Labour market income inequality and mortality in North American metropolitan areas

C Sanmartin, N A Ross, S Tremblay, M Wolfson, J R Dunn, J Lynch

Objective: To investigate relations between labour market income inequality and mortality in North American metropolitan areas.

Methods: An ecological cross sectional study of relations between income inequality and working age (25–64 years) mortality in 53 Canadian (1991) and 282 US (1990) metropolitan areas using four measures of income inequality. Two labour market income concepts were used: labour market income for households with non-trivial attachment to the labour market and labour market income for all households, including those with zero and negative incomes. Relations were assessed with weighted and unweighted bivariate and multiple regression analyses.

Results: US metropolitan areas were more unequal than their Canadian counterparts, across inequality measures and income concepts. The association between labour market income inequality and working age mortality was robust in the US to both the inequality measure and income concept, but the association was inconsistent in Canada. Three of four inequality measures were significantly related to mortality in Canada when households with zero and negative incomes were included. In North American models, increases in earnings inequality were associated with hypothetical increases in working age mortality rates of between 23 and 33 deaths per 100 000, even after adjustment for median metropolitan incomes.

Conclusions: This analysis of labour market inequality provides more evidence regarding the robust nature of the relation between income inequality and mortality in the US. It also provides a more refined understanding of the nature of the relation in Canada, pointing to the role of unemployment in generating Canadian metropolitan level health inequalities.

Abbreviations: MA, metropolitan area; NTEI, non-trivial earned income; AEI, all earned income
all households reporting annual earnings of $1000 or more. This income concept excludes those with trivial labour market earnings (that is, < $1000), the unemployed and those reporting negative incomes. This approach succeeds in eliminating those households who have effectively no significant attachment to the labour market.12

- All earned income (AEI): earnings from wages and salary and farm and non-farm self employed income for all households including those households with trivial earnings, zero earned income and those reporting negative incomes. This income concept is used to capture the potential effects of including the unemployed households as part of the income distribution in generating metropolitan level inequalities.

Definitions of income inequality measures

Income inequality was estimated using a variety of measures, which, by design, have properties that emphasise different aspects of the income distribution. The Gini coefficient is a global measure of income inequality that is sensitive to the proportion of households in the middle income groups. Similarly, the median share, while a point estimate, is also sensitive to the middle of the income distribution. The coefficient of variation (CV) is sensitive to the upper end of the distribution, giving increased weight to higher income households, while the exponential measure mathematically weights the near-zero income households most heavily giving more emphasis to inequality generated by very low income groups within MAs.

Additional details are provided below15:

- Gini coefficient: a global measure of the degree of deviation of the income distribution from “perfect equality” where each proportion of households controls a proportionately equal amount of resources. The Gini coefficient is calculated using the Lorenz curve and ranges in value between 0 (perfect equality) and 1 (perfect inequality).
- Median share: a measure of the proportion of total household income accruing to the least well off 50% of households. In a situation of perfect equality, the median share would equal 0.50, and so higher median share values indicate more equal income distributions.
- Coefficient of variation (CV): a measure of the dispersion of incomes in a defined area. The CV reflects the average deviation from the mean income as a proportion of the average income. A higher CV reflects a more dispersed and often unequal distribution of income.
- Exponential: a bottom sensitive measure of income inequality reflecting the distance from the average income with more weight placed on income values below the mean. Higher exponential values indicate higher levels of inequality.

Unweighted and weighted correlation analyses were used to assess the association between the income inequality measures for each income concepts. Weighted multiple linear regression models were used to analyse the relation between income inequality and mortality by income concept and inequality measure both within a North American model and separately for each country. Weighted (by MA population size) regression analyses adjusting for median household income and unemployment are also provided. For a more in depth discussion of the weighting see Lynch et al10 and Ross et al.11 The regression analyses were based on standardised measures of income inequality to allow more direct compar-
isons of the regression coefficients across inequality measures.

RESULTS

The MAs in the US (n = 282) ranged in population between 56 735 (Enid, Oklahoma) and 18 087 251 (New York City, NY) with a median population of 242 847. In Canada MAs (n = 53) ranged between 50 193 (Saint-Hyacinthe, Quebec) and 3 893 046 (Toronto, Ontario) with a median population of 116 100. Working age mortality rates varied in the US from 237 per 100 000 in Rochester (MN) to 571 per 100 000 in Florence (SC). In Canada, working age mortality rates ranged between 244 per 100 000 in Abbotsford (BC) and 400 per 100 000 in Prince George (BC).

Bivariate analyses of inequality measures

Income inequality measures were highly correlated in North America for NTEI. The unweighted and weighted Pearson r values ranged between 0.80 and 0.99 and between 0.76 and 0.99 respectively. All correlations were significant at the p<0.01 level. As expected, the association between middle sensitive measures (that is, the median share and the Gini) was strong for both analyses (unweighted and weighted: r = −0.98). Similarly, a strong association existed between the middle sensitive measures and the exponential (bottom sensitive) measure. Correlations between the median share and CV values were the weakest (unweighted: r = −0.80; weighted: r = −0.76) but still significant.

When inequality measures were analysed within countries, the type of inequality measure had a modest effect on the rank order of MAs. For instance, in the US, Sheboygan (WI) and Mcallen (TX) were consistently ranked as the most and least equal MAs, respectively, for three of the four NTEI inequality measures. In Canada, Oshawa (ON) and Barrie (ON) consistently appeared as the most equal cities while Kelowna (BC) and Sydney (NS) ranked as the most unequal places, regardless of the inequality measure used. In both countries, the greatest variation in rank order occurred with the CV measure.

Labour market income inequality

The US MAs were consistently more unequal than their Canadian counterparts. This was especially evident with the top sensitive CV measure. The average CV values for US MAs were 0.90 and 0.99 for NTEI and AEI inequality, respectively, compared with 0.70 and 0.82 for Canadian MAs (table 1).

As expected, MAs appear more equal when the non-trivial earnings concept is used to measure inequality (table 1). The average NTEI median share for US MAs was 0.25, approximately 17% higher than the average AEI median share (0.21). The Gini coefficient and the CV also showed the same pattern: greater average inequality in the all earnings measures compared with the non-trivial earnings measures among US MAs.

Among Canadian MAs, the average NTEI median share was 0.26, 24% higher than the average AEI median share (0.21). Average AEI Gini coefficient and CV values were 20% and 17% higher respectively compared with measures based on NTEI. There was less variability for the exponential across income concepts in both Canada and the US.

A combined US and Canada model

Labour market income inequality was a significant explanatory factor for working aged mortality in US and North American-wide models even after adjusting for median household income (table 2). For NTEI inequality, the effect of income inequality on working age mortality, after adjusting for median income, varied slightly across inequality measures. The coefficients may be interpreted as follows: a hypothetical 1 standard deviation increase in inequality is associated with an increase in the mortality rate of between 25 and 26 deaths per 100 000 population, depending on the inequality measure. Explained variation in these models did not exceed 20%. When Canadian MAs were added to the model, there were significant gains in the explained variation with adjusted $r^2$ values increasing to approximately 0.40. (table 2). The increase in $r^2$ is due in large part to the fact that the addition of the dummy variable accounting for the long standing mortality differences between Canada and the US is an effective explanatory variable. Labour market income inequality remains an important and significant explanatory variable in the final combined model.

The results were similar for the AEI models (table 2). The effects of labour market inequality on mortality were slightly higher when AEI was considered, ranging from 29 to 33 deaths per 100 000 population, after adjusting for median income. Adjusted $r^2$ values ranged between 0.23 (CV) and 0.33 (median share and Gini). Once again, the addition of the Canadian MAs increased the explanatory power of the combined model with adjusted $r^2$ values increasing to between 0.43 (CV) and 0.51 (median share and Gini).

US compared with Canada

When the association between labour market inequality and mortality was assessed for each country separately, the association was significant and in the hypothesised direction for the US MAs for both NTEI and AEI income concepts (table 3). For NTEI, models with median share ($\hat{p} = −24.03; p<0.01$), Gini coefficient ($\hat{p} = 24.85; p<0.01$), CV ($\hat{p} = 22.23; p<0.01$) and exponential ($\hat{p} = 22.21; p<0.01$) were all significant with adjusted $r^2$ values between 0.16 (CV) and 0.20 (Gini). The estimated effects on mortality, therefore, were between 23 and 24 deaths per 100 000 per one standard deviation increase in inequality. The results were similar for AEI inequality with estimated increases in mortality ranging from 25 (CV) to 31 (Exp) deaths per 100 000 for each standard deviation increase in inequality. Explained variation in mortality was slightly higher than the NTEI models with $r^2$ values ranging from 0.22 (CV) and 0.31 (Gini).

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Average measure of income inequality by type of inequality measure and labour market income concept, Canada and US Metropolitan areas, 1990/91 (standard deviation)</th>
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<tbody>
<tr>
<td></td>
<td>Median share</td>
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<tr>
<td>US metropolitan areas (n = 282)</td>
<td></td>
</tr>
<tr>
<td>NTEI</td>
<td>0.25 (0.02)</td>
</tr>
<tr>
<td>AEI</td>
<td>0.21 (0.02)</td>
</tr>
<tr>
<td>Canadian metropolitan areas (n = 53)</td>
<td></td>
</tr>
<tr>
<td>NTEI</td>
<td>0.26 (0.01)</td>
</tr>
<tr>
<td>AEI</td>
<td>0.21 (0.02)</td>
</tr>
</tbody>
</table>
In Canada, however, the results varied by both income concept and inequality measure. The association was not significant for NTEI bottom and middle sensitive measures (fig 2). Labour market inequality, however, was significantly associated with mortality for NTEI inequality CV ($\beta = -10.8; p<0.05$), but not in the hypothesised direction. This counter-intuitive result may be a function of the limited variability in CV values within Canadian MAs. Overall, CVs in Canada cluster at the lower range between 0.58 and 0.80 compared to values in the US in which there is a twofold difference between the lowest (0.70) and highest (1.44) CV values. Higher CV values for US MAs are due to the higher concentration of earned income in the upper income category (> $250000). In the US, about 4% of the total earnings can be attributed to households in the top income category, compared with only 2% in Canada. The higher CVs in Canada occur almost exclusively in the larger cities where diversified labour markets generate higher and more dispersed earnings. In smaller MAs incomes tend to be lower and less dispersed (hence lower CVs), but smaller MAs in Canada also tend to have higher mortality rates. It sets up the possibility of the coexistence of relatively high earnings inequality (especially as measured by the top-sensitive CV) and relatively low mortality in large Canadian MAs.

There was a significant association between AEI inequality and mortality in Canada for the median share ($\beta = -14.4; p<0.01$), the Gini ($\beta = 11.2; p<0.01$) (fig 2), and the EXP ($\beta = 12.6; p<0.01$), with $r^2$ values ranging from 0.18 to 0.27 (table 3). In subsequent regression analyses (table 4), the association between AEI inequality and mortality disappeared in Canada when unemployment was added to the model. As expected, unemployment was significantly associated with mortality ($\beta = 15.5; p<0.05$) and the adjusted $r^2$ increased to 0.31 but the income inequality measure (in this case the Gini coefficient) was no longer significant. For the US MAs, AEI inequality remained significantly associated with mortality even when unemployment rates were added to the model.

**DISCUSSION**

Our analysis of earned income inequality has revealed the effects of various aspects of the labour market in generating inequalities among MAs in both the US and Canada. US MAs had greater earnings inequality and higher mortality rates than their Canadian counterparts, consistent with previous analyses. In both countries, as expected, MAs appeared more equal when a non-trivial earned income definition was used to represent inequality among high and low earners. Metropolitan areas demonstrated higher levels of inequality when all earned income was used—that is, including zero and negative incomes—pointing to the potential effect of unemployment in generating labour market inequalities.

Results of the weighted regression analyses suggested that both the type of measure and type of income matter for accounting for metropolitan scale mortality patterns in Canada but not in the United States. The relation between income inequality and mortality was consistent (significant and same direction) in the US regardless of the type of measure or income concept used. US models explained between 16% and 30% of the variation in working aged mortality.
mortality, even after adjustments were made for median household income and unemployment.

In Canada, however, the association between income inequality and mortality varied depending on the income concept and inequality measure used despite the fact that the inequality measures were highly correlated. Our analysis of labour market income inequalities provides new evidence regarding this association and the role of labour market inequality resulting from unemployment in accounting for metropolitan scale patterns of working age mortality in Canada. While both concepts of earnings inequality (all and non-trivial earnings) were influential in accounting for the geographical variation of metropolitan scale mortality in the US, geographical variation in Canada was accounted for only after the inclusion of the most economically vulnerable households in the calculation of income inequality. Indeed, the inclusion of the unemployment rates into models of Canadian MA mortality removed the effect of all earned income inequality.

Our findings could be interpreted as showing that to better understand the geographical distribution of mortality across Canada, it is important to include information on the role of labour market exclusion. In the US this is not the case. Ecological fallacy aside, in the US it appears to make no difference if labour market exclusion is considered or not, perhaps because of the nature of the US labour market where there is less distinction—at least in terms of mortality risk—between being employed in a low wage job at the bottom of the earnings distribution and being unemployed. In epidemiological terms, these results can be understood as the effects of truncating the exposure distribution. Whatever the mechanism involved, patterns of health vulnerability of the US population are still revealed by truncating the earnings distribution (that is, excluding the unemployed households), but this is not so for patterns of health vulnerability in Canada.

### Table 4 Summary of the association between income inequality, unemployment, and mortality for all earned income (AEI), Canada and US metropolitan areas

<table>
<thead>
<tr>
<th></th>
<th>Canada (n = 52)</th>
<th>US (n = 28)</th>
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<tbody>
<tr>
<td></td>
<td>Intercept</td>
<td>Gini</td>
</tr>
<tr>
<td>Gini</td>
<td>286**</td>
<td>11.2**</td>
</tr>
<tr>
<td>Gini and</td>
<td>287**</td>
<td>1.33</td>
</tr>
<tr>
<td>unemployment</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
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**Significant at p < 0.01. Standardised regression coefficients; analyses weighted by metropolitan area population size.
There is an extensive literature linking unemployment to poor health outcomes in individuals. Bartley's review outlined a number of mechanisms that might account for the consistent relation between unemployment and health and they are very similar to the types of explanations often offered up linking income inequality to poor health: the role of relative poverty, social isolation/loss of self esteem and the creation of cultures of risky health behaviours. Thus it would appear that whether the statistical relation is between unemployment or income inequality, the mechanisms thought to increase the risk of adverse health are very similar and could probably be approached in much the same way from a policy perspective.

The findings of this study echo those of previous ecological studies investigating the relation between income inequality and mortality. They also provide a more refined understanding of the role of labour market generated inequality among Canadian MAs. Many argue, however, that the best approach to studying social environmental determinants of health is with a study design that simultaneously accounts for known health determinants at the individual and ecological scales. Recent studies have adopted a multi-level approach to tease out the net effects on health of societal level inequality, while controlling for individual characteristics such as income and employment status. The results of these studies are mixed (for a review see Wagstaff and van Doorslaer), perhaps because of variations in sample sizes of the studies and the variety of geographical scales at which income inequality is measured. In cross national studies, however, a multi-level approach is often not possible as individual level health data are rarely comparable across countries.

Policy implications

- In these cross sectional, ecological analyses, labour market income inequality is an important explanatory factor for the pattern of working age mortality in North American metropolitan areas. The hypothetical effects are indeed large from a public health point of view and therefore suggest that any number of policies aimed at the amelioration of inequalities in the labour market could prove important for population health.

References


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