. Nevertheless, this question merits further empirical exploration.

Another potential weakness is the use of census data without considering census undercounts. To the extent that undercounts at the CT level are correlated with mortality or SES factors, these results will be biased. Also, the analysis has not weighted CTs according to their population sizes.

The major strength of this analysis is the development of robust CT-level estimates of LE for Canada, which were then used first to quantify the extent of small geographic area variations, and then to explore previously unexamined correlations with widely studied SES factors. Another strength is that the Canadian CT-level LE estimates have been constructed to be methodologically highly comparable with those produced for the United States.

Conclusion

Canada is a more egalitarian society than the United States. However, the ranges of variations in LE within large cities are generally as wide in Canada as in the United States. CT-level LE in a number of Canada's 15 largest cities differs by well over a decade. Among these 15 cities, however, there are considerable differences in how wide this variation in LE is (e.g., there was almost twice the difference in LE across Victoria and Montréal as across the CTs in Toronto and Oshawa [Table 3]).

In Canada and the United States, these variations were significantly associated with income-poverty rates, but these associations were not only variable across the 15 cities in Canada (in Figure 2 and for median incomes in Figure 3), but also substantially stronger in the largest U.S. cities than in Canada's largest cities (figures 4 and 5). Because these variations were at the city level, in some cases with more than one city per province or state, explanatory factors operating at the national or provincial or state levels of geography are unlikely.

The generally weaker associations between LE and SES factors in Canada compared with the United States suggests the existence of substantially stronger mitigating factors in Canada. However, even though SES factors are not as strongly correlated with LE across CTs in Canadian cities than in U.S. cities, the ranges of variations in LE within cities were in some cases even wider in Canadian cities than in U.S. cities. In both cases—weaker SES associations with CT-level LE in Canada than in the United States and, at the same time, even wider dispersion in CT-level LE within some Canadian cities—the underlying factors are unknown.

Some evidence suggests that Canada–United States differences in social stratification (with significantly more intergenerational mobility in Canada than in the United States) and municipal governance (with more equitable distributions of local public goods given less fragmentation of local governance) rather than racial segregation as such may be the most important factors. To the extent these study results are borne out in future research, emphasis on equitably distributed public education and other local services may be more critical for improved population health than is generally appreciated. These observed systematic patterns of differential longevity call out for further investigation, as there may be opportunities to alter the underlying factors giving rise to the differences, especially to improve overall population health and to reduce health inequities. More probing analysis must await more detailed and comparable submunicipal data for cities in both countries.

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