EVIDENCE BASED PUBLIC HEALTH POLICY AND PRACTICE

Avoidable mortality by neighbourhood income in Canada: 25 years after the establishment of universal health insurance

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Aim: To examine neighbourhood income differences in deaths amenable to medical care and public health over a 25-year period after the establishment of universal insurance for doctors and hospital services in Canada.

Methods: Data for census metropolitan areas were obtained from the Canadian Mortality Database and population censuses for the years 1971, 1986, 1991 and 1996. Deaths amenable to medical care, amenable to public health, from ischaemic heart disease and from other causes were considered. Data on deaths were grouped into neighbourhood income quintiles on the basis of the census tract percentage of population below Canada's low-income cut-offs.

Results: From 1971 to 1996, differences between the richest and poorest quintiles in age-standardised expected years of life lost amenable to medical care decreased 60% ($p<0.001$) in men and 78% ($p<0.001$) in women, those amenable to public health increased 0.7% ($p=0.94$) in men and 20% ($p=0.55$) in women, those lost from ischaemic heart disease decreased 58% in men and 38% in women, and from other causes decreased 15% in men and 9% in women. Changes in the age-standardised expected years of life lost difference for deaths amenable to medical care were significantly larger than those for deaths amenable to public health or other causes for both men and women ($p<0.001$).

Conclusions: Reductions in rates of deaths amenable to medical care made the largest contribution to narrowing socioeconomic mortality disparities. Continuing disparities in mortality from causes amenable to public health suggest that public health initiatives have a potentially important, but yet unrealised, role in further reducing mortality disparities in Canada.

With the establishment of government-funded health insurance for all medically necessary services provided by hospitals in 1957 and by doctors in 1968, the Canadian health insurance system has been organised to ensure access on the basis of health need, rather than income.[1 2] Yet, despite continued gains in average life expectancy, socioeconomic differences in mortality and health continue to exist.[3 4]

Persisting health disparities have led to important debates regarding access to and use of health services offered by Canada's universal health insurance system. Some Canadian studies have found that higher socioeconomic status was associated with better access to specialised services.[5–7] Other studies have shown that socioeconomic status is not associated with waiting times for elective surgery and that differences in medical need have been the main determinant of primary care and hospital admissions.[7–10] Owing to a lack of appropriate population health indicators, the contribution of the health system to changes in health outcome inequalities has not been determined.

In 1976, the Working Group on Preventable and Manageable Diseases proposed using ''unnecessary untimely deaths'' as an indicator of medical care quality.[11] The Working Group presented lists of conditions for which deaths may be ''avoidable'' if appropriate medical care is provided in a timely fashion. Since then, the avoidable mortality concept has been applied as an indicator of healthcare performance at the population level and to signal possible deficiencies in healthcare that warrant additional investigation.[12 13]

The relationship between avoidable mortality and socioeconomic status may provide a population-based indication of the role of different components of healthcare for reducing mortality inequalities in Canada. We examined the changes in neighbourhood income-related differences in avoidable mortality in urban Canada over a 25-year period. Using the Working Group's approach, the contribution of medical care and public health were considered separately by grouping deaths into those amenable to medical care and those preventable through public health interventions.

METHODS

Data source

Death registration data for residents of Canadian census metropolitan areas were obtained from the Canadian Mortality Database for the years 1971, 1986, 1991 and 1996. Census tract coded data for 2001 recently became available (April 2006), but could not be included in this study. The study area was restricted to metropolitan areas because neighbourhoods are more clearly defined, and residential segregation by income is more pronounced in large cities compared with small towns and rural areas.[14] The analysis for 1971 was based on 21 census metropolitan areas representing 54% of the total Canadian population. For 1986, 1991 and 1996, 25 areas met the census metropolitan area definition and all were included in the study, representing approximately 60% of the total Canadian population.

Street address data from death registrations were used to establish the census tract of usual residence for each deceased person. Census tract population and income data were obtained from Canadian population censuses for the years 1971, 1986, 1991 and 1996. People were classified as low income if their total economic family income or unattached individual income in the year preceding a given census was below that year's Statistics

Abbreviations: IHD, ischaemic heart disease; PYLL, potential years of life lost; SEYLL, age-standardised expected years of life lost

Canada low-income cut-offs.[4] Within census metropolitan areas, each census tract was ranked according to the percentage of population below the low-income cut-off. Census tracts were then assigned to quintile groups in the order of lowest to highest percentage of low-income residents, such that each quintile comprised approximately one-fifth of the total non-institutional population of the census metropolitan area. The quintile data were then pooled across census metropolitan areas.

People living in the same urban neighbourhoods may be heterogeneous in terms of socioeconomic characteristics, and individual socioeconomic homogeneity within urban neighbourhoods generally increases as the neighbourhood size decreases.[14–17] However, studies comparing the health outcome association trends using census tracts (2500–8000 people) or the smaller enumeration areas (125–440 households or dwellings) as area-level indicators of socioeconomic status have shown similar results.[15 18–21]

Avoidable deaths classification

A list of amenable deaths was created before the analyses with reference to classification lists from selected avoidable mortality studies.[22–28] The avoidable causes of death were then categorised into causes amenable to medical care and causes amenable to public health (table 1). Ischaemic heart disease (IHD) was considered as a separate category. All other deaths were grouped into a single category of ''other causes''.

Deaths amenable to medical care are those for which it is reasonable to expect a death to be prevented through medical care (ie, hospital and physician services) after the condition has developed. This list includes causes such as appendicitis and asthma, where the medical nature of the intervention is apparent. This list also includes causes such as cervical cancer, where deaths are preventable through early detection and effective treatment. Deaths amenable to public health are those for which medical services may be less effective for treating the condition, but where there are interventions that are known to prevent the condition from occurring. This group includes lung cancer and liver cirrhosis, which are mainly amenable to changes in health behaviours (such as tobacco and alcohol use) and motor vehicle accidents, which are amenable to legislative measures (such as speed limits and laws requiring use of seatbelts and helmets).[28] IHD was categorised separately because (a) both medical interventions and public health can contribute to reducing such deaths and (b) the large number of deaths from IHD would conceal the effect of medical care and public health on the other causes of death.[28]

Exclusions

Deaths of residents of long-term care facilities were excluded because the income of institutional residents is not collected in Canadian censuses, and the income level of the census tract in which an institution is located may be unrelated to the income of the institutional residents. Census tracts with a non-institutional population of <250 were excluded because their income data were not published. Deaths after 74 years of age were excluded because deaths above this age are not as likely to be preventable and cause of death certification has been shown to be less accurate for deaths at older ages.[29] This cut-off age is consistent with recent literature using the avoidable mortality concept.[12 28 30–32]

Analysis

The number of years of life lost is an indicator of premature mortality that takes into account the age at death. Expected years of life lost rates were computed using the method applied for the Global Burden of Disease Project,[33] where the age-specific years of life lost were estimated using the urban Canada 1996 male and female life expectancies of the richest quintile (Q1) as the standard. To account for the different age distributions between the income quintiles, expected years of life lost rates were age-standardised by the direct method with Canada's population in 1991 as the reference population, yielding the age-standardised expected years of life lost (SEYLL). The formula for calculating the SEYLL rate for a given cause is presented below:

$$\text{SEYLL rate} = \sum_{i \leqslant 1}^{70\text{–}74} E_i \times (d_i/p_i) \times (P_{Ri}/N_R)$$

where the sum is over age groups from 0 to 74 years, E_i is the 1996 life expectancy for the mid-age of age group i of Q1, d_i is the number of deaths from the cause in the age group i, p_i is the number of people in the examined population age group i, p_{Ri} is the number of people in the 1991 Canadian reference population age group i, and N_R is the number of people in the reference population <75 years of age. In all cases, the life years lost were determined by reference to ordinary ''period'' life tables based on cross-sectional data for a given year or period of years, as opposed to ''cohort'' life tables based on data for the entire life span of a generation.

Potential years of life lost (PYLL) is an alternative way of calculating the mortality burden from various causes of death. SEYLL differs from PYLL in the way the person-years of life lost are calculated. For PYLL, the life years lost are obtained by subtracting the observed age at death from an arbitrary upper limit such as 65 or 75 years. For SEYLL, the life years lost are obtained by subtracting the observed age at death from the expected age at death for a person of that age, as shown in a life table. So that death at a given age is counted equally across socioeconomic groups (whose life expectancies differ), the expected age at death for all socioeconomic groups is standardised by always taking it from the life table for the richest income quintile. The effects are that both PYLL and SEYLL give greater weight to deaths at younger ages, but compared with PYLL, SEYLL gives relatively greater weight to deaths at older ages.

A change in the absolute interquintile (Q5–Q1) SEYLL rate difference from 1971 to 1996 was selected as the primary outcome measure to determine whether mortality disparities across the neighbourhood income quintiles altered over time. We elected not to present relative differences (such as rate ratios) in mortality because relative disparity measures assist in determining aetiology and the mechanisms of interventions, which are beyond the scope of this study. Changes in the absolute differences in mortality over time provide information regarding the population health effect of health policies and interventions.[34 35]

Income-related ''excess mortality'' (a measure of population attributable risk) was calculated as the difference in the SEYLL rate for the total population less that of the richest quintile (QT–Q1). This comparison quantifies the reduction in mortality that would occur if the entire population experienced the mortality level of the richest quintile.[4 35] We calculated the proportion of all-cause income-related excess mortality in 1996 attributable to avoidable causes of death. SEYLL rates by neighbourhood income quintile were calculated and presented for selected avoidable causes.

Using methods developed at Statistics Canada (G Roberts, personal communication, 2003), variance estimates for the SEYLL rates were calculated assuming that the number of deaths in each age group follows a Poisson distribution. The variance of the change between 1971 and 1996 in the Q5–Q1 difference in SEYLL for a particular cause was obtained as the sum of the four variances for SEYLLs in Q1:1971, Q1:1996, Q5:1971 and Q5:1996. A Z test was used to make the comparison of this change between

Table 1 List of ''avoidable'' deaths, showing ICD codes and age ranges

Cause	ICD8 code	ICD9 code	Age groups (years)
Ischaemic heart disease	410–414	410–414, 429.2	35–74
Deaths amenable to medical care			
Intestinal infection	000–009	001–009	0–14
Tuberculosis	010–019	010–018, 137	0–74
Diphtheria	032	032	0–74
Whooping cough	033	033	0–14
Tetanus	037	037	0–74
Septicaemia	038	038	0–74
Poliomyelitis	040–044	045	0–74
Measles	055	055	1–14
Syphilis	090–097	090–097	0–74
Other bacterial infections	020–031, 034, 320, 381–383,390–392, 680–686,710	019–031, 034, 320–322, 381–383, 390–392, 680–686, 711	0–74
Female breast cancer	174	174	25–74
Cervical cancer	180	180	15–74
Other uterine cancer	182	179, 182	15–74
Testicular cancer	186	186	0–74
Hodgkin's disease	201	201	0–74
Leukaemia	204–207	204–208	0–14
Diseases of the thyroid	240–246	240–246	0–74
Diabetes mellitus	250	250	0–49
Deficiency anaemias	280–281	280–281	0–74
Epilepsy	345	345	0–74
Active rheumatic fever	390–392	390–392	0–74
Chronic rheumatic heart disease	393–398	393–398	0–74
Hypertensive disease	400–404	401–405	35–74
Cerebrovascular disease	430–438	430–438	35–74
Influenza	470–474	487	0–74
Pneumonia	480–486	480–483, 485–486	0–74
Other acute respiratory infections	460–466	460–466	1–14
Asthma	493	493	0–49
Peptic ulcer	531–534	531–534	0–74
Appendicitis	540–543	540–543	0–74
Abdominal hernia	550–553	550–553	0–74
Ilieus without hernia	560	560	0–74
Cholelithiasis, cholecystitis and cholangitis	574–575	574–575.1, 576.1	0–74
Nephritis and nephrosis	580–584	580–589	0–74
Infections of the urinary system	590,595	590,595	0–74
Hyperplasia of the prostate	600	600	0–74
Complications of pregnancy	630–678	630–676	0–74
Osteomyelitis and periostitis	720	730	0–74
Congenital cardiovascular anomalies	746–747	745–747	0–74
Congenital digestive anomalies	750–751	750–751	0–74
Perinatal conditions	760–779	760–779	*
Deaths amenable to public health			
HIV	—	042	0–74
Lung cancer	162	162	0–74
Skin cancer	173	173	0–74
Chronic obstructive pulmonary disease	490–492	490–492, 496	0–74
Cirrhosis of the liver	571	571	0–74
Motor vehicle accidents	E810–823	E810–825	0–74

*, no age restrictions, other than the one used to define perinatal deaths, were imposed on deaths from this cause.

causes amenable to medical care and causes amenable to public health interventions. In order to simplify their presentation, 95% CIs were not included in the plots of trends.

RESULTS

Table 2 shows the socioeconomic characteristics of each neighbourhood income quintile in urban Canada in 1996. Poorer quintiles had a higher proportion of people unemployed, with <9 years of education, and a lower proportion in managerial or professional occupations, or who owned their own homes.

Table 3 presents the deaths and populations available for analysis by neighbourhood income quintile and by sex: after exclusions, a total of 203 605 deaths and 58.5 million person-years at risk. For both men and women, the quintile population sizes were comparable in each year.

Figure 1 presents the income-related disparities in avoidable mortality (Q5–Q1 SEYLL rate differences) for causes amenable to medical care, amenable to public health, from IHD and from other causes. From 1971 to 1996, the disparity for causes amenable to medical intervention diminished 60% (1287 SEYLL per 100 000 people) in men and 78% (1264 SEYLL per 100 000 people) in women. For IHD, the disparity decreased 58% (1041 SEYLL per 100 000 people) in men and 38% (261 SEYLL per 100 000 persons) in women. The largest reductions in amenable mortality disparities from these causes occurred between 1971 and 1986. For instance, disparities in women decreased 55% (902 SEYLL per 100 000 people) and 36% (249 SEYLL per 100 000 people) for causes amenable to medical care and from IHD, respectively, during that time. For causes amenable to public health, the disparities increased 0.7% (12 SEYLL per 100 000 people) in men and increased 20% (63 SEYLL per 100 000 people) in women. Income-related disparities in avoidable mortality from other causes of death (not amenable to medical care, public health or IHD) decreased 15% (559 SEYLL per 100 000 people) in men and 9% (145 SEYLL per 100 000 people) in women.

Table 2 Socioeconomic characteristics of each neighbourhood income quintile, urban Canada, 1996

Income quintile	Low income* (%)	Average household income (Can$)	IPPE† (Can$)	Income from government transfers (%)	Housing owned (%)	Foreign born (%)	Recent immigrants‡ (%)	Unemployed§ (%)	Managerial professional occupations¶ (%)	Low education (<9 years)** (%)
QT (all quintiles)	21.5	51 718	34 901	21.1	58.6	25.1	5.6	9.3	9.8	10.4
Q1 (richest)	7.6	72 944	45 592	7.3	84.7	16.2	2.7	6.1	13.2	5.7
Q2	12.8	61 780	39 636	9.6	75.7	20.4	4.1	7.3	11.0	8.1
Q3	19.2	52 880	35 393	12.0	62.2	25.5	5.6	8.7	9.5	9.8
Q4	27.1	43 921	30 616	15.0	49.4	29.7	6.9	10.6	8.1	13.0
Q5 (poorest)	41.7	33 421	24 531	20.3	30.2	34.0	8.6	14.5	6.7	15.2

Data Source: 1996 Canadian census tract profile data for the non-institutional population.
*Less than Statistics Canada's low-income cut-off for family size and metropolitan area population size group.
†Income per person equivalent (average household income adjusted for household size).
‡Immigrants who arrived from 1991 to 1996, as a percentage of all persons age ⩾5 years in 1996.
§As percentage of labour force aged ⩾15 years.
¶Includes occupations in managerial, administrative, teaching and related occupations, as well as occupations in medicine and health.
**As percentage of population aged ⩾15 years.

Table 3 Included deaths by neighbourhood income quintile and by sex in urban Canada from 1971 to 1996

	1971			1986			1991			1996		
	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women
QT	46 548 (4.1)	29 465 (5.3)	17 083 (3.0)	51 983 (3.6)	32 401 (4.5)	19 582 (2.7)	51 996 (3.3)	32 343 (4.1)	19 653 (2.4)	53 078 (3.1)	32 585 (3.9)	20 493 (2.4)
Q1	6127 (2.8)	3824 (3.5)	2303 (2.1)	7160 (2.5)	4407 (3.1)	2753 (1.9)	7094 (2.2)	4379 (2.7)	2715 (1.7)	8020 (2.3)	4881 (2.8)	3139 (1.8)
Q2	7350 (3.3)	4624 (4.1)	2726 (2.4)	8431 (2.9)	5254 (3.6)	3177 (2.2)	8541 (2.7)	5224 (3.3)	3317 (2.1)	9055 (2.7)	5504 (3.3)	3551 (2.1)
Q3	8936 (4.0)	5540 (5.0)	3396 (3.0)	10 048 (3.5)	6196 (4.4)	3852 (2.6)	10 256 (3.2)	6331 (4.0)	3925 (2.4)	10 145 (3.0)	6172 (3.7)	3973 (2.3)
Q4	9877 (4.4)	6089 (5.5)	3788 (3.3)	11 363 (4.0)	7005 (5.0)	4358 (3.0)	11 790 (3.7)	7,266 (4.7)	4,524 (2.8)	11 757 (3.5)	7142 (4.4)	4615 (2.7)
Q5	14 258 (6.1)	9388 (8.1)	4870 (4.2)	14 981 (5.1)	9539 (6.6)	5442 (3.7)	14 315 (4.6)	9143 (6.0)	5172 (3.3)	14 101 (4.2)	8 886 (5.4)	5215 (3.1)

Qt, all quintiles; QA, richest quintile; Q5, poorest quintile.
Crude death rates per 1000 are indicated in parentheses.

Figure 2 shows the proportion of the all-cause income-related excess mortality (QT–Q1 SEYLL rate difference) attributable to avoidable causes of death for men and women in 1996. For instance, avoidable deaths from IHD contributed 14% to the all-cause SEYLL difference between the total population and the richest quintile in that population (ie, the income-related excess mortality). In 1996, avoidable causes of death together accounted for about half (49.6%) of all income-related excess mortality among men, and 42% among women. Of the excess attributable to avoidable causes, 30% among men and 18% among women were due to medically amenable causes of death. In addition, 42% of that among men and 44% among women were due to IHD.

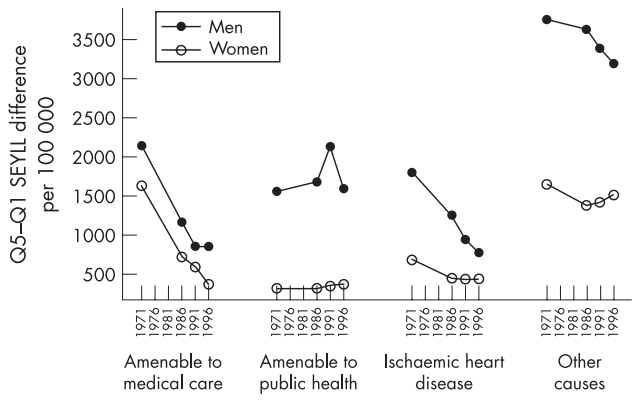

Figure 1 Avoidable mortality disparity (Q5–Q1 age-standardised expected years of life lost (SEYLL) rate difference per 100 00 population) for causes amenable to medical care, amenable to public health, from ischaemic heart disease and from other causes in urban Canada from 1971 to 1996. The reduction in Q5–Q1 SEYLL difference from 1971 to 1996 was significant for deaths amenable to medical care ($p<0.001$ for men and women), but not for deaths amenable to public health ($p=0.94$ for men and $p=0.55$ for women). The changes in SEYLL difference from 1971 to 1996 were significantly larger for deaths amenable to medical care than for deaths amenable to public health, for both men and women ($p<0.001$).

IHD, lung cancer, perinatal mortality, cerebrovascular disease HIV and chronic obstructive pulmonary disease contributed the most to the excess, together accounting for 49% and 43% of the overall excess for men and women, respectively.

Negative proportions were observed for deaths from motor vehicle accidents in men, as well as from congenital cardiovascular abnormalities and breast cancer in women. These negative proportions indicate that the richest quintile experienced more deaths associated with those causes compared with the rest of the population in 1996.

Figures 3–5 show avoidable mortality (SEYLL rates) by neighbourhood income quintile, for each cause that contributed >1% to the overall income-related excess mortality from avoidable causes (QT-Q5 SEYLL rate difference) in 1996. For most of these causes, mortality disparities diminished over time. However, disparities in mortality from lung cancer among men showed only marginal net changes from 1971 and 1996, whereas the disparities among women widened. For men, disparities in mortality from HIV widened considerably from 1986 to 1991 and narrowed marginally thereafter. For women, disparities in mortality from chronic obstructive pulmonary disease widened from 1971 to 1996. Income-related disparities in mortality from cerebrovascular disease did not change appreciably from 1971 to 1996.

For clarity, the 14 panels of figs 3–5 show only the richest, poorest and middle income quintiles. Nevertheless, this shows that the socioeconomic gradient in mortality varied by cause. However, had these data been presented for each of the five quintiles separately (data available on request from the corresponding author), one could observe that the gap between the poorest and second-poorest quintile was generally greater than the gap between any other adjacent quintiles. In other

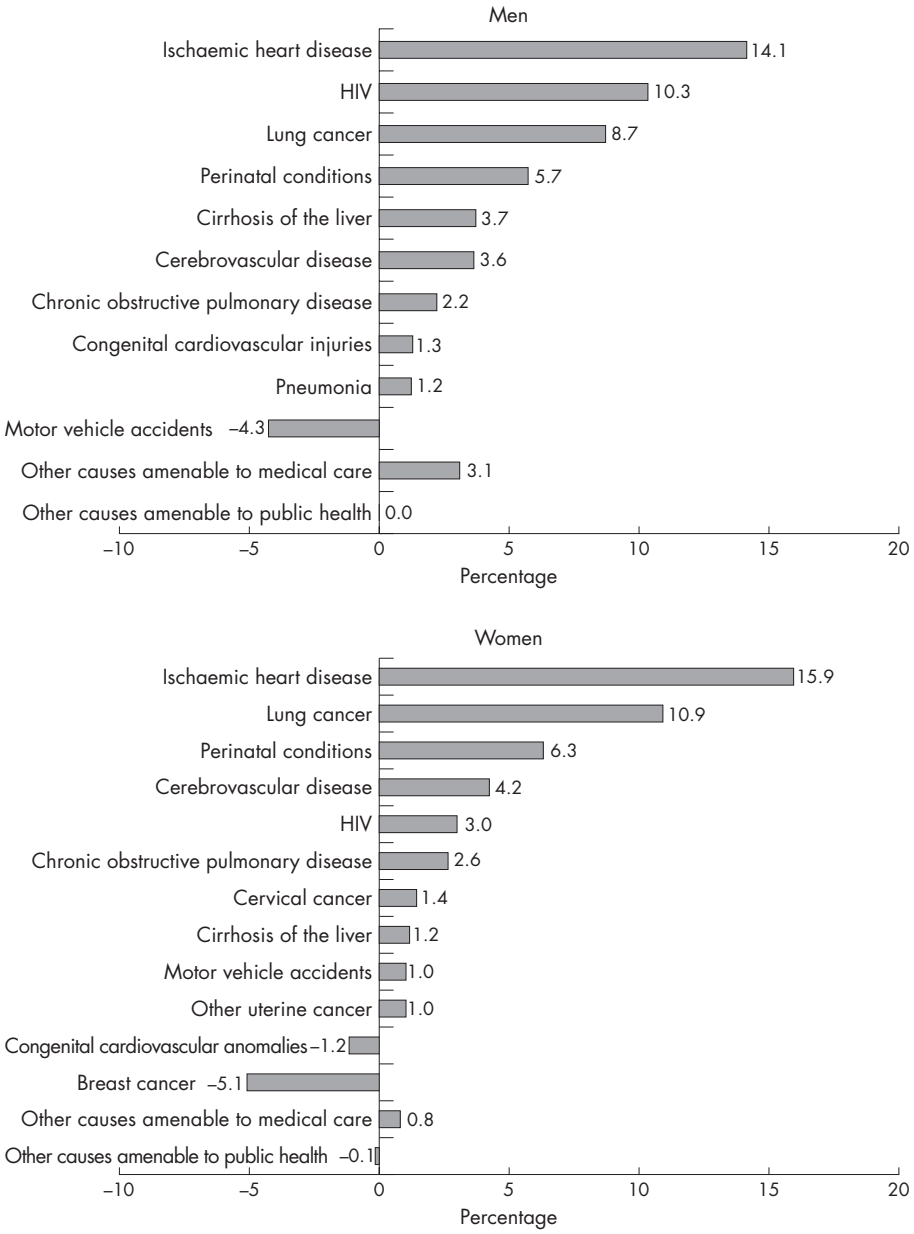

Figure 2 Proportion of all-cause income-related excess mortality (QT–Q1 SEYLL rate difference) attributable to avoidable causes of death in urban Canada in 1996.

words, the gradient was more often curvilinear rather than linear. Note that our summary measure of disparity—the difference between the richest quintile and the total for all quintiles together—quantifies the reduction in mortality that would occur if the entire population (not just the poorest quintile) experienced the mortality of the richest quintile. This is a means of summarising the inter-quintile differences that respects the non-linearity of the results.

DISCUSSION

Our study shows that there was a large reduction in socioeconomic mortality gradients in Canada between 1971 and 1996. However, the reduction in gradients varied considerably between diseases. As others have done,[22 24 36 37] we have attempted to infer what health system factors contribute to disease mortality reduction. We grouped diseases into the most responsible healthcare sectors (public health or medical care). This task is difficult because mortality from most diseases is influenced by a reduction in both disease onset (largely within the mandate of public health) and progression of disease to death (largely the mandate of medical care). With this caveat noted, we found a striking difference between the potential contribution of medical care and public health in reducing socioeconomic gradients.

It has been suggested that medical care has played a limited role in reducing health disparities and that future health policies should be oriented towards public health initiatives in order to improve health and reduce health inequalities at the population level.[3 38–41] Our results suggest that traditionally defined medical services such as physician and hospital care have contributed to reducing the income-related burden of illness from 1971 to 1996. For most causes of death considered amenable to medical interventions, income-related disparities in mortality were relatively small in 1996. The exception is IHD, which is largely amenable to both medical care and public health.

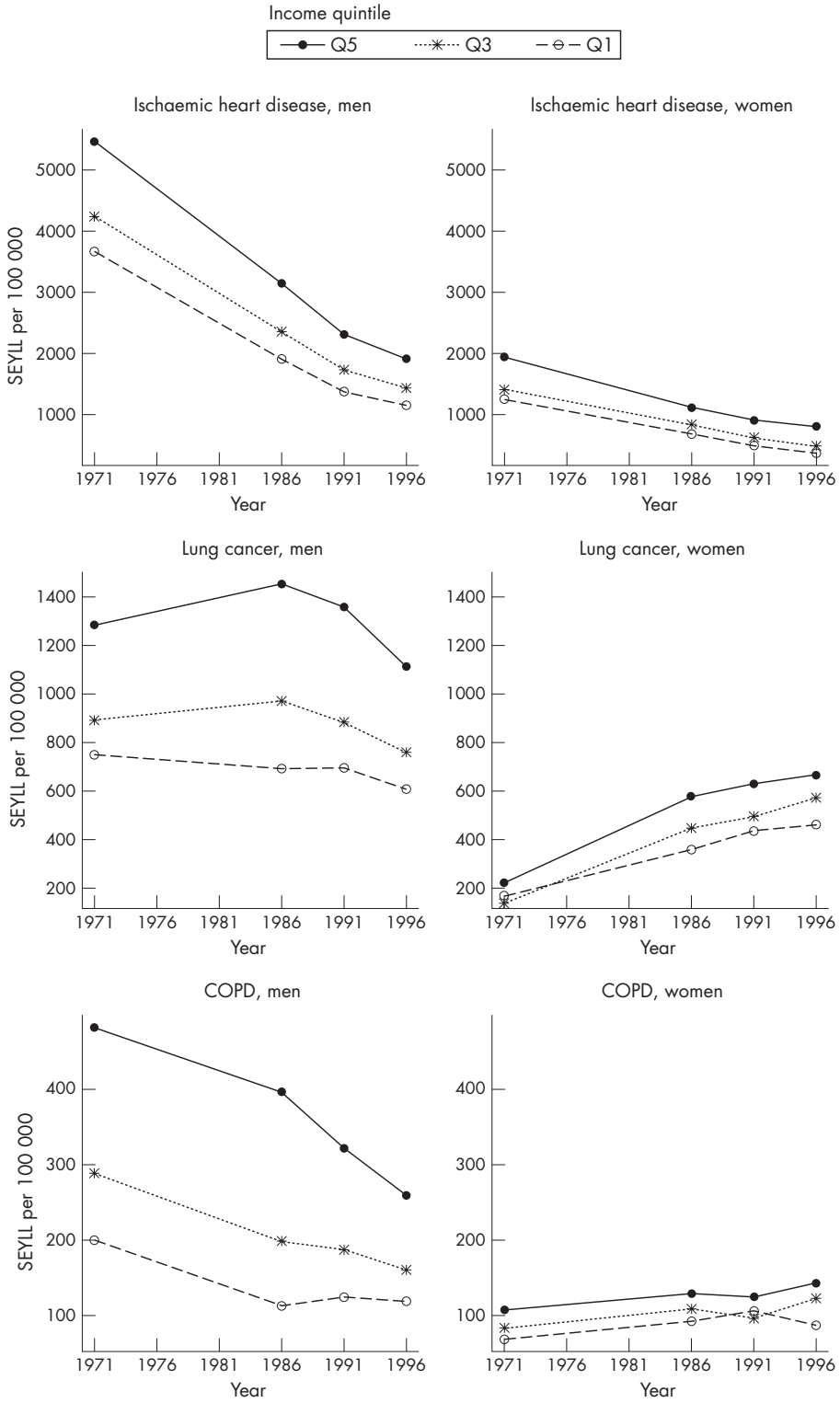

Figure 3 Avoidable mortality (SEYLL rate per 100 000 people) by neighbourhood income quintile, for ischaemic heart disease, lung cancer, chronic obstructive pulmonary disease (COPD) in men and women in urban Canada from 1971 to 1996.

Overall, there was little change in income-related disparities in mortality from causes amenable to public health interventions. Some specific mortality diagnoses, such as cirrhosis of the liver, contributed to a reduction in mortality differences between income groups, whereas for other diseases, most notably lung cancer in women, there were widening differences in income-related deaths. Canadian studies suggest that lung cancer mortality disparities are probably the result of differences in lung cancer incidence rather than survival.[42–45]

There seems to be considerable unrealised potential of public health for further reducing health disparities in Canada. Indeed, there exist remarkable socioeconomic differences in individual

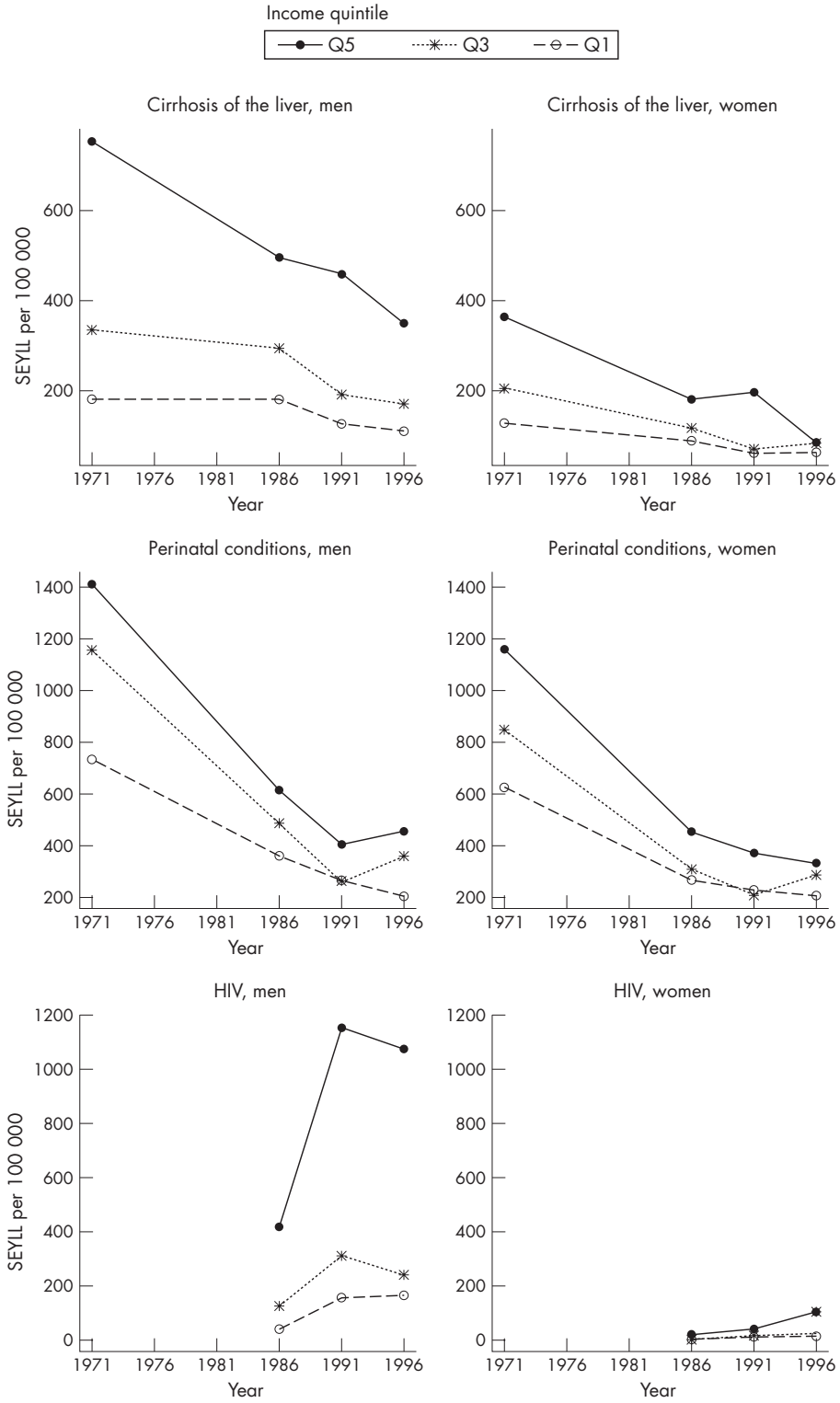

Figure 4 Avoidable mortality (SEYLL rate per 100 000 people) by neighbourhood income quintile, for cirrhosis of the liver, perinatal conditions and HIV in men and women in urban Canada from 1971 to 1996.

risk factors, such as smoking, sedentary living, poor diet, obesity, stress and physical inactivity. Knowledge about these risk factors has also been shown to differ between socioeconomic groups in Canada.[46–50] The most notable example is tobacco-related deaths. The causal relationship between tobacco and disease mortality is well described and these same diseases have a large contribution to socioeconomic disparities. There are large numbers of public health interventions to reduce smoking that are effective, but they are either unused or underused.[51–53]

Criticism regarding the effectiveness of the public health sector compared with the medical care system should take into context the distribution of resources. The proportion of total

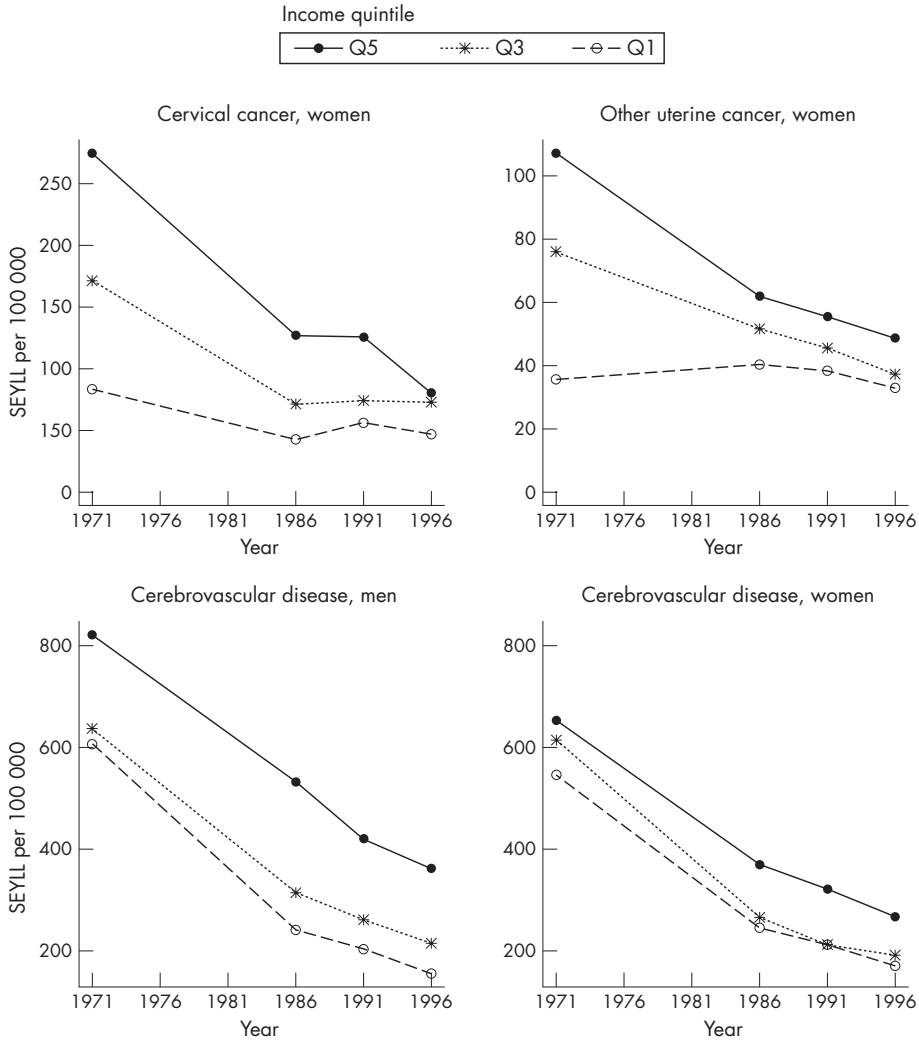

Figure 5 Avoidable mortality (SEYLL rate per 100 000 people) by neighbourhood income quintile, by cervical cancer and other uterine cancer in women, and for cerebrovascular disease in men and women in urban Canada from 1971 to 1996.

Canadian public sector health expenditures allocated to public health was 4.4% in 1975 and 6.5% in 1996.[54] There is a growing concern that public health has been chronically under-resourced, which has limited its potential to contribute to improving health and reducing health inequalities.[55] Concern regarding the ability of the public health sector to respond to severe acute respiratory syndrome in 2002 has resulted in public health reorganisation and reinvestment with the creation of a new national public health agency and a US$700 million increase in funding.

Various studies have highlighted the effects of physical and social environments on health. The results of these investigations suggest that health policies should focus not only on individuals, but also on the communities in which people live.[18 56–60] Innovative intersectoral social policies, as well as targeted public health interventions, will be required to ensure progress in diminishing socioeconomic disparities.

The most important limitation of this study is the difficulty assigning deaths to their avoidable cause. IHD is a case in point. It is probable that about half of the substantial reduction in deaths from IHD were related to improvements in health behaviours (attributable largely to public health), with the remaining half attributable to medical care.[61] Both medical care and public health have reduced income-related disparities in IHD, and much of the remaining income-related disparity could be reduced by either public health or medical care interventions. Canadians of lower socioeconomic status are known to have a higher prevalence of various cardiovascular disease risk factors.[49 62] Recent studies have reaffirmed the role of these risk factors for IHD.[63 64] For medical care, the Polypill may substantially reduce IHD[65] and if socioeconomic groups were to adhere equally to the recommendations, income-related IHD disparities could diminish as well. However, it should be noted that differentials in Polypill use and adherence might lead to an increased income-related IHD mortality disparity. Studies conducted by Alter *et al*[5 66] and Kapral *et al*[6] have shown that Ontarians from lower income neighbourhoods were less likely to receive specialised health services for acute myocardial infarction and stroke, respectively. However, in both studies, lower income was shown to be associated with mortality independent of medical service characteristics, suggesting that patients of lower socioeconomic status experience greater disease severity owing to factors stemming from outside the medical care setting as well.

There are similar challenges attributing deaths to their underlying avoidable cause for other conditions in this study. Although previous investigations have applied perinatal deaths as an indicator of medical care performance,[24] because most

such deaths occur early in the neonatal period, recent evidence suggests that the disparities in perinatal mortality are also likely to be amenable to public health interventions that deal with maternal behavioural and psychosocial risk factors.[67–70] Increases in HIV mortality and mortality disparities from 1986 to 1991 and subsequent reductions in mortality disparities afterwards are congruent with the development of antiretroviral therapy in the late 1980s as well as investments in AIDS research and treatment in Canada through the National AIDS Strategy in 1990. Nevertheless, because there is no cure for HIV or AIDS, preventive strategies remain the principle methods of avoiding HIV-related deaths.

This study has the advantage of examining the health system in Canada from a population health perspective using readily available mortality data. Rutstein *et al*[11] and other investigators point out that this is a starting point for drawing attention to areas for further investigation. It is difficult to examine the overall role of different parts of the healthcare sector over time using other sources of data and methods.

In a similar study using mortality data from New Zealand, Marshall *et al*[71] showed narrowing but persistent social class mortality differences from medically amenable causes of death. In England and Wales, Mackenbach *et al*[12] showed widening occupational class mortality gradients over time for some causes of death amenable to medical care. They concluded that medical care contributed to the widening mortality differences between socioeconomic groups. Although these dissimilar observations can be partly explained by differences in analytical methods and categorisation of amenable deaths, they also suggest that medically amenable mortality disparity trends may be variable across different contexts.

The outcome chosen for this study was an absolute reduction in mortality. Examining differences in mortality inequalities in using absolute (rate differences) and relative (rate ratios) measures would yield conflicting results. Indeed, in this study, the ratio of mortality comparing the poorest to richest quintile increased for men and decreased for women from 1971 to 1996 for causes of death amenable to medical care. An absolute reduction has greater public health meaning than a relative reduction because of its closer relation to overall health burden. The extent of absolute reductions in mortality between socioeconomic groups is a combination of both the baseline risk and the relative risk reduction. Because poorer quintiles had a higher baseline risk of death than richer quintiles early in the study, they had a greater opportunity to benefit (in absolute terms) from health interventions. Anderson *et al*[72] argue that medical care often has the same relative effectiveness between socioeconomic groups, and thus is well suited for reducing health inequalities if there is good access to medical services for lower socioeconomic groups. Our observations support their contention.

In conclusion, during the 25-year period of this study, reductions in rates of deaths amenable to medical care made the largest contribution to narrowing socioeconomic mortality disparities in urban Canada. Continued public support for physician and hospital services seems to be warranted in the interest of further reducing inequities in health. In addition, public health initiatives have a potentially important, but yet largely unrealised role in further reducing mortality disparities in Canada.

What this study adds

- A decrease in the rate of deaths amenable to medical care made the largest contribution to reducing socioeconomic differences in mortality over a 25-year period after the establishment of universal health insurance in Canada.
- There remain significant and modifiable disparities in mortality from ischaemic heart disease and other causes amenable to public health.

Policy implications

- Public support for physician and hospital services seems warranted in the interest of further reducing inequities in health.
- Public health initiatives also have a potentially important, but as yet unrealized, role in further reducing mortality disparities in Canada.

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PDJ had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Below is a summary of the authors' contributions to this manuscript:

Study concept and design: PDJ, RW, DGM. Acquisition of data: RW. Analysis and interpretation of data: PDJ, RW, ASD, PT, DGM. Drafting of the manuscript: PDJ, RW, ASD, PT, DGM. Critical revision of the manuscript for important intellectual content: PDJ, RW, ASD, PT, DGM. Statistical analysis: PDJ,RW, DGM. Obtained funding: PT, DGM. Administrative, technical or material support: RW, ASD, PT, DGM. Study supervision: RW, PT, DGM. Final approval: PDJ, RW, ASD, PT, DGM.

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