ORIGINAL RESEARCH

Relationships between income inequality and health: a study on rural and urban regions of Canada

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A B S T R A C T

Introduction: Many studies have demonstrated that health is a function of relative and not absolute income within populations. Canadian studies are not conclusive; most indicate that there is no relationship between income inequality and health within Canada. There is a need for further investigation into the validity of the 'relative income' hypothesis in the Canadian population. The primary objective of this research was to test the 'relative income' hypothesis across Canadian health regions. The second objective was to extend the hypothesis to consider rural versus urban populations.
Methods: This research involved ecological analyses. The source of the data was the Canadian Community Health Survey, Cycle 3.1. The units of analysis were Canadian health regions. Health of a region was estimated as the percentage of people who rated their health as good or excellent. The primary exposure variable was the ratio of people whose personal income was less than $15,000 relative to those reporting more than $80,000 in the year preceding the survey. This ratio provided a measure of the distribution of income. The main covariates were ecological measures of socio-demographic variables, social capital, substance use behaviours (smoking and alcohol consumption), rural/urban status of the region, and absolute income in the region. Correlation analyses and multiple linear regressions were performed to ascertain the relationship between income inequality and population health, adjusting for important covariates.

Results: The measure of income inequality alone appeared to explain 18% of the variability in the measure of population health. However, after adding the measure of absolute income to the model, although 29% of the variability was explained, the independent contribution of the inequality measure became non-significant. Linear regression models suggested that the absolute income variable alone could explain 30% of the variance in the health status of populations. Other variables with a statistically significant contribution to the final model were education and alcohol consumption. The effect of rural/urban geographic status on the relationship of interest was similar to other covariates. This variable did not change the individual relationship between income inequality or absolute income and the measure of population health status. In both rural and urban regions, absolute income and education had positive effects on population health. In urban regions alcohol consumption was a significant negative contributor to population health status; whereas, in rural regions, smoking status had a significant negative effect on population health status.

Conclusion: Across Canadian health regions, health status in populations was a function of absolute income but not relative income. Regions with higher levels of education had better levels of self-rated health. A larger percentage of heavy drinkers was also correlated with lower population health status. Findings were consistently observed in rural and urban populations. The study findings have implications for public health, economic, and social policies.

Keywords: Canada, income inequality, relative income hypothesis, population health, self-rated health.

Introduction

Among various socioeconomic factors that can determine population health, income is one important determinant of health[1]. Higher income, particularly in developing countries, often leads to a healthier environment[2]. In the early 1990s Wilkinson described a new hypothesis to explain the relationship between relative income and health. In a series of published papers and books, he suggested that among developed countries the distribution of income in a geopolitical aggregate and not the absolute wealth is a more reliable determinant of health[3-6]. The relative income hypothesis triggered a large amount of debate and numerous studies with conflicting interpretations and non-conclusive results. International studies and research on unequal societies such as the USA and the UK are mostly supportive of the hypothesis, whereas results of studies within countries with smaller income imbalances such as Canada[7], Denmark[8,9], and Finland[10] are either negative or non-conclusive. It seems that the relative income hypothesis might only operate in large geographic regions[11].

In Canada the hypothesis has been tested within individual provinces[12-14], but not across the country. The purpose of the current study was therefore to examine the 'relative income' hypothesis across all Canadian health regions. Ecological research was conducted to test the potential relationship between a measure of income inequality and a measure of population health within Canada.

Methods

Study design

An ecological analysis of the Canadian Community Health Survey (CCHS), Cycle 3.1, 2005 data was conducted. Income distribution is only measurable at an aggregate level[4,15]; hence, an ecological design was the preferred choice for the current study. All variables were measured at the ecological level.

Data and measures

Data source: The data source for this study was the CCHS, Cycle 3.1[16], a national level survey of approximately

130 000 persons conducted in 2004. The target population included household residents aged 12 years and older in all Canadian provinces and territories. Exclusions were the populations on Indian Reserves, those residing in institutions, members of the Canadian Forces who reside in bases, and those in some remote areas.

The survey had a multistage stratified cluster design in which the dwelling was the final sampling unit. The CCHS Cycle 3.1 employed rigorous strategies in weighting and obtaining a high response rate (79%). All variables required for this research except the rural–urban status variable were obtained from the Public Use Microdata File of the CCHS Cycle 3.1. This file was accessed through the Social Science Data Centre at Queen's University, Kingston, Ontario. Rural/urban status data were obtained from CCHS Cycle 3.1 Master File Data which was accessed via the Statistics Canada Research Data Centre at Queen's University.

Dependent variable: The dependent variable in this research was a measure of health status of populations. A subjective indicator of health (self-rated health) was used to ascertain the health status of the population. In the CCHS Cycle 3.1 all participants rated their current status of their health as one of the following categories: excellent, very good, good, fair, or poor. To provide an estimate of general health status of each health region, the percentage of people who rated their current state of health as good or higher was calculated.

Independent variable: A range measure[17] of income inequality (the ratio of two extreme categories of income) was employed. The ratio of the percentage of people whose income was less than $15,000 to those who made more than $80,000 during the year before interview (2004) was calculated for each Canadian health region.

Covariates: Various covariates required consideration with regard to potential confounding effects on the relationship of interest as they might be related to both outcome (perceived health) and exposure (income inequality). The most important independent variable, absolute wealth of each

aggregate, was estimated by calculating the percentage of people who had a personal income of more than $30,000 in the year preceding the survey (2004) in each Canadian health region. Variables considered a priori as potential confounders and controlled for in the analyses as follows (Table 1): (i) health care utilization; (ii) sex; (iii) age; (iv) education; (v) smoking rate; (vi) alcohol consumption; (vii) rural/urban status; and (viii) social capital.

Analysis

Most of the analyses in this investigation were conducted using 'Queen's WebInterface for SPSS' (QWIFS; Social Science Data Centre, Queen's University) as an interface for SPSS v15.0 (SPSS; Chicago, IL, USA). In addition, SAS v9.1 (SAS Institute; Cary, NC, USA) was used for further data manipulation and analyses.

The range, extreme values and measures of central tendency of each ecological variable were estimated (Table 2). Median values of variables were used to establish a threshold to divide the observations into two categories. These categories were utilized in sub-group analyses and tests of interaction. Pearson's correlation was used to describe bivariate relationships between continuous variables. Simple and multiple linear regression analyses were used to examine relationships between the variables of interest while controlling for other factors, and to understand how much variation in Canadian population health status can be explained by the independent variable.

Ethics

The research used data from secondary sources already in the public domain. Before starting data collection and analyses ethics approval was obtained. To avoid any potential identification of study participants, the Statistics Canada rules relating to privacy and confidentiality were followed at all times during the research.

Table 1: Description of variables and source

Variable	CCHS source	Description
Population health	GENEDHDI	Percentage of people with good, very good and excellent health in each health region.
Income inequality	INCEGPER	Ratio of number of people whose income is less than $15,000 to those who make more than $80,000 in each health region.
Absolute income	INCEGPER	Percentage of people whose income is more than $30,000 in each health region.
Health care utilization	HCUE_1AA	Percentage of people who have a regular medical doctor in each health region.
Sex	DHHE_Sex	Percentage of males in each health region.
Age	DHHEGAGE	Percentage of people who are more than 65 years old in each health region.
Education	EDUEDR04	Percentage of people who have at least some post-secondary education in each health region.
Daily smoking	SMKEDSTY	Percentage of people who are daily smokers in each health region.
Alcohol consumption	ALCE_6	Percentage of people who consume more that 12 drinks regularly each week in each health region.
Rural /urban status	GEOnDUR2	Percentage of people who live in rural areas in each health region.
Social capital	GENE_10	Percentage of people who rate their sense of belonging to their local community as strong, in each health region.

CCHS, Canadian Community Health Survey.

Table 2: Mean, minimum, median, and maximum values of variables used in the analysis

Variable	Values				
	Mean	Median	Min	Max	Range
Report good health %	87.6	88	80.3	92.5	12.2
Income inequality (ratio < $15,000 : >$80,000)	7.15	4.84	1.47	38.0	36.5
Absolute income (% with > $30,000 earners)	45.3	46.6	28.3	58.6	30.3
Have regular family doctor %	86.9	87.6	67.5	97.2	29.7
Male %	49.5	49.5	47.5	52.4	4.90
Age >65 years %	15.5	15.6	7.40	23.7	16.3
Education at least secondary %	56.4	56.3	42.4	71.7	29.3
Daily smoker %	18.3	18.6	7.30	27.0	19.7
Heavy drinker %	21.4	21.6	5.60	43.2	37.6
Rural population %	29.2	29.5	0.00	82.0	82.0
Strong sense of belonging %	65.3	66.6	23.1	95.2	72.1

Results

Preliminary descriptive analyses revealed that all variables except the income inequality variable were normally distributed across health regions (Table 2). Results of correlation analyses suggested that the dependent variable (health status in populations) had a statistically significant positive correlation with the absolute income and education variables (Table 3). The correlation between the primary exposure variable (income inequality) and the outcome variable became non-significant after controlling for a measure of absolute income (Pearson correlation coefficients were changed from -0.43 [$p<0.0001$] to +0.09 [$p0.3816$]). Simple linear regression analysis showed that the relative income inequality measure appears to explain 18% of the variance in the population health, but after adding the measure of absolute income to the model, income inequality was not a significant predictor of variations in the population health. The measure of absolute income was able to explain 30% of the variability of the measure of population health and its independent contribution stayed significant after adding the measure of income inequality to the model (Table 4, model 2).

Various strategies in the REG procedure in SAS version 9.1 were employed to identify important covariates and to build the most parsimonious model[18]. The final model (model 6a, table 4) showed that apart from absolute income, the two variables education and alcohol consumption have positive and negative statistically significant effects on population health status, respectively. No second-order interaction terms containing the variables in the final model were significant. Based on tests of collinearity, multicollinearity between variables did not appear to be an issue in the regression analyses. Furthermore, outlier detection and influential diagnostics analyses were conducted. Health regions with extreme values did not have any significant influence on the results of regression analyses.

In both rural and urban geographic regions the measure of income inequality became non-significant after adding absolute income to the model (Table 5, part C). In both regions, absolute income versus relative income, was a better predictor of health disparities in the population (in rural regions the adjusted R^2=0.25 vs 0.09, and in urban regions 0.11 vs 0.07; Table 5). In urban regions the optimal model was similar to the model for Canada as a whole but in rural regions variable smoking compared with variable alcohol was better able to explain the variations in the outcome.

Discussion

The national study systematically tested competing absolute income and relative income hypotheses among Canadian health regions. Previous Canadian research was mostly either non-conclusive[19] or non-supportive of the relative income hypothesis[20,21]. The research demonstrated that compared with the relative income hypothesis, the absolute income hypothesis was better able to explain variations in the measure of population health in Canada. In the regression analyses, when the measure of absolute income was considered as the main independent variable, the adjusted R^2 was higher compared with the models in which relative income was the main independent variable (0.30 in model 1b vs 0.18 in model 1a, Table 4). The measure of absolute income remained a significant and independent contributor in the final model after controlling for potential confounders. This finding was similar to other studies on small geographic regions[22], one thesis on Ontario public health units[12], and research on countries with lower degrees of income inequality[7,10,11].

Table 3: Correlation matrix of variables

Variable	Health	Inequality	Absolute	Physician	Sex	Age	Education	Smoking	Alcohol	Rural	Belonging
Health	1.00	-0.43****	0.55****	-0.06	0.03	-0.38****	0.50****	-0.39****	-0.32***	-0.44****	-0.26**
Inequality		1.00	-0.77****	0.06	-0.20*	0.32**	-0.37***	0.17	0.06	0.58****	0.16
Absolute			1.00	0.01	0.16	-0.50****	0.51	-0.25*	-0.20	-0.63****	-0.20
Physician				1.00	-0.37***	0.15	0.04	-0.26**	-0.02	-0.003	0.10
Sex					1.00	-0.38****	-0.34***	0.30**	0.03	0.18	-0.07
Age						1.00	0.32**	0.04	0.24*	0.37****	0.26**
Education							1.00	-0.06****	-0.19	-0.65****	0.30**
Smoking								1.00	0.29**	0.38****	-0.02
Alcohol									1.00	0.30**	0.11
Rural										1.00	0.18

*$p<0.05$, **$p<0.01$, ***$p<0.001$, ****$p<0.0001$.

Table 4: Linear regression analyses results according to model

Model & independent variable	Results				
	ß	Standardized ß	Adjusted R^2	t	p
1a. Inequality	-0.15*	-0.43	0.18	-4.76	0.0001
1b. Absolute income	0.18†	0.55	0.30	6.25	<0.0001
2. Absolute + inequality			0.29		
Inequality	0.50*	0.14		4.11	0.3816
Absolute	0.19†	0.56		4.22	<0.0001
3a. Inequality + all covariates	-0.67*	-0.20	0.34	-1.63	0.1100
3b. Absolute + all covariates	0.12†	0.37	0.40	3.18	0.0100
4. Inequality + absolute + covariates			0.39		
Inequality	0.17*	0.14		0.84	0.4100
Absolute	0.15†	0.47		2.81	0.0100
5a. Inequality + rural	-0.89*	-0.26	0.22	-2.23	0.0241
5b. Absolute + rural	0.15†	0.45	0.31	4.16	<0.0001
6a. Absolute + alcohol + education	0.12†	0.37	0.39	3.99	0.0001
6b. Absolute + alcohol + smoking + belonging	0.13†	0.40	0.39	4.73	<0.0001
6c. Absolute + alcohol + smoking + education	0.13†	0.38	0.39	4.10	<0.0001

*ß, t, and p for income inequality variable; †ß, t, and p for absolute income variable.

Table 5: Results of linear regression analysis of association between income inequality, absolute income and health within different levels of rural/urban status

(A) Independent variable = Income inequality						
	n	ß*	Standardized ß	Adjusted R^2	t*	p**
Rural regions	47	-1.14	-0.34	0.09	-2.54	0.02
Urban regions	53	-1.12	-0.29	0.07	-2.17	0.03
(B) Independent variable = Absolute income						
	n	ß†	Standardized ß	Adjusted R^2	t†	p†
Rural regions	47	0.18	0.52	0.25	4.05	0.0002
Urban regions	53	0.14	0.36	0.11	2.76	0.01
(C) Independent variables = Income inequality + absolute income						
	n	ß*	Standardized ß	Adjusted R^2	t*	p*
Rural regions	47	0.57	0.17	0.25	0.83	0.97
Urban regions	53	0.22	0.06	0.10	0.23	0.9

*ß, t, and p for income inequality variable; †ß, t, and p for absolute income variable.

The findings may be interpreted in two ways. First, the units of analysis (Canadian health regions) were relatively small geographically and in terms of population size. In smaller areas there is a lower likelihood of social heterogeneity, which is the main reason for the effect of income inequality on health[23,24]. Second, there is also some debate that the relationship between income inequality and health may depend on the level of inequality and be apparent only above a certain income inequality threshold[25]. Canada, compared with some other western countries, namely the USA and UK, has lower levels of income inequality (the Gini coefficient for Canada=0.32, for USA=0.45, and for UK=0.34)[26]. The lower level of income inequality in Canada may be another reason for lack of support of the relative income hypothesis in this research.

Based on the optimal model (model 6a, Table 4), the existence of a higher percentage of people with post-secondary education is associated with better population health. It is not surprising that better educated people are also healthier, but it was concluded that more educated people in each region also affected the health of the whole community. Also, the model showed that the higher proportion of heavy drinkers in a region was a negative contributor to population health.

Rural/urban geographic status of a region was neither a confounder nor an effect-modifier factor for the relationship between absolute income and population health in the study. Final models were constructed separately for each of rural and urban regions. In both regions, absolute income and education had positive effects on the measure of population health. In rural regions in contrast to urban regions, an ecological measure of smoking had a significant negative effect on population health while alcohol consumption had no effect.

The main methodological concern in this study was the choice of the income inequality measure. Not accessible, however, were individual data required for calculating disproportionality measures such as the Gini coefficient and a 'range measure' was used based on an existing approach to assessment of income inequality[17]. To assess the sensitivity of the range measure, three other range measures which varied the ratio between the percentages of high and low income persons were also calculated. All analyses were repeated with these three new measures and no significant changes in results were observed. The measure of income inequality appeared to be a reliable measure of relative income inequality.

The limitations of this research warrant comment. First, the cross-sectional study design did not permit a full exploration of temporality. Measures of absolute income and population health were measured at the same time and it was not possible to establish if higher wealth in a region actually contributes to better population health. Second, since all variables were measured at an ecological level, the conclusions cannot be extended to individuals. The study showed that among Canadian health regions, more prosperous regions have higher percentages of people with good self-rated health, but one should not conclude that richer individuals inside a region are necessarily healthier. The database (CCHS Cycle 3.1, 2005), although employing a reliable sampling methodology, did not cover the entire Canadian population. The exclusion of on-reserve Aboriginal people, who are among the poorest and least healthy of the Canadian population, is a problem in generalizing the results of this research.

Longitudinal analyses are required to establish whether changes in absolute income will have an effect on population health. More research is needed to refute or approve the study findings. To establish a more comprehensive picture of relationships between income and health among Canadian populations, inclusion of on reserve Aboriginal people in future studies is warranted.

Conclusion

In summary, this study supported the absolute income hypothesis in Canada. The study results showed that higher

aggregate absolute wealth and higher percentages of people with post-secondary education are associated with better population health. Higher rates of alcohol consumption were also correlated with lower population health status in urban regions and smoking was correlated with lower population health status in rural regions. This study was performed in a single country, Canada, which has unique economic and health characteristics. If the current study findings are borne out consistently in other settings, there are a number of implications for population health policies and programs.

Overall, this research shows that policies on improving income, education, and lowering alcohol consumption (in urban areas) and smoking rates (in rural regions) may improve the health of Canadian urban and rural populations. In both rural and urban areas, increasing absolute income by economic development and providing employment will improve the health of the population. However, in rural Canada, the policy implications of the absolute income hypothesis is more complex. Historically, incomes are generally measured in terms of cash income. People living in rural areas often have in-kind assets but fewer cash assets, for this reason income in rural areas appears lower but the availability of economic resources may be at the same level as that of urban residents. For example, farmers can grow their own food, therefore they spend less money for groceries but this does not necessarily mean that compared with urban residents they have worse nutrition. Second, the older population is over-represented in rural areas and their health status is less likely to be affected by changes in income status in their final years. In this respect, increasing the incomes of older people by improving government transfers (eg Canada Old Age Security) and pensions (eg Canada and Quebec Pension Plans), might improve their quality of life and, indirectly, their psycho-social wellbeing but not necessarily their physical health.

Further studies are warranted that take into account the differences between relative income and absolute income status, Canada's poorest and least healthy population groups, and longitudinal frameworks in contrast to cross-sectional frameworks.

Acknowledgements

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