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 Britain5 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 Britain16-23 and elsewhere in Europe (Sweden,24 Italy,25 Spain,26 France27), as well as in the United States,28,29 Japan30 and New Zealand.31 Such indexes cover a wide range of domains, from material deprivation alone17,20,23 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...
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.

 Townsend’s definition is that deprivation is related to a number of other concepts. Material deprivation evokes the concept of poverty, 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 and associated concepts, such as social fragmentation and social isolation. 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. The selected unit is the dissemination area (DA), 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.

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, the employment/population ratio of people aged 15 years and older, the average income of people aged 15 years and older, the proportion of individuals aged 15 years and older living alone, the proportion of individuals aged 15 years and older who are separated, divorced or widowed, and the proportion of single-parent families.

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...
than demographic, these indicators, with the exception of F_MONO, were adjusted according to the age-sex structure of the Canadian population using direct standardization. Moreover, certain indicators were transformed in order to normalize their distribution. 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. 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.

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 whose relationships with socio-economic conditions have been extensively documented on an international scale.

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 over-dispersion. 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.

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. 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.
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of deprivation. 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 1

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

<table>
<thead>
<tr>
<th>Area</th>
<th>Total Covered</th>
<th>DA Covered</th>
<th>Average population&lt;sup&gt;†&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Major CMAs</td>
<td>11 159 876</td>
<td>97.5</td>
<td>17 962</td>
</tr>
<tr>
<td>Other CMAs</td>
<td>8 137 050</td>
<td>97.2</td>
<td>13 357</td>
</tr>
<tr>
<td>CAs</td>
<td>4 542 160</td>
<td>97.9</td>
<td>6 921</td>
</tr>
<tr>
<td>Small towns and rural communities</td>
<td>6 168 008</td>
<td>98.4</td>
<td>14 753</td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atlantic</td>
<td>2 285 729</td>
<td>98.7</td>
<td>4 202</td>
</tr>
<tr>
<td>Quebec</td>
<td>7 237 479</td>
<td>97.8</td>
<td>12 153</td>
</tr>
<tr>
<td>Ontario</td>
<td>11 410 046</td>
<td>97.6</td>
<td>18 596</td>
</tr>
<tr>
<td>Prairies</td>
<td>5 073 323</td>
<td>97.6</td>
<td>10 315</td>
</tr>
<tr>
<td>British Columbia</td>
<td>3 907 738</td>
<td>97.4</td>
<td>7 463</td>
</tr>
<tr>
<td>Canada</td>
<td>30 007 094</td>
<td>97.7</td>
<td>52 993</td>
</tr>
</tbody>
</table>

<sup>†</sup> 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

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Material</th>
<th>Social</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCOLAR&lt;sup&gt;‡&lt;/sup&gt;</td>
<td>-0.83</td>
<td>0.00</td>
</tr>
<tr>
<td>EMPLOI&lt;sup&gt;†&lt;/sup&gt;</td>
<td>0.71</td>
<td>-0.19</td>
</tr>
<tr>
<td>REVENUE&lt;sup&gt;‡&lt;/sup&gt;</td>
<td>0.82</td>
<td>-0.27</td>
</tr>
<tr>
<td>SEULES&lt;sup&gt;§&lt;/sup&gt;</td>
<td>-0.01</td>
<td>0.84</td>
</tr>
<tr>
<td>S_D_V&lt;sup&gt;</td>
<td></td>
<td>&lt;/sup&gt;</td>
</tr>
<tr>
<td>F_MONO&lt;sup&gt;#&lt;/sup&gt;</td>
<td>-0.34</td>
<td>0.65</td>
</tr>
<tr>
<td>Explained variance</td>
<td>34%</td>
<td>33%</td>
</tr>
<tr>
<td>Cumulative variance</td>
<td>34%</td>
<td>67%</td>
</tr>
</tbody>
</table>

<sup>‡</sup> Ratio of individuals 15 years and older with no high school diploma to the population 15 years and older
<sup>†</sup> Ratio of individuals 15 years and older who are employed to the population 15 years and older
<sup>‡</sup> Average personal income for the population 15 years and older
<sup>§</sup> Ratio of individuals 15 years and older living alone to the population 15 years and older
<sup>||</sup> Ratio of individuals 15 years and older who are separated, divorced or widowed to the population 15 years and older
<sup>#</sup> 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.
### TABLE 3
#### Principal components of the deprivation index by geographic area

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

* 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

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

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

<table>
<thead>
<tr>
<th>Deprivation quintile</th>
<th>Population</th>
<th>Age group</th>
<th>Socio-economic profile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Material</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>5 862 195</td>
<td>17.7</td>
<td>12.2</td>
</tr>
<tr>
<td>2</td>
<td>5 862 218</td>
<td>19.4</td>
<td>11.6</td>
</tr>
<tr>
<td>3</td>
<td>5 862 082</td>
<td>19.4</td>
<td>12.3</td>
</tr>
<tr>
<td>4</td>
<td>5 863 106</td>
<td>19.4</td>
<td>12.9</td>
</tr>
<tr>
<td>5</td>
<td>5 862 500</td>
<td>20.4</td>
<td>13.0</td>
</tr>
<tr>
<td>Social</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>5 862 396</td>
<td>21.7</td>
<td>9.6</td>
</tr>
<tr>
<td>2</td>
<td>5 862 428</td>
<td>20.7</td>
<td>11.2</td>
</tr>
<tr>
<td>3</td>
<td>5 861 776</td>
<td>19.9</td>
<td>12.5</td>
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<tr>
<td>4</td>
<td>5 862 833</td>
<td>18.6</td>
<td>13.9</td>
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<tr>
<td>5</td>
<td>5 862 668</td>
<td>15.5</td>
<td>14.9</td>
</tr>
<tr>
<td>Material and social</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 &amp; 1</td>
<td>1 211 019</td>
<td>22.0</td>
<td>8.9</td>
</tr>
<tr>
<td>5 &amp; 5</td>
<td>1 321 335</td>
<td>19.7</td>
<td>13.9</td>
</tr>
<tr>
<td>Canada</td>
<td>29 312 101</td>
<td>19.3</td>
<td>12.4</td>
</tr>
</tbody>
</table>

* 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
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. Other CMAs and their results are presented elsewhere. (Data available upon request.)

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, the presence of Aboriginal people, recent immigration, and the risks associated with the use of geographic proxies. 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 6

**Socio-economic discrepancies by geographic area and region of Canada**

<table>
<thead>
<tr>
<th>Geographic area/region</th>
<th>SCOLAR</th>
<th>EMPLOI</th>
<th>REVENU</th>
<th>SEULES</th>
<th>S_D_V</th>
<th>F_MONO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ratio</td>
<td>A</td>
<td>Ratio</td>
<td>A</td>
<td>Ratio</td>
<td>A</td>
</tr>
<tr>
<td>Toronto CMA</td>
<td>2.5</td>
<td>29.0</td>
<td>1.4</td>
<td>64.3</td>
<td>3.3</td>
<td>32 812</td>
</tr>
<tr>
<td>Montréal CMA</td>
<td>3.9</td>
<td>29.4</td>
<td>1.5</td>
<td>60.5</td>
<td>2.8</td>
<td>26 730</td>
</tr>
<tr>
<td>Vancouver CMA</td>
<td>2.5</td>
<td>27.3</td>
<td>1.4</td>
<td>61.2</td>
<td>2.9</td>
<td>28 883</td>
</tr>
<tr>
<td>Other CMAs</td>
<td>2.6</td>
<td>29.7</td>
<td>1.4</td>
<td>63.7</td>
<td>2.8</td>
<td>28 879</td>
</tr>
<tr>
<td>CAs</td>
<td>2.1</td>
<td>36.1</td>
<td>1.5</td>
<td>58.9</td>
<td>2.1</td>
<td>25 792</td>
</tr>
<tr>
<td>Small towns, rural communities</td>
<td>1.9</td>
<td>42.8</td>
<td>2.0</td>
<td>57.0</td>
<td>2.0</td>
<td>23 108</td>
</tr>
<tr>
<td>Atlantic</td>
<td>2.5</td>
<td>39.2</td>
<td>1.8</td>
<td>52.8</td>
<td>2.4</td>
<td>27 713</td>
</tr>
<tr>
<td>Quebec</td>
<td>3.4</td>
<td>32.7</td>
<td>1.5</td>
<td>58.6</td>
<td>2.5</td>
<td>25 035</td>
</tr>
<tr>
<td>Ontario</td>
<td>2.5</td>
<td>31.5</td>
<td>1.4</td>
<td>62.9</td>
<td>2.7</td>
<td>30 487</td>
</tr>
<tr>
<td>Prairies</td>
<td>2.5</td>
<td>36.2</td>
<td>1.4</td>
<td>66.0</td>
<td>2.7</td>
<td>26 931</td>
</tr>
<tr>
<td>British Columbia</td>
<td>2.5</td>
<td>30.6</td>
<td>1.4</td>
<td>59.4</td>
<td>2.4</td>
<td>27 306</td>
</tr>
<tr>
<td>Canada</td>
<td>2.6</td>
<td>33.1</td>
<td>1.5</td>
<td>61.2</td>
<td>2.8</td>
<td>27 554</td>
</tr>
</tbody>
</table>

Source: 2001 Census of Canada.
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, 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. 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.

Combating social inequalities in health has become a major challenge for health systems, both in Canada and around the world. 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, the development of strategic goals, the evaluation of both provincial and local services and resource allocation to the regions.

A recent study by the Canadian Institute for Health Information (CIHI) 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.
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.

Acknowledgements

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References


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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