A deprivation index for health planning in Canada

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Abstract

Administrative databases in the Canadian health sector do not contain socio-economic information. To facilitate the monitoring of social inequalities for health planning, this study proposes a material and social deprivation index for Canada. After explaining the concept of deprivation, we describe the methodological aspects of the index and apply it to the example of premature mortality (i.e. death before the age of 75). We illustrate variations in deprivation and the links between deprivation and mortality nationwide and in different geographic areas including the census metropolitan areas (CMAs) of Toronto, Montréal and Vancouver; other CMAs; average-size cities, referred to as census agglomerations (CAs); small towns and rural communities; and five regions of Canada, namely Atlantic, Quebec, Ontario, the Prairies and British Columbia. Material and social deprivation and their links to mortality vary considerably by geographic area. We comment on the results as well as the limitations of the index and its advantages for health planning.

Key words: *Social inequalities, deprivation, health, health planning, premature mortality, Canada, geographical areas, metropolitan areas, urban areas, regions*

Introduction

At a recent Canadian conference on health indicators, the participants proposed a list of 150 indicators as a means of giving the public, care providers and health authorities reliable and comparable data on health and the health system.[1] The participants also pointed out the need to report on inequalities in health, especially those resulting from socio-economic status and urban or rural location of residence.

Since the late 1970s, the production of health surveys such as the Canada Health Survey,[2] the National Population Health Survey (NPHS)[3] and the Canadian Community Health Survey (CCHS)[4] have addressed this need. They contain general measures of health and health service use, as well as information on income, education, family structure and other socio-economic characteristics of respondents which can easily be cross-tabulated. The same cannot be said of the administrative databases created by provincial authorities to track the progression of vital statistics, such as mortality, or the use of health services, such as hospital admissions and primary care; these databases contain no socio-economic data on the individuals concerned.

To make up for this shortcoming, researchers generally use geographic proxies. These pieces of socio-economic information relate to small areas that can be introduced into administrative databases by linking these areas to the data available in the databases. This approach was initiated in Great Britain[5] and then introduced to other countries,[6-8] including Canada.[9-13]

All the Canadian studies that have used geographic proxies tracked social inequalities in health, generally using mortality as a health indicator, although some also considered measures of morbidity and use of health services. These analyses have also largely focused on urban areas and have tended to use only one indicator of social disparity—neighbourhood income.

The contribution made by these studies is undeniable. However, while income is a powerful indicator of health and has ramifications for other determinants of health, it cannot take the place of all those other determinants.[14,15] This is why more complex measures, namely deprivation indexes, have been developed in Great Britain[16-23] and elsewhere in Europe (Sweden,[24] Italy,[25] Spain,[26] France[27]), as well as in the United States,[7,28,29] Japan[30] and New Zealand.[31] Such indexes cover a wide range of domains, from material deprivation alone[17,20,23] to seven separate domains, including income, employment, health, education, crime, housing and living environment.[22] Such indexes have already been proposed in Canada, namely in Manitoba and Quebec, and in the metropolitan area of Vancouver.[32-35] They vary substantially in content and design and none covers Canada as a whole.

The deprivation index developed in Quebec has been widely used in the health sector. Since 2000, it has been introduced into a

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dozen administrative databases covering mortality, births, hospital admissions, medical services, nursing homes, youth protection services, clients of *Centres Locaux de Services Communautaires* (CLSCs) and community organizations.[34,36-44] The index is also being used for regional resource allocation in Quebec[40] and is associated with various products (for example, SAS program used to assign the index, population tables based on the index, interactive index mapping, etc.) that are available free of charge on the Internet.[45]

We propose a national version of the deprivation index developed in Quebec. Our goal is to describe the conceptual and methodological bases of the index, to explore its validity and variations according to geographic areas that reflect Canada's diversity, and to illustrate its use in health planning through a single example—premature mortality.

We begin by defining the concept of deprivation and go on to describe the data and methods that are the foundation of the index. We present the results in relation to premature mortality and discuss the advantages of using the index in health planning.

The concept of deprivation

In the mid-1980s, Peter Townsend proposed a definition of deprivation as "a state of observable and demonstrable disadvantage relative to the local community or the wider society or nation to which an individual, family or group belongs."[46] This disadvantage may occur at various levels, for example, with regard to food, housing, education, work or social ties. A person is considered deprived if he or she falls below the level attained by the majority of the population or below what is considered socially acceptable. Townsend distinguishes two forms of deprivation: material and social. Material deprivation involves deprivation of the goods and conveniences that are part of modern life, such as adequate housing, a car, a television set, or a neighbourhood with recreational areas. Social deprivation refers to relations within the family and in the workplace and community.

This idea of deprivation is related to a number of other concepts. Material deprivation evokes the concept of poverty, [47] as in a lack of financial resources. For Townsend, however, poverty leads to deprivation in that it stands in the way of the acquisition of the goods and conveniences that are part of modern life. Social deprivation is related to the concept of social capital[47] and associated concepts, such as social fragmentation[48] and social isolation.[49] In all cases, it is a question of the type of social interactions (mutual trust and help, for example), as well as the intensity and quality of such interactions.

In summary, what we need to retain from Townsend's definition is that deprivation cannot be reduced to a single material or economic dimension; it must also take into account social interactions.

Data and methodology

Basic spatial unit

The deprivation index is based on a spatial unit. Since the index is intended as a substitute for measures of individuals, the selected unit must be as small as possible in order to ensure a high degree of homogeneity in the socio-economic conditions attributed to each resident in this unit.[8] The selected unit is the dissemination area (DA),[50] which comprises one or more neighbouring blocks of houses, with a population of 400 to 700 persons.

We constructed the index in two stages. In the first stage, we set aside DAs comprising no population, DAs with a high proportion of collective households or institutionalized persons (more than 15% of the total population or over 80 people living in collective households), DAs that had no B profile (socio-economic) or income data (sparsely populated DAs), and DAs in Nunavut Territory or located on a First Nations reserve. This left 42 430 DAs covering slightly more than 93% of the Canadian population. In the second stage, we projected the obtained deprivation values onto an additional number of DAs, including the DAs for which it was possible to adequately impute* an income value (3572 DAs); the DAs located in Nunavut and on First Nations reserves with a complete B profile or imputed income value (857 DAs); and DAs that had been excluded due to their high proportion of collective households or institutionalized persons but whose population with a B profile (or imputed income) accounted for more than 85% of the total population (605 DAs). As a result, a deprivation index was established for 47 464 DAs, or close to 98% of the population of Canada.

Socio-economic indicators

The indicators used to construct the index were selected on the basis of a literature review. To be selected, indicators needed to meet four criteria: have known links with health, previous use as geographic proxies, affinity with the material or social dimensions of deprivation, and availability by DA.[5,14,15,25,35,49,51,52] This approach made it possible to identify the six indicators that were taken into account to construct the index: the proportion of people aged 15 years and older with no high school diploma (SCOLAR); the employment/population ratio of people aged 15 years and older (EMPLOI); the average income of people aged 15 years and older (REVENU); the proportion of individuals aged 15 years and older living alone (SEULES); the proportion of individuals aged 15 years and older who are separated, divorced or widowed (S_D_V); and the proportion of single-parent families (F_MONO).†

In some instances, the selected indicators varied significantly with the age and sex of the population. This was true of education, for example, since many young people less than 20 years old have not completed their schooling while many older people have a low level of education. Since the variations being tracked are socio-economic rather

* Imputation of income was by the nearest-neighbour method, based on the Euclidian distance between the other indicators (other than income) included in the deprivation index, using the SAS FASTCLUS procedure.

† Families include couples with or without children and single parents with at least one child. [50]

than demographic, these indicators, with the exception of F_MONO, were adjusted according to the age-sex structure of the Canadian population[31] using direct standardization.[53] Moreover, certain indicators were transformed in order to normalize their distribution.[54] For example, the REVENU variable was transformed into its log values and the SEULES variable into its arcsine values.

Integration of indicators

The integration of indicators in the form of a deprivation index was carried out using principal component analysis (PCA), the preferred approach for developing such indexes.[25-29,31,49,55] This analysis yields fewer dimensions, reflecting the spatial organization of socio-economic indicators. A varimax rotation was applied to these dimensions to increase readability and to make them independent (or orthogonal). To validate the relevance of this factor structure across Canada, the PCA was repeated for the three largest census metropolitan areas (major CMAs), Toronto, Montréal and Vancouver; various other geographic areas, namely other CMAs, census agglomerations (CAs), small towns and rural communities; and each of five regions, Atlantic, Quebec, Ontario, the Prairies and British Columbia. The literature shows that measures of deprivation perform differently in urban and rural settings.[52,56-60]

For each component identified, the PCA produces a factor score which represents the value of the component in each DA. To ensure statistical accuracy in analyzing social inequalities in health, the DAs were grouped together. The DAs were first ranked according to their factor score from the most to the least privileged. Then, the distribution of DAs was broken down into quintiles, with each quintile representing 20% of the population. Quintile 1 (Q1) represents the most privileged population and quintile 5 (Q5), the least. These operations were carried out separately for each component of the analysis. Since deprivation is seen as a relative disadvantage compared with the community to which people belong, different versions of the index were produced by modifying the reference territory. Accordingly, there is a national version, a version by major CMA, a version by geographic area and a version by region. These versions are based on the PCA conducted in each setting and on the distribution of factor scores, ensuring an equal distribution of the population (20%) per material and social quintile.

Any of these versions can be used to reflect the discrepancies in deprivation that exist in each setting and also to compare populations of the same proportion. In the following analysis, the version of the index varies according to the reference territory considered. The values presented for Canada as a whole stem from the national version. Those presented for the geographic areas, major CMAs and regions of Canada stem from the geographic area, major CMA, and region of Canada versions, respectively.

Premature mortality

To illustrate how the index can be used to study socio-economic indicators of health for the purpose of health planning, we use the example of premature mortality, or death before 75 years of age. This is a general measure of population health[1] whose relationships with socio-economic conditions have been extensively documented on an international scale.[61-66]

Taking into account deaths in 2001 and using the reference population from the census of the same year, we estimated the mortality rates using the negative binomial regression model, a generalization of the Poisson regression model that takes into account the problem of overdispersion.[67] We estimated models in each geographic area for all deaths (all causes combined) and the entire population (both sexes combined). In these models, mortality rates were estimated for each quintile of material and social deprivation, from the most privileged (Q1) to the most deprived (Q5), and for the extreme quintiles on both dimensions (Q1-Q1 and Q5-Q5), adjusting for age, sex and, where applicable, geographic area and the other form of deprivation (material or social). Thus, when the mortality rate varies with both forms of deprivation simultaneously, this signifies that each form of deprivation is contributing to mortality independently. An interaction term between the two forms of deprivation was introduced into the models when a significance threshold of 5% was reached. The variability of adjusted rates was estimated using the Delta method.[68]

To obtain a satisfactory portrait of the inequalities in mortality according to deprivation, we considered three measures: the adjusted mortality rate, the ratio, and the difference in adjusted mortality rates.[69-71] The mortality rate (per 100 000 inhabitants) expresses the level of mortality in each group. The ratio and the difference in the mortality rates illustrate, respectively, the relative and absolute discrepancies in mortality rates between groups at the extreme ends of the deprivation spectrum. Taking both forms of deprivation into consideration simultaneously, the mortality ratio is obtained by dividing the rate for the most deprived group (Q5-Q5) by that of the most privileged group (Q1-Q1). The difference in mortality is obtained by subtracting the rate for the most privileged group (Q1-Q1) from that of the most deprived group (Q5-Q5).

Results

The deprivation index

The deprivation index covers almost 98% of the Canadian population, and this percentage varies little from one geographic area to the next (Table 1). The index covers close to 90% of DAs in Canada, with a higher proportion of DAs in CMAs than in smaller towns and rural communities. This discrepancy is due to the greater number of DAs with no population in smaller towns and rural communities.

The Canada-wide PCA reveals the presence of a two-component factor structure (Table 2). Each of these components summarizes approximately one-third of the variations associated with the six indicators considered, for a total of 67% of these variations. The meaning of the components differs considerably. Whereas the first component primarily portrays variations associated with education, employment and income, the second indicates the state of being separated, divorced or widowed, living alone, or being a member of a single-parent family. This configuration echoes Townsend's material and social dimensions

TABLE 1
Population and dissemination areas (DAs) covered by the deprivation index by geographic area and region of Canada, 2001

	Population			DA			Average population†
	Total	Covered		Total	Covered		
	n	n	%	n	n	%	n
Area*							
Major CMAs	11 159 876	10 881 733	97.5	17 962	17 297	96.3	629
Other CMAs	8 137 050	7 913 022	97.2	13 357	12 697	95.1	623
CAs	4 542 160	4 446 726	97.9	6 921	6 088	88.0	730
Small towns and rural communities	6 168 008	6 070 620	98.4	14 753	11 382	77.2	533
Region							
Atlantic	2 285 729	2 256 726	98.7	4 202	3 526	83.9	640
Quebec	7 237 479	7 074 786	97.8	12 153	11 208	92.2	631
Ontario	11 410 046	11 132 340	97.6	18 596	17 212	92.6	647
Prairies	5 073 323	4 950 516	97.6	10 315	8 902	86.3	556
British Columbia	3 907 738	3 806 636	97.4	7 463	6 448	86.4	542
Canada	30 007 094	29 312 101	97.7	52 993	47 464	89.6	618

* Approximate populations by geographic area: the major census metropolitan areas (CMAs), 2 000 000 or more; the other CMAs, between 100 000 and 1 000 000; the census agglomerations (CAs), between 10 000 and 100 000; and small towns and rural communities, less than 10 000.

† Average population of dissemination areas in the geographic area or region of Canada.

Source: 2001 Census of Canada.

TABLE 2
Principal components of the deprivation index in Canada

	Component	
Indicator	**Material**	**Social**
SCOLAR*	-0.83	0.00
EMPLOI†	0.71	-0.19
REVENU‡	0.82	-0.27
SEULES§	-0.01	0.84
S_D_V‖	-0.16	0.87
F_MONO#	-0.34	0.65
Explained variance	34%	33%
Cumulative variance	34%	67%

* Ratio of individuals 15 years and older with no high school diploma to the population 15 years and older

† Ratio of individuals 15 years and older who are employed to the population 15 years and older

‡ Average personal income for the population 15 years and older

§ Ratio of individuals 15 years and older living alone to the population 15 years and older

‖ Ratio of individuals 15 years and older who are separated, divorced or widowed to the population 15 years and older

\# Ratio of single-parent families to the total number of families

NOTE: The above values are saturations. They should be interpreted as correlation coefficients between the indicator and the component.

Source: 2001 Census of Canada.

of deprivation.[46] For this reason, and to facilitate the ensuing analysis and discussion, these two components will be referred to as material and social. The PCAs carried out in the different geographic areas and regions of Canada show that these two components were present everywhere, with the exception that the proportion of single-parent families in CMAs is associated with both material and social components equally (Table 3 and Table 4). The explained variance for both components is only slightly lower in small towns and rural communities and decreases from east to west across the country.

Material and social deprivation in Canada

The deprivation index reveals appreciable discrepancies in socio-economic conditions in Canada (Table 5). Material deprivation is accompanied by well-recognized variations in education, employment and income and, to a lesser degree, single-parent families. Social deprivation is more prevalent with single-parent families, with people living alone, and with those who are separated, divorced or widowed. This form of deprivation is also not totally independent of employment and income, as well as a certain degree of population aging, even though the indicators considered have been adjusted for age. By combining the two forms of deprivation and comparing the most privileged population (Q1 and Q1) with the least privileged population (Q5 and Q5) on both the material and social dimensions simultaneously, we note startling contrasts for all indicators that make up the deprivation index.

Such contrasts are observed across Canada, regardless of the geographic area or region (Table 6). However, the magnitude of socio-economic disparities can vary by area or region. The discrepancies in material and social deprivation are generally greater in the major CMAs than in census

TABLE 3
Principal components of the deprivation index by geographic area

Indicator	Major CMAs						Other CMAs		CAs		Small towns, rural communities	
	Toronto		Montréal		Vancouver							
	Component		Component		Component		Component		Component		Component	
	Material	Social	Material	Social	Material	Social	Material	Social	Social	Material	Material	Social
SCOLAR*	-0.81	0.10	-0.84	0.09	-0.81	-0.11	-0.85	-0.01	0.15	-0.77	-0.78	-0.04
EMPLOI†	0.67	-0.13	0.73	-0.19	0.65	0.00	0.67	-0.23	-0.17	0.77	0.75	-0.23
REVENU‡	0.85	-0.17	0.84	-0.25	0.84	-0.20	0.78	-0.35	-0.33	0.80	0.85	-0.03
SEULES§	0.12	0.87	-0.08	0.86	0.10	0.87	-0.04	0.89	0.84	-0.14	0.04	0.79
S_D_V‖	-0.25	0.84	-0.18	0.82	-0.10	0.90	-0.30	0.84	0.88	-0.21	-0.02	0.85
F_MONO#	-0.57	0.54	-0.44	0.63	-0.49	0.48	-0.52	0.56	0.72	-0.32	-0.23	0.68
Explained variance	37%	30%	36%	32%	34%	31%	35%	33%	36%	33%	33%	31%
Cumulative variance	37%	67%	36%	68%	34%	65%	35%	68%	36%	69%	33%	64%

* Ratio of individuals 15 years and older with no high school diploma to the population 15 years and older
† Ratio of individuals 15 years and older who are employed to the population 15 years and older
‡ Average personal income for the population 15 years and older
§ Ratio of individuals 15 years and older living alone to the population 15 years and older
‖ Ratio of individuals 15 years and older who are separated, divorced or widowed to the population 15 years and older
Ratio of single-parent families to the total number of families

NOTE: The above values are saturations. They should be interpreted as correlation coefficients between the indicator and the component. When each component explains essentially the same percentage of the total variance, their position can be inverted.

Source: 2001 Census of Canada.

TABLE 4
Principal components of the deprivation index by region of Canada

Indicator	Atlantic		Quebec		Ontario		Prairies		British Columbia	
	Component		Component		Component		Component		Component	
	Material	Social	Material	Social	Material	Social	Social	Material	Social	Material
SCOLAR*	-0.89	-0.01	-0.84	-0.05	-0.82	-0.02	-0.05	-0.86	-0.02	-0.80
EMPLOI†	0.85	0.00	0.77	-0.17	0.66	-0.24	-0.28	0.54	-0.10	0.68
REVENU‡	0.88	-0.19	0.85	-0.24	0.84	-0.22	-0.26	0.81	-0.24	0.80
SEULES§	0.13	0.80	-0.12	0.82	0.03	0.87	0.82	-0.03	0.87	-0.07
S_D_V‖	-0.06	0.88	-0.09	0.84	-0.28	0.84	0.88	-0.16	0.89	-0.16
F_MONO#	-0.27	0.73	-0.23	0.74	-0.47	0.57	0.67	-0.35	0.57	-0.40
Explained variance	40%	33%	35%	34%	35%	32%	34%	31%	32%	32%
Cumulative variance	40%	73%	35%	69%	35%	67%	34%	65%	32%	64%

* Ratio of individuals 15 years and older with no high school diploma to the population 15 years and older
† Ratio of individuals 15 years and older who are employed to the population 15 years and older
‡ Average personal income for the population 15 years and older
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NOTE: The above values are saturations. They should be interpreted as correlation coefficients between the indicator and the component. When each component explains essentially the same percentage of the total variance, their position can be inverted.

Source: 2001 Census of Canada.

TABLE 5
General characteristics of the Canadian population by quintile of material and social deprivation

Deprivation quintile	Population	Age group		Socio-economic profile					
		Under age 15	65 and over	SCOLAR*	EMPLOI†	REVENU‡	SEULES§	S_D_V‖	F_MONO#
	n	%	%	%	%	$	%	%	%
Material									
1	5 862 195	17.7	12.2	18.1	68.5	40 148	10.1	12.5	11.6
2	5 862 218	19.4	11.6	27.0	66.0	29 658	8.3	13.0	13.5
3	5 862 082	19.4	12.3	32.8	63.0	26 206	8.5	13.5	15.2
4	5 863 106	19.4	12.9	38.7	59.3	23 215	9.1	14.3	17.3
5	5 862 500	20.4	13.0	48.7	49.0	18 542	9.6	14.6	21.5
Social									
1	5 862 396	21.7	9.6	33.2	62.8	30 763	2.7	7.8	8.1
2	5 862 428	20.7	11.2	32.9	62.6	29 038	5.2	10.9	11.2
3	5 861 776	19.9	12.5	33.5	61.4	27 367	7.4	13.2	14.7
4	5 862 833	18.6	13.9	33.3	60.5	26 338	10.8	15.8	18.9
5	5 862 668	15.5	14.9	32.4	58.5	24 261	19.7	20.2	26.3
Material and social									
1 & 1	1 211 019	22.0	8.9	18.5	69.0	47 711	2.2	6.9	5.8
5 & 5	1 321 335	19.7	13.9	47.4	46.3	16 920	18.8	21.9	34.5
Canada	29 312 101	19.3	12.4	33.1	61.2	27 554	9.1	13.6	15.8

* Ratio of individuals 15 years and older with no high school diploma to the population 15 years and older
† Ratio of individuals 15 years and older who are employed to the population 15 years and older
‡ Average personal income for the population 15 years and older
§ Ratio of individuals 15 years and older living alone to the population 15 years and older
‖ Ratio of individuals 15 years and older who are separated, divorced or widowed to the population 15 years and older
\# Ratio of single-parent families to the total number of families

The values of these characteristics (except for F_MONO) are adjusted according to the age and sex of the Canadian population.

Source: 2001 Census of Canada.

agglomerations (CAs), small towns and rural communities, and the Atlantic region. Conversely, however, the average level of material deprivation is lower in CMAs than in small towns and rural communities, and the Atlantic region.

Deprivation and premature mortality in Canada

Approximately 94% of premature deaths in 2001 were given a deprivation index, for a total of 85 614 deaths (Table 7). Of the deaths that were not given a deprivation index (n = 5 625), 14% were the result of erroneous postal codes and 86% were the result of DAs with no index corresponding to institutionalized populations.

The adjusted premature mortality rate in 2001, 310 deaths per 100 000, progresses in line with both material and social deprivation (Figure 1). The mortality ratio between material and social deprivation groups at extreme ends of the spectrum is 2.41 and the difference in mortality is 302 deaths per 100 000, a value equivalent to that observed for Canada as a whole.

While such discrepancies can be seen everywhere in Canada, their magnitude varies enormously by geographic area and region. Accordingly, among the most deprived individuals in Canada, we find that those who live in CAs as well as in small towns and rural communities have the highest rates of premature death (Figure 2). Conversely, in small towns and rural communities, the relative and absolute discrepancies in the mortality rate (ratio and difference) according to deprivation are relatively low (Figure 3). In terms of the regions of Canada, the greatest disparities in mortality according to deprivation are found in the Prairies and in British Columbia, whereas at the CMA level, they are seen in Vancouver and in the "other CMAs" group. Of the three major Canadian CMAs, Toronto has the smallest disparities.

Discussion

The deprivation index comprises six indicators grouped into two components, material deprivation and social deprivation. These two components occur nationwide, in rural settings and in all the various urban settings (large CMAs, other CMAs and CAs). They point to major socio-economic inequalities in income, education, employment and family structure everywhere, demonstrating the relevance and applicability of the index beyond the urban settings that are usually preferred for the production of geographic proxies.[9,11-13,33,35]

Variations in the deprivation index are closely linked to variations in premature mortality. Material and social deprivation

TABLE 6
Socio-economic discrepancies by geographic area and region of Canada
Ratio* of most to least deprived persons (material and social) and average value (A)

Geographic area/ region	Socio-economic characteristics											
	SCOLAR†		EMPLOI‡		REVENU§		SEULES‖		S_D_V#		F_MONO**	
	Ratio	A %	Ratio	A %	Ratio	A $	Ratio	A %	Ratio	A %	Ratio	A %
Toronto CMA	**2.5**	29.0	**1.4**	64.3	**3.3**	32 812	**15.1**	6.8	**3.6**	11.7	**7.9**	16.4
Montréal CMA	**3.9**	29.4	**1.5**	60.5	**2.8**	26 730	**9.7**	11.9	**2.7**	15.5	**6.1**	18.3
Vancouver CMA	**2.5**	27.3	**1.4**	61.2	**2.9**	28 883	**9.5**	9.5	**3.5**	13.0	**5.3**	15.4
Other CMAs	**2.6**	29.7	**1.4**	63.7	**2.8**	28 879	**11.3**	9.6	**3.6**	13.6	**6.9**	16.3
CAs	**2.1**	36.1	**1.5**	58.9	**2.1**	25 792	**6.8**	9.8	**3.0**	15.0	**4.9**	16.3
Small towns, rural communities	**1.9**	42.8	**2.0**	57.0	**2.0**	23 108	**2.7**	8.3	**2.2**	12.9	**6.3**	13.1
Atlantic	**2.5**	39.2	**1.8**	52.8	**2.4**	22 713	**3.4**	8.2	**2.4**	13.4	**5.5**	16.2
Quebec	**3.4**	32.7	**1.5**	58.6	**2.5**	25 035	**8.0**	11.5	**2.4**	15.5	**4.9**	16.8
Ontario	**2.5**	31.5	**1.4**	62.9	**2.7**	30 487	**10.8**	7.9	**3.4**	12.9	**6.8**	15.3
Prairies	**2.5**	36.2	**1.4**	66.0	**2.7**	26 931	**11.7**	8.5	**3.4**	12.2	**8.1**	15.3
British Columbia	**2.5**	30.6	**1.4**	59.4	**2.4**	27 306	**7.2**	9.7	**3.3**	14.3	**5.3**	15.7
Canada	**2.6**	33.1	**1.5**	61.2	**2.8**	27 554	**8.5**	9.1	**3.2**	13.6	**5.9**	15.8

* Ratio of the most deprived group (material and social) (Q5 and Q5) and the least deprived (Q1 and Q1). For SCOLAR, SEULES, S_D_V and F_MONO, ratio: Q5 and Q5/Q1 and Q1. For EMPLOI and REVENU, ratio: Q1 and Q1/Q5 and Q5.

† Ratio of individuals 15 years and older with no high school diploma to the population 15 years and older

‡ Ratio of individuals 15 years and older who are employed to the population 15 years and older

§ Average personal income for the population 15 years and older

‖ Ratio of individuals 15 years and older living alone to the population 15 years and older

\# Ratio of individuals 15 years and older who are separated, divorced or widowed to the population 15 years and older

** Ratio of single-parent families to the total number of families

The ratios and averages (except for F_MONO) are adjusted for the age and sex of the population in the area or region in question.

Source: 2001 Census of Canada.

contribute independently to mortality, and this contribution increases gradually with the level of deprivation (Figure 1). Such gradients can be observed everywhere in Canada, including in large CMAs and other geographic areas, and in all regions. (Data not presented, available upon request.) Thus, deprivation not only affects groups that are extremely deprived: it is a matter of concern for the entire population.

The combined effect of the two forms of deprivation can be observed by comparing the mortality of groups at the extreme ends of social and material deprivation – Q5Q5 vs. Q1Q1 (Figure 2 and Figure 3). The combined effect is also observable—although in a less marked fashion—in populations whose size is similar to that of populations considered for each dimension separately, that is, on a quintile basis. Hence, in Canada, the mortality rate ratio and rate difference between extreme quintiles (Q5 vs. Q1) were, respectively, 1.82 (95% CI, 1.73-1.92) and 192 deaths per 100 000 (95% CI, 174-210) when both dimensions of deprivation are considered simultaneously, as opposed to 1.50 (95% CI, 1.45-1.55) and 125 deaths (95% CI, 115-136) for the material dimension and 1.65 (95% CI, 1.60-1.70) and 161 deaths (95% CI, 151-172) for the social dimension, treated separately. Similar differences can be seen in the various geographic settings. (Data available upon request.)

Other studies have already identified social disparities in mortality in Canadian CMAs.[9-12] This study shows that these inequalities extend to all geographic areas that reflect Canada's diversity. Due to different study methodologies and due to the absence of research on the geography of social disparities in health—in Canada and internationally—it is difficult to compare these results with those obtained elsewhere. In fact, the deprivation index sheds new light on the social disparities in health in Canada by expressing their variability by geographic area.

These initial results on premature mortality require further study, either to identify the exact causes of death, to determine if there is a difference in effect on sex, or to decipher the underlying factors. For instance, it would be interesting to explore factors such as relative deprivation,[72] the presence of Aboriginal people,[73] recent immigration,[74] and the risks associated with the use of geographic proxies.[75] The use of such proxies may explain, at least in part, the presence of weak ratios and differences in mortality in small towns and rural communities. These initial results could also be compared to those generated with

TABLE 7
Population and deaths in persons under age 75 by geographic area, region, and quintile of material and social deprivation, Canada, 2001

	Population	Deaths
	Number	Number
Geographic area		
Toronto CMA	4 384 015	10 514
Montréal CMA	3 164 585	9 634
Vancouver CMA	1 837 025	4 632
Other CMAs	8 491 360	24 811
CAs	4 178 475	14 744
Small towns, rural communities	5 705 250	21 279
Region of Canada		
Atlantic	2 123 610	7 359
Quebec	6 711 995	22 298
Ontario	10 554 165	31 377
Prairies	4 692 225	13 706
British Columbia	3 588 725	10 568
Material deprivation		
Quintile 1	5 545 815	13 541
Quintile 2	5 573 520	15 176
Quintile 3	5 557 830	16 765
Quintile 4	5 536 780	18 470
Quintile 5	5 546 765	21 662
Social deprivation		
Quintile 1	5 662 775	13 381
Quintile 2	5 613 635	15 370
Quintile 3	5 557 085	16 871
Quintile 4	5 490 310	18 197
Quintile 5	5 436 905	21 795
Material and social deprivation		
Quintile 1 and Quintile 1	1 172 970	2 277
Quintile 5 and Quintile 5	1 237 555	6 123
Canada	27 760 710	85 614

Source: Census and mortality database, 2001.

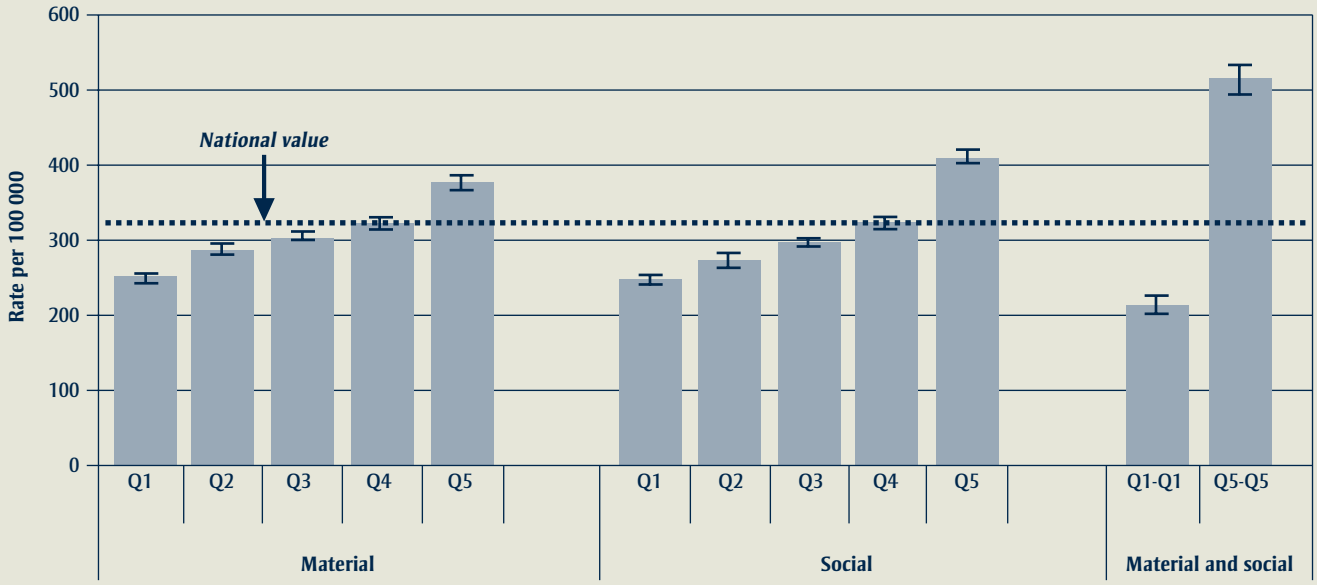
respect to other socio-economic indicators, such as low income. In order to be useful and correctly carried out, however, such a comparison should consider several socio-economic and health indicators simultaneously, with due attention paid to their conceptual foundations and their performance in relation to technical and political criteria,[5,7,20,21,28,35,51,76-78] an exercise that is well beyond the framework of this study.

The deprivation index has its limitations. It is not an individual measure of socio-economic conditions, but rather a measure of the conditions seen at the neighbourhood level. The index could be used in an etiological analysis, but it cannot replace an individual measure, which is the only way of portraying individual or family education, for example. Therefore, in an etiological analysis, these two types of measures should be considered simultaneously, through multilevel modelling.[79] This is now possible thanks to a new file combining a sample from the 1991 Census of Canada with mortality data from 1991 to 2001.[80]

Combating social inequalities in health has become a major challenge for health systems, both in Canada[81] and around the world.[82] The availability of tools to measure inequalities is a prerequisite to any planning to reduce them. In Quebec, the deprivation index is now used at every stage of the health planning process, including the measurement and monitoring of inequalities,[36-38,42,43] the development of strategic goals,[83] the evaluation of both provincial and local services[40,44] and resource allocation to the regions.[84]

A recent study by the Canadian Institute for Health Information (CIHI)[85] demonstrated the existence of clear gradients in hospital admissions and in self-reported health in 15 CMAs, based on this deprivation index. The relevance and usefulness of a measure often become apparent only when the measure is put to use. The Canadian index of material and social deprivation is therefore available for trial by researchers and managers in the health sector. It is also associated with a variety of products now available on the *Institut national de santé publique du Québec* (INSPQ) website.[86]

FIGURE 1
Premature mortality rate by quintile of material and social deprivation Canada, 2001



NOTE: Death rates are adjusted for age, sex, geographic area and the other forms of deprivation.

Source: 2001 Census of Canada; Statistics Canada, 2001 Canadian Mortality Database.

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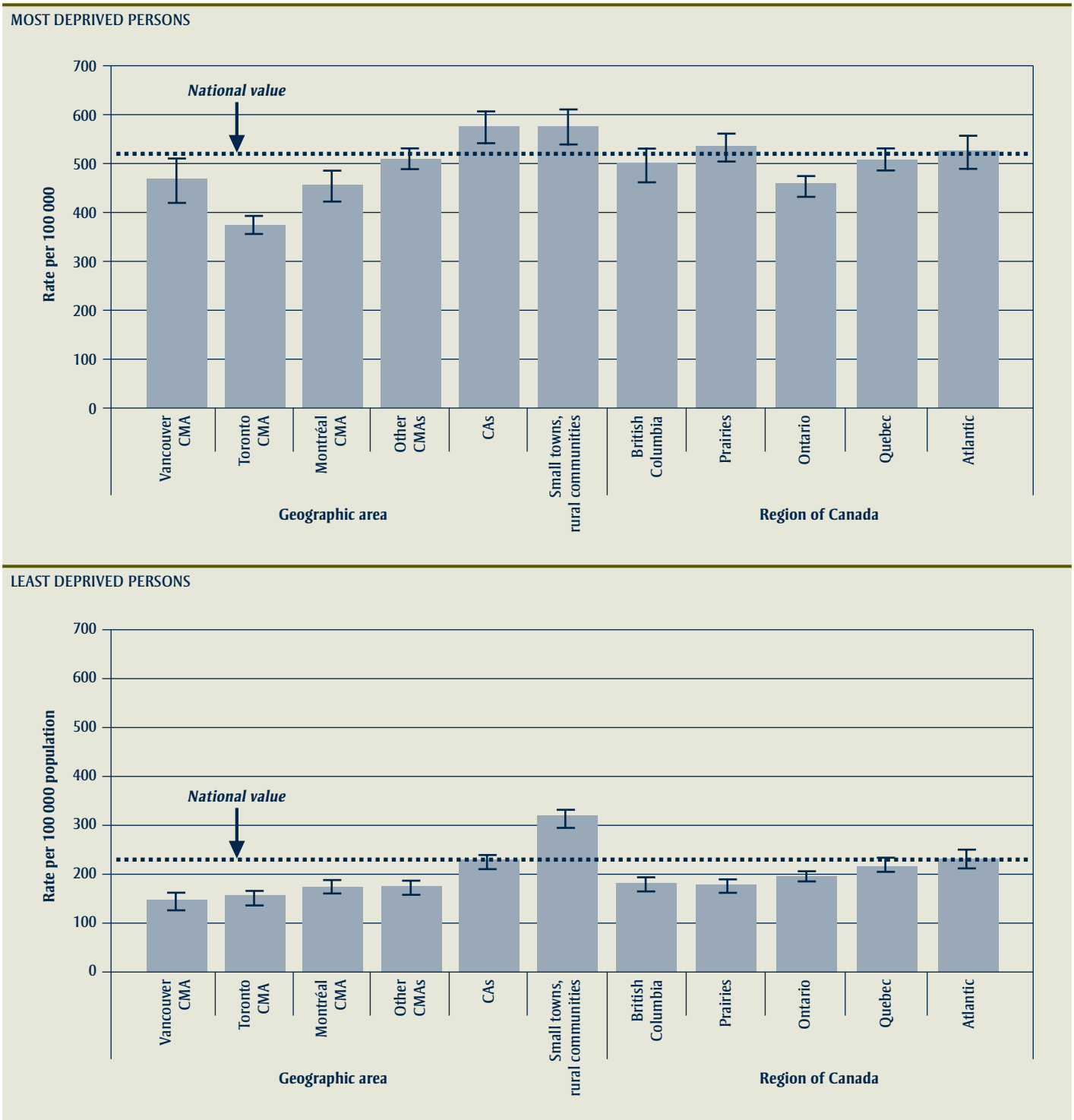
FIGURE 2

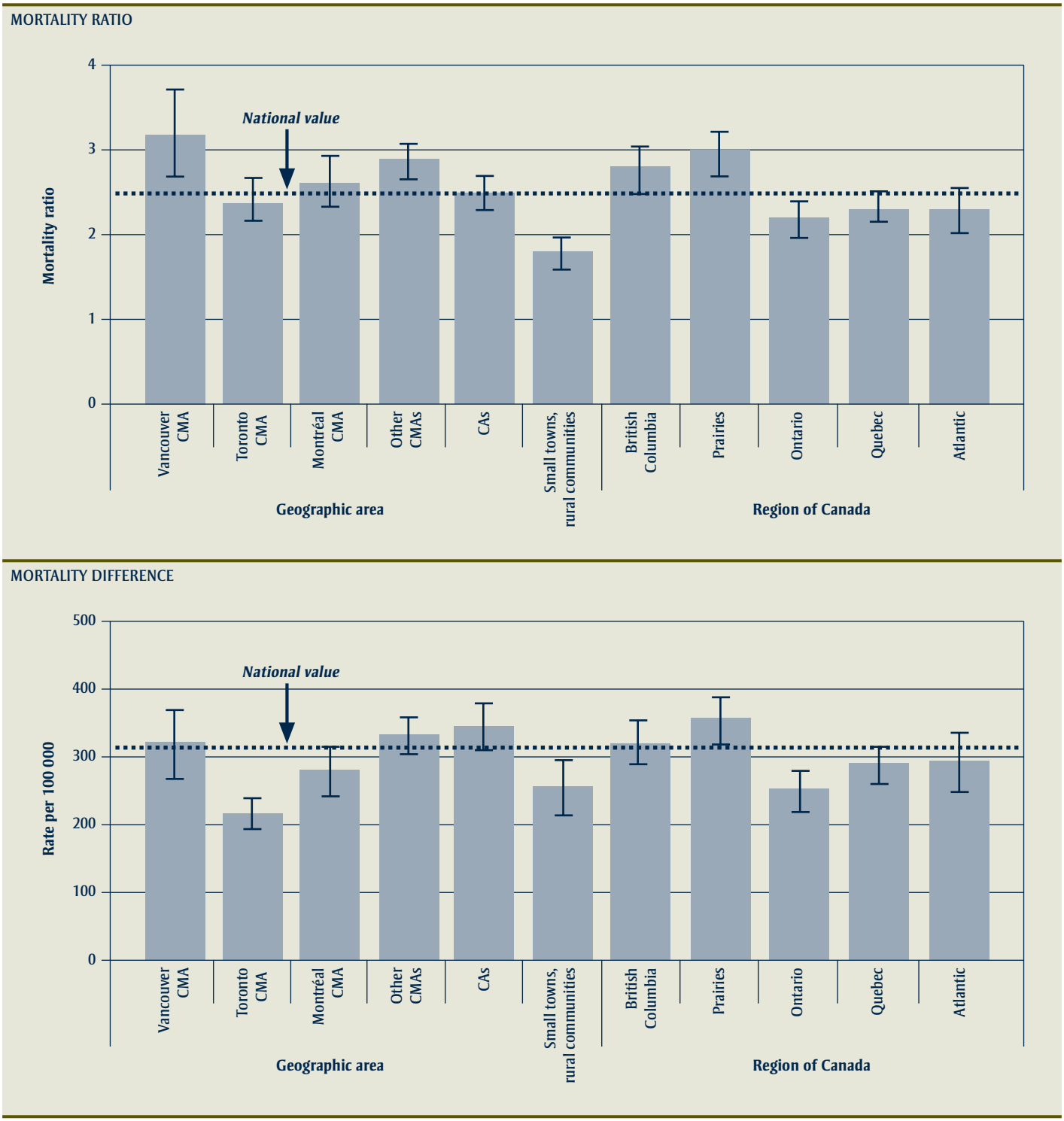
Premature mortality rate in the most and least deprived persons (material and social) by geographic area and region of Canada, 2001



NOTE: The rates are adjusted for age, sex and, in the case of regions of Canada, geographic area.

Source: 2001 Census of Canada; Statistics Canada, 2001 Canadian Mortality Database.

FIGURE 3
Ratio and difference in premature mortality between the most and least deprived persons (material and social) by geographic area and region of Canada, 2001



NOTE: Rates are adjusted for age, sex and, in the case of regions of Canada, geographic area.

Source: 2001 Census of Canada; Statistics Canada, 2001 Canadian Mortality Database.

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