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Abstract

Background
An important step in monitoring progress toward reducing or eliminating inequalities in health is to determine the distribution of mortality rates across various groups defined by education, occupation, income, language, ethnicity, and Aboriginal, visible minority and disability status. This article describes the methods used to link census data from the long-form questionnaire to mortality data, and reports simple findings for the major groups.

Data and methods
Mortality from June 4, 1991 to December 31, 2001 was tracked among a 15% sample of the adult population of Canada, who completed the 1991 census long-form questionnaire (about 2.7 million, including 260,000 deaths). Age-specific and age-standardized mortality rates were calculated across the various groups, as were hazard ratios and period life tables.

Results
Compared with people of higher socio-economic status, mortality rates were elevated among those of lower socio-economic status, regardless of whether status was determined by education, occupation or income. The findings reveal a stair-stepped gradient, with bigger steps near the bottom of the socio-economic hierarchy.

Keywords
age-standardized mortality rates, longitudinal, non-institutional, proportional hazards, record linkage, socio-economic, survival analysis

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A goal of Canadian health policy is to reduce or eliminate socio-economic inequalities in health.[1] An important step in achieving this goal is to determine the distribution of health status across groups defined by income, education, occupation, language and ethnicity, Aboriginal or visible minority status, and disability status. Each of these characteristics must be directly addressed in terms of the most fundamental aspects of health: life or death, and relative risks of premature death from various causes.

Several countries have undertaken large, nationally representative population-based cohort studies of mortality by socio-economic status (usually by linking to national censuses and population registries): the United States,[2-5] the United Kingdom or England and Wales,[6-9] Scotland,[10] France,[11-16] Finland,[17-19] Denmark,[20-22] Sweden,[23-25] Norway,[26-29] Italy,[30] Spain,[31] Switzerland,[32-34] Belgium,[35] Austria,[36] Lithuania,[37] Israel,[38] and New Zealand.[39] These studies have mainly investigated differences by education and occupation, and have consistently shown lower education levels and lower-status occupational categories (and the economically inactive) to have the highest mortality rates, and higher educational levels and higher status occupational categories (managerial and professional) to have the lowest mortality rates. Increasingly, researchers have analysed such disparities from a cause-specific and often international perspective[40] (breast cancer,[41,42] lung cancer,[43] alcohol-related diseases,[44,45] stroke,[46] ischaemic heart disease,[47] all cardiovascular diseases,[48,49]) or by age group (the middle-aged[50] and elderly[51]).

In Canada, no nationally representative population-based cohort studies have examined mortality by socio-economic status in the total population. Instead, several record-

linkage-based mortality follow-up studies starting from selected samples of (or from administrative data files about) the general population have been conducted.[52-64] While these studies have contributed to our knowledge of socio-economic differentials in mortality in Canada, their generalizability is limited by the scope of the universe covered (for example, geographically or by age, sex and/or occupation), small sample sizes, lack of information about cause of death, or a combination of these constraints.

In response to these limitations in existing information, a database linking census data from the long-form questionnaire to mortality data was created to develop a set of baseline indicators of mortality to monitor health disparities in Canada. More specifically, the goal was to facilitate analyses of mortality and causes of death by indicators of social position, occupation and industry, ethnicity, birthplace and other socio-demographic variables, and multi-level analyses of those effects, including local area variations. This report describes the methods used to create the database and highlights some initial findings that illustrate the breadth and depth (and research potential) of the database. Because of the richness of the census long-form questionnaire, this study is able to provide baseline information on mortality across a wide range of individual, family, household and neighbourhood characteristics.

Methods

Mortality was tracked for more than a decade among a 15% sample of the adult population of Canada (some 2.7 million) who completed the 1991 census long-form questionnaire. During the follow-up period (June 4, 1991 to December 31, 2001), there were over 260,000 deaths in the sample.

The study was approved by the Statistics Canada Policy Committee[65] after consultations with the Statistics Canada Confidentiality and Legislation Committee, the Data Access and Control Services Division, and the Federal Privacy Commissioner. It was approved by the Research Ethics Committee of the University of Toronto, and was peer-reviewed by the Canadian Population Health Initiative, the Canadian Institutes of Health Research, and the Research Advisory Council of the Ontario Workplace Safety and Injury Board. It was also internally reviewed by the Institut national de santé publique du Québec, the Institute for Work and Health, and the Health Statistics Division of Statistics Canada.

Linking to the "bridge" file

The electronic files of census data contained no names, but names were needed to find the corresponding deaths. Therefore, the first link was to a nominal list (name) file to bridge between the census and the deaths files.

Names were encrypted before linking and were not retained on the analysis file. The name file was abstracted from tax-filer data from 1990 and 1991 (from filings typically submitted in April 1991 and April 1992—either about two months before or 10 months after the 1991 census day, June 4). The name file also contained date of birth and postal code, plus spousal (including common-law partner) date of birth. Spousal records were first matched (using encrypted social insurance numbers), and the additional information about the other spouse was copied to the record of each spouse. The nominal list file records for the same person for the two years were then compared. Changes detected in postal code, dates, marital status or names (such as from maiden to married name) resulted in the generation of additional, alternative records for such cases, so that subsequent matches could be made to the best-fitting record.

Probabilistic record linkage from the census file to the name file was then carried out. It was based mainly on dates of birth and postal codes (of both spouses, if applicable). Since most people on the name file would *not* have completed a long-form census questionnaire (administered to only a 20% sample of households), and since we wanted to minimize false positive links, deterministic matching was first done from the entire census universe to the name file. (However, because postal codes had not been captured from the short form census records, postal codes were first imputed for the short-form records from the postal code(s) of the nearest neighbours [higher or lower household numbers in the same enumeration area] with a captured postal code. If the postal codes of the two donor households differed, both were retained on alternate records.) People on the name file who were better matched to a census short form record were not "in scope," and were removed from consideration as potential members of the cohort. This process minimized the possibility of false positive links to persons on the name file who were not eligible to be part of the cohort followed for mortality.

Using probabilistic record linkage techniques,[66] the in-scope census records (N=3,576,487 from long-form questionnaires for people aged 25 or older) were then matched to the remaining records on the name file. Overall, 80% (N=2,860,244; the "response" rate) of the in-scope census records were matched to the name file. Details of the matching success, which varied by socio-economic characteristics, are presented in the Results section. The accuracy of the linkage from the census in-scope records to the name file was also evaluated. Based on a manual search of a stratified random sample of the manuscript census questionnaires, 99% of the matches were determined to be good matches—that is, to the correct person.

Cohort membership

Individuals were eligible to be part of the study cohort if they were usual residents of Canada on the day of the census, were in the long-form census records, and had attained age 25 by census day. These were the 3.6 million "in-scope" persons shown in Table 1.

But among eligible persons, only those matched to a name record could be reliably followed for mortality. Matching to a name record was attempted only for people with at least a reported year of birth (unimputed) and a postal code (reported or imputed, since imputed postal codes were mostly of high quality). Of the in-scope census records, 716,243 (or 20%) could not be linked to the name file.

To be considered an institutional resident (inmate), and thus not eligible for cohort membership, a person living in an institution on census day must have had no other residence in Canada, or have been living at the institution for at least six months. Thus, people experiencing short-term episodes of hospitalisation or incarceration were not considered institutional residents and were eligible to be part of the study cohort if their household received a long-form census questionnaire.

Only people who were counted by the census could be part of the cohort. Data quality reports found that the 1991 census missed 3.43% of the Canadian population of all ages, an estimated 965,000. The missed individuals were more likely to be young, mobile, low income, of Aboriginal ancestry,[67] or homeless.

As reported above, 2,860,244 persons were both eligible to be in the cohort, and were successfully linked to the name file. However, to reduce the size of the final cohort to equal 15% of the Canadian population aged 25 or older (18.2 million), about 4.4% (125,092 person records) of the sample who could have been followed were randomly removed, leaving 2,735,152 people in the cohort. Thus, the final ratio of the cohort to the "in-scope" population of interest was 76% (approximately 3 out of 4 census long-form respondents).

Linking to the death file

Only census records that could be "bridged" to the name file (which had been abstracted from non-financial tax-filer data) could be reliably followed

Table 1

Derivation of cohort from in-scope census records, and cohort as percentage of 1991 population aged 25 or older, Canada

	Number
Derivation of cohort	
In-scope census records (residents of Canada aged 25 or older with long-form questionnaire)	3,576,487
Not linked to name file	716,243
Linked to name file	2,860,244
Linked to name file, but not followed for deaths*	125,092
Linked to name file and followed for deaths (the cohort)	2,735,152
Percentage of population	
1991 mid-year population estimate for all Canada, population aged 25 or older†	18,225,349
Cohort as percentage of population aged 25 or older (%)	15.0

* simple random sample of 4.4% of those linked to name file
† CANSIM table 051-0001/3604
Source: Census mortality follow-up study, 1991 to 2001.

for mortality using the Canadian Mortality Database. Except for encryption and the large size of the cohort, the methods of probabilistic record linkage[66] for the mortality follow-up were nearly the same as those routinely employed for mortality follow-up studies at Statistics Canada.[68]

Content of the analysis file

For cohort members, the linked file contained data from the long-form census questionnaires, and where applicable, data from the post-censal Health and Activity Limitation Survey,[69] and death data from Canadian vital statistics. Nearly all of the 1991 census long-form content was available, including education, occupation, income, visible minority and Aboriginal status (mainly based on ethnicity of ancestors), place of birth, language (mother tongue, home languages, knowledge of official languages), place of residence, mobility, marital status, living arrangements, housing, place of work, and activity limitations. Death data included underlying cause of death (previously coded) and date of death. Records from responses to the 1991 Health and Activity Limitation Survey (HALS) had previously been linked to census long-form records, and this study had approval to use those data. As a result, for cohort members who were also part of that survey (N=17,132), information from the HALS was available for analysis, but is not reported

here. Information from the 1991 post-censal Aboriginal Peoples Survey (APS) was not included in this study.

Mortality analyses

For each member of the cohort, person-days of follow-up were calculated from the beginning of the study (June 4, 1991) to the date of death, emigration (ascertained from the name file and known for 1991 only), or end of the study (December 31, 2001). Person-days of follow-up were then divided by 365.25 to get person-years at risk.

For each single year of age (at the time of the census) and sex, the proportion of the initial cohort surviving (not known to have died or emigrated) was calculated to the end of the study period (10.6 years), and compared with the proportion of the total population expected to survive 10.6 years, by single-year-of-age and sex, according to the 1995 to 1997 life tables for Canada.[70] The number of deaths in the cohort was also compared with the number expected, based on mortality rates for the non-institutional population of urban Canada.[71]

Age- and sex-specific mortality rates by 5-year age groups (at baseline) were used to calculate age-standardized mortality rates (ASMRs) for subgroups of the population, using the cohort population structure (person-years at risk), both sexes together, as the standard population. Corresponding 95% confidence intervals (CIs) for the

ASMRs were calculated as described by Carrière and Roos.[72] A similar method was used to calculate the ASMR rate differences (RD) and rate ratios (RR) and their 95% CIs.

For age-specific analyses, cohort members were categorized by 10-year age groups from 25-to-34 to 75-to-84, and 85 or older. The mortality rates within each age group were age-standardized using 5-year age groups. For example, the mortality rate in the 25-to-34 age group was age-standardized using the cohort age distribution for 25-to-29- and 30-to-34-year-olds. Most analyses used age at baseline (June 4, 1991), while supplemental analyses used age at the beginning of each year of follow-up (for period life tables and related statistics).

For Aboriginal results, standardization for the ASMRs used the age distribution (person-years at risk) of Aboriginal cohort members rather than that of all cohort members. This was done because the Aboriginal population was much younger than other Canadians, and age-standardizing to the entire cohort population would give undue influence to the older ages. As well, because there was a notable cross-over of mortality rates in the upper age groups (with lower age-specific rates for older Aboriginal persons of both sexes, and much higher rates among younger Aboriginal persons), using the Aboriginal population as the standard provided a clearer picture of the impacts of those differentials on overall Aboriginal mortality.

Mortality hazard ratios adjusted for age and corresponding 95% CIs were calculated for each of the various categories of socio-economic characteristics (coded as indicator or "dummy" variables), using Cox proportional hazard regression. Age in completed years on census day was included as a variable in all models (so that age had an exponential effect on the hazard). Separate models were run for men and women. All such computations were performed using the PHREG procedure in the Statistical Analysis System (SAS) Version 9.1 for Windows (SAS Institute, Cary North Carolina).

Period life tables for each sex and major socio-economic grouping, plus corresponding standard errors and 95% CIs were calculated according to the method of Chiang.[73] These calculations were done after age was transformed from age at baseline to age at the beginning of each year of follow-up, and deaths and person-years at risk were calculated separately for each year (or partial year) of follow-up. Deaths and person-years at risk were then pooled by age at the beginning of each year of follow-up, before the calculation of the life tables. Life tables for both sexes together were constructed by combining the columns for survivors and life years lived from the life tables for each sex, rather than by using mortality rates based on pooled death and population data. This ensured that the actual distribution of the population by age and sex would have no effect on the life table results.

The underlying cause of death of those who died during the study period had been previously coded to the World Health Organization's *International Classification of Diseases, Ninth Revision* (ICD-9)[74] for deaths occurring in the period 1991 through 1999, and to the *Tenth Revision* (ICD-10)[75] for deaths occurring in 2000 or 2001. For analyses by cause of death, deaths were first grouped broadly by ICD chapter (based on ICD-9 or ICD-10 equivalent), and then more specifically according to cause groupings established by the Public Health Agency of Canada (formerly the Laboratory Centre for Disease Control (LCDC) cause of death categories). For 418 deaths that were identified through the name file but not linked in the vital statistics death records, the cause was unknown. Three other deaths were linked on the vital statistics death records, but without any stated cause. Those 421 deaths were retained in the database, but with cause of death set to "missing." Information on contributing causes of death was not recorded on the Canadian Mortality Data Base. Analyses by cause of death are not reported here, but will be in subsequent reports.

Definitions

Socio-economic characteristics

Highest level of education was grouped into four categories: less than secondary graduation, secondary graduation (or trades certificate), postsecondary certificate or diploma (short of a university bachelor's degree), and university degree (bachelor's or higher).

The socio-economic status of occupations (coded to the 4-digit National Occupational Classification) was ranked according to Boyd-NP scores,[76] which are based on the aggregate census data for the income and education of all persons with a given occupation. Boyd-NP scores are akin to the more familiar Blishen Index,[77] but are based on 1991 (and subsequent censuses) rather than on 1981 census data. For the entire non-institutional census target population aged 25 or older (the in-scope population), quintiles of population ranked by Boyd-NP score were constructed, first nationally, and also within each area. Areas were defined as census metropolitan area (CMA), census agglomeration (CA), or provincial or territorial residual area not in any CMA or CA (rural and small-town Canada). Because the differences in mortality between quintiles were more pronounced using the area-based quintiles, only those results are shown.

The socio-economic status of each occupation was also ranked according to five broad skill levels derived from the coding structure of the National Occupational Classification as originally defined by Employment and Immigration Canada (according to the original alpha-numeric coding before renumbering by Statistics Canada): professional, managerial, skilled/technical/supervisory, semi-skilled, and unskilled. People without an occupation

were retained as a separate "no occupation" category.

Quintiles and deciles of population ranked by income adequacy were constructed. First, for each economic family or unattached individual, total pre-tax, post-transfer income from all sources was pooled across all family members, and the ratio of total income to the Statistics Canada low-income cut-off (LICO) for the applicable family size and community size group was calculated.[78] Thus, all members of a given family were assigned the same LICO ratio, which was calculated for all non-institutionalized persons (the in-scope population), including people living on Indian reserves. The non-institutional population was then ranked according to the LICO ratio, and quintiles and deciles of population were constructed, first nationally and also within each CMA/CA or rural and small-town area. The purpose of constructing the quantiles within each area was to take account of regional differences in housing costs, which are not reflected in the LICOs, and to permit comparisons across areas to be based on comparable proportions of population in each quantile. Since the differences in mortality between quantiles were more pronounced using the area-based quantiles, only those results are shown.

Because visible minority status based on self-identification was not available for the 1991 census, visible minority status was inferred from answers to ethnic origin questions about ancestry. For purposes of federal legislation (Employment Equity Act of 1986), Aboriginal peoples are not considered visible minorities unless they report ancestry placing them into one of the 11 official visible minority categories: Black; Chinese, Japanese, Korean (grouped as East Asian); Southeast Asian, Filipino, Other Pacific Islanders (grouped as Southeast Asian and Pacific); South Asian; Southwest Asian or Arab; Latin American; and multiple visible minorities.

The three main groups of Aboriginal peoples in Canada are North American Indians (First Nations), Métis (mixed Aboriginal and non-Aboriginal descendants of mostly French-speaking fur traders and settlers in Western Canada), and Inuit. The 1991 census did not ask respondents to self-identity as an Aboriginal person, if applicable. Instead, Aboriginal categories were derived from responses to questions on ethnic origin (ancestry), Registered or Treaty Indian status, and Band or First Nations membership.

For this report, disability status at baseline was derived from the four census long-form disability screening questions (activities limited at home; activities limited at school or work; limited in other activities; disabled or handicapped). Persons with a "yes" to any of those questions were considered disabled.

Mortality rates are presented by community size and metropolitan influence zone.[79] Metropolitan influence zones classify geographic areas based on the extent of commuting flows between rural and small-town areas (not in any CMA or CA, so population less than 10,000) and urban centres (CMA or CA, so population at least 10,000).

Results

Characteristics of the cohort

Overall, 2,735,152 adults aged 25 or older were successfully "bridged" to the name file and followed for mortality. The probability of a successful bridge linkage to the name file varied by an individual's characteristics. Table 2 shows the number of persons in the cohort by characteristics related to linkage success, the cohort as a percentage of the total "in-scope" population, and the number of in-scope persons not linked to the name file. The second-last column shows, for each category, the ratio of the percentage of the in-scope population which was not matched to the bridge file, compared with the percentage in the cohort followed for mortality. Categories with a ratio greater than 1 were more likely

to be unmatched, and thus, unable to be followed. These included women (because they were less likely to be in the labour force), seniors aged 65 or older (more likely to be retired, and therefore, less likely to be tax-filers), people who were unmarried or not in a common-law union (fewer matching variables available), rural residents (postal codes less precise for matching purposes), movers in the previous year (more likely not to match on postal codes), people with less than secondary graduation (less likely to be employed), people not in the labour force (less likely to be tax-filers), people in the lowest income adequacy quintile (less likely to be tax -filers), and those with any Aboriginal ancestry.

Figure 1 shows, for each single year of age, the percentage of cohort members who survived from 1991 to the end of 2001 (approximately 10.6 years), compared with the expected percentage of survivors after 10.6 years based on the official Canada life tables for 1995 to 1997. For both sexes, until about age 75, the cohort and life table curves are very close and often nearly superimposed. At older ages, the cohort survival curve becomes noticeably higher than the life table survival curve, particularly for women. This is as expected, since the cohort excluded residents of institutions (most of whom were institutionalized because of failing health) and anyone who failed to file a 1990 or 1991 tax return (including people not in the labour force or chronically unemployed, and others with very low incomes)—all groups expected to have higher mortality. Based on comparisons with life table data for non-institutionalized persons in urban Canada,[71] ascertainment of deaths in the cohort followed for mortality was estimated to be approximately 97%.

Mortality differences

For both sexes and all age groups except the oldest (85 or older), the percentage of the cohort surviving from June 4, 1991 to the end of 2001 increased in each successively higher income

Table 2
Cohort followed and deaths ascertained, non-institutionalized population aged 25 or older at baseline, Canada, 1991 to 2001

Category	In-scope census respondents (A)	Persons in cohort (B)	(C)*	Cohort as % of total (B/A)	Persons not linked (D)	(E)*	Ratio (E/C)	Deaths
	number			%	number	%		number
Total	3,576,500	2,735,200	100	76	716,200	100	1.00	260,820
Sex								
Men	1,738,000	1,358,400	50	78	317,700	44	0.89	153,522
Women	1,838,500	1,376,800	50	75	398,500	56	1.11	107,268
Age group								
25 to 64	2,972,800	2,312,700	85	78	544,300	77	0.92	89,888
65 or older	603,700	422,500	15	70	161,900	23	1.46	170,932
Marital status								
Married or common-law	2,544,900	2,030,500	74	80	421,700	59	0.79	154,513
Not married	1,031,600	704,700	26	68	294,600	41	1.60	106,307
Residence								
Urban	2,682,600	2,085,400	76	78	501,600	70	0.92	194,652
Rural	893,900	649,700	24	73	214,600	30	1.26	66,168
Mobility								
Non-mover in last year	2,974,600	2,342,500	86	79	524,900	73	0.86	234,325
Mover in last year	499,900	350,400	13	70	133,400	19	1.45	16,831
Not applicable	102,000	42,200	2	41	57,900	8	5.24	9,664
Education								
Secondary graduation or more	2,225,300	1,781,700	65	80	362,200	51	0.78	105,222
Less than secondary graduation	1,351,200	953,500	35	71	354,100	49	1.42	155,598
Labour force participation								
In labour force	2,421,500	1,955,600	72	81	376,800	53	0.74	68,554
Not in labour force	1,155,000	779,500	28	67	339,500	47	1.66	192,226
Income adequacy quintile								
Quintile 1 - poorest	715,400	470,400	17	66	223,600	31	1.82	75,229
Quintile 2	715,500	531,100	19	74	159,900	22	1.15	66,402
Quintile 3	715,100	565,400	21	79	123,800	17	0.84	44,658
Quintile 4	715,300	580,800	21	81	108,100	15	0.71	37,938
Quintile 5 - richest	715,000	587,400	21	82	100,900	14	0.66	36,593
Aboriginal origins								
No Aboriginal origins	3,392,500	2,624,300	96	77	648,000	90	0.94	253,225
Any Aboriginal origins	184,000	110,800	4	60	68,200	10	2.35	7,595

* percent distribution of characteristic within each category
Note: Census population counts rounded to nearest 100.
Source: Census mortality follow-up study, 1991 to 2001.

adequacy quintile (data not shown). The differences across the quintiles increased with advancing age to a maximum at ages 65 to 74. However, among women aged 85 or older (and not living in an institution at baseline), the pattern was almost reversed, with the percentages surviving generally greater among those in the lower than the higher income quintiles.

Remaining life expectancy at age 25 and the life table proportion expected to survive to age 75 are shown in Table 3 and Figures 2 and 3. For both sexes, life expectancy increased in each successively higher income quintile.

The inter-quintile difference (Q5-Q1) in life expectancy was 6.8 years for men, and 4.3 years for women. The differences between the poorest and next-poorest quintiles (3.1 years for men, 2.3 years for women) were more than twice as large as the differences between the richest and next-richest quintiles (1.3 years for men, 0.6 years for women). For both sexes, the proportion expected to survive to age 75 also increased in each successively higher income quintile. Only 51% of men in the poorest quintile were expected to survive to age 75, compared with 72% of those in the richest quintile.

The corresponding figures for women were 72% versus 84%.

Main findings

Table 4 (men) and Table 5 (women) show age-standardized mortality rates (ASMRs), rate ratios (RRs) and rate differences (RD) for the entire cohort aged 25 or older at baseline, by selected characteristics.

In the usual sequence of events, getting an education qualifies a person for an occupation, and working at an occupation provides an income. Consequently, the main findings are presented in that order. Many other

Figure 1
Percentage surviving 10.6 years, by age and sex, cohort followed for mortality from 1991 to 2001 versus all-Canada life tables for 1995 to 1997
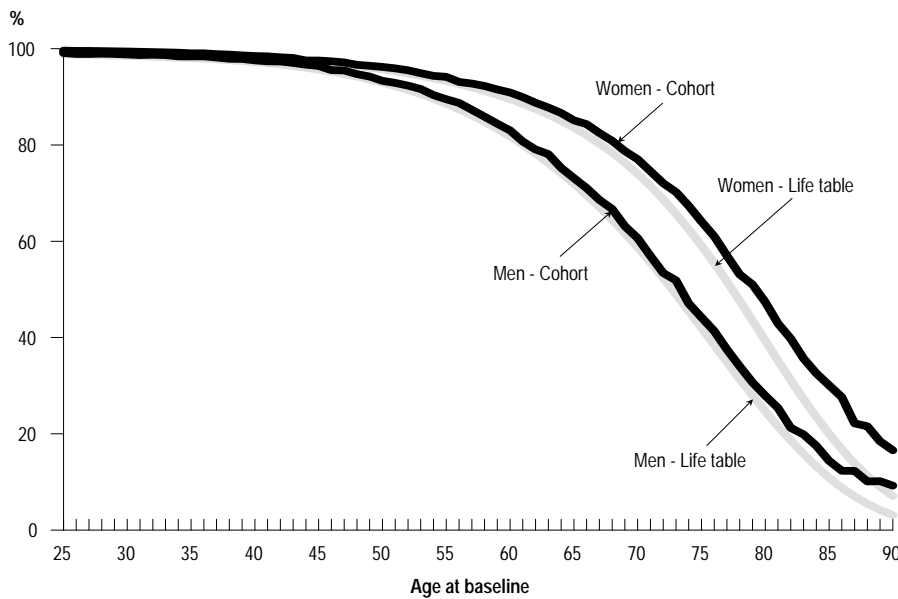
Source: Census mortality follow-up study, 1991 to 2001; Statistics Canada, Life Tables – Canada, Provinces and Territories, 1995-1997 (Catalogue 84-537), 2002.[70]

Table 3
Remaining life expectancy at age 25 and percentage expected to survive to age 75, by income adequacy quintile and sex, non-institutionalized population aged 25 or older, Canada, 1991 to 2001

	Total			Men			Women		
		95% confidence interval			95% confidence interval			95% confidence interval	
Income adequacy quintile	years	from	to	years	from	to	years	from	to
Remaining life expectancy at age 25									
Total	55.8	55.8	55.9	52.6	52.6	52.7	59.0	58.9	59.1
Quintile 1 - poorest	52.4	52.3	52.5	48.4	48.3	48.6	56.4	56.3	56.5
Quintile 2	55.1	55.0	55.2	51.5	51.4	51.6	58.7	58.6	58.9
Quintile 3	56.3	56.2	56.4	53.0	52.9	53.2	59.5	59.4	59.7
Quintile 4	57.1	57.0	57.2	54.0	53.9	54.1	60.1	60.0	60.3
Quintile 5 - richest	58.0	57.9	58.1	55.3	55.2	55.4	60.7	60.5	60.8
Difference: Quintile 5 - Quintile 1	5.6	5.4	5.7	6.8	6.6	7.0	4.3	4.1	4.5
Percentage expected to survive to age 75	**%**	**from**	**to**	**%**	**from**	**to**	**%**	**from**	**to**
Total	71.5	71.3	71.6	64.0	63.8	64.2	79.0	78.8	79.2
Quintile 1 - poorest	61.0	60.7	61.4	50.6	50.1	51.1	71.5	71.0	71.9
Quintile 2	68.6	68.3	69.0	59.8	59.4	60.3	77.5	77.1	77.9
Quintile 3	72.7	72.4	73.0	64.9	64.4	65.3	80.6	80.2	81.0
Quintile 4	75.1	74.8	75.4	68.2	67.7	68.6	82.0	81.5	82.4
Quintile 5 - richest	78.1	77.8	78.4	72.4	72.0	72.8	83.8	83.4	84.2
Difference: Quintile 5 - Quintile 1	17.0	16.6	17.5	21.7	21.1	22.4	12.3	11.8	12.9

Source: Census mortality follow-up study, 1991 to 2001.

socio-economic variables were available, relating either to ascribed characteristics (determined at birth or infancy, and essentially unchangeable) or achieved characteristics (attained over the life course, and changeable). Ascribed characteristics included visible minority and Aboriginal status, place of birth and mother tongue. Achieved characteristics included knowledge of official languages, place of residence, mobility, marital status and living arrangements. Activity limitations could have existed at birth or developed later.

Education
The first panel of Tables 4 and 5 shows results by educational attainment. ASMRs were lowest among people with a university degree and highest for those with less than secondary graduation. A linear relationship was evident, with mortality rates increasing at successively lower levels of education. The mortality gradient was steeper for men than women.

Appendix Table A shows RRs by education, by 10-year age group at baseline. The RRs are based on ASMRs calculated for each age group. For both sexes and for all except the oldest age group (85 or older), mortality rates were highest among those with the least education, and dropped with each increment of attainment. As well, RRs were highest in the youngest age groups and diminished with advancing age, as previously reported in a small pilot study for Manitoba.[80] For the oldest age group, the pattern by education was reversed, so that the point estimates of most RRs were below that of the reference group (university degree), especially for women, although none of these was statistically significantly different from 1. Mortality rates among people aged 85 or older at baseline could be calculated only for those who had survived to that age and were not institutionalized at the time of the census. (Appendix Table B shows hazard ratios corresponding to the RRs of Appendix Table A. The results are similar, but the proportional hazard modelling used

Figure 2
Life expectancy at age 25, by sex and income adequacy quintile, non-institutionalized population aged 25 or older at baseline, Canada, 1991 to 2001
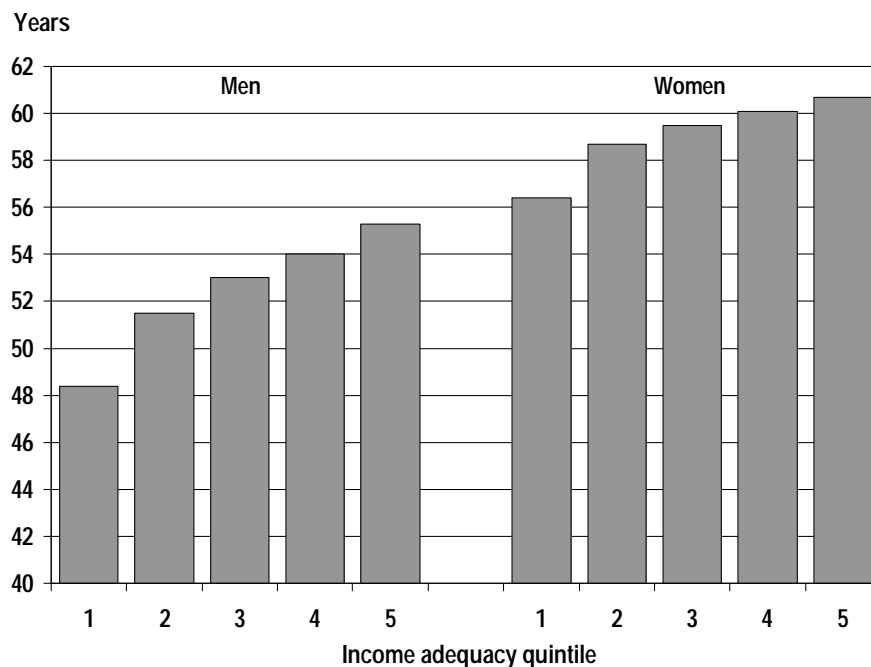
Source: Census mortality follow-up study, 1991 to 2001.

Figure 3
Percentage expected to survive to age 75, by sex and income adequacy quintile, non-institutionalized population aged 25 or older at baseline, Canada, 1991 to 2001
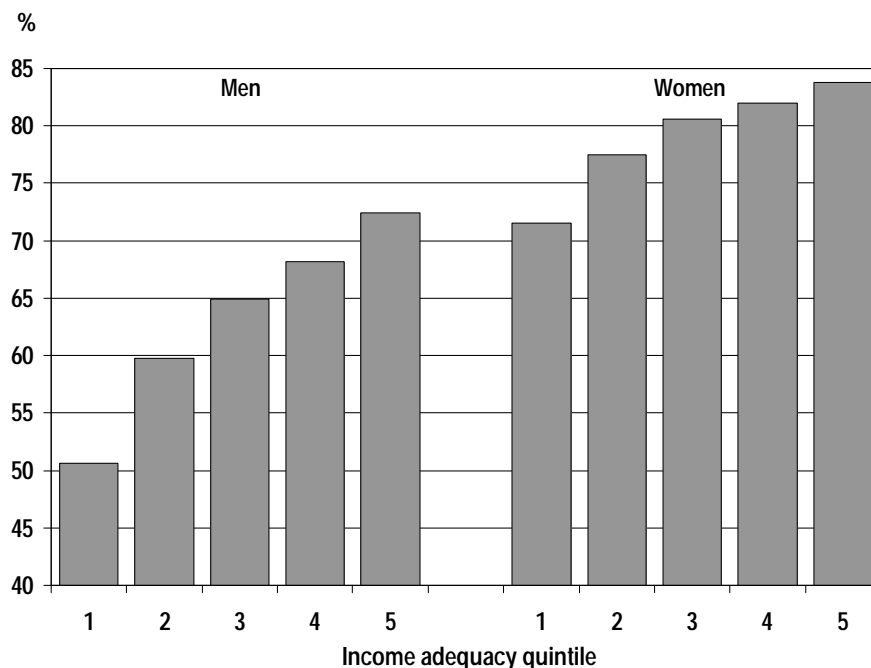
Source: Census mortality follow-up study, 1991 to 2001.

in Appendix Table B does not produce absolute rates or rate differences.)

Occupation-based socio-economic groupings

ASMRs by sex for each quintile of the population with an occupation (ranked according to its Boyd-NP socio-economic score),[76] are shown in the second panel of Tables 4 and 5. ASMRs were lowest in the highest quintile (occupations with the highest socio-economic ranking). The gradients were not as steep as those for education and did not necessarily increase across each successive quintile. For example, the ASMRs were similar for quintiles 1, 2 and 3 among employed men, and for quintiles 1 and 2 among employed women. People without an occupation had much higher ASMRs, compared with even the lowest ranked quintile with any occupation.

A clearer pattern was evident for occupational categories ranked by skill level, as shown in the third panel of Tables 4 and 5. ASMRs for people with an occupation were lowest among professionals and highest among those in unskilled occupations. For men, ASMRs rose with each decrease in skill level (though the difference between adjacent categories was not always significant). For women, RRs were similar for all skill levels except unskilled occupations (RR of 1.34 compared with professionals).

In general, for people aged 25 to 75 at baseline, compared with professional occupations, RRs were higher for all other categories of occupations (second panel of Appendix Table A). The gradient was stronger in younger than older age groups. For the unskilled occupations, the RR was highest in the 35-to-44 age group for both sexes (but with a stronger effect for men). Particularly noteworthy were the RRs for men in age groups younger than 55 and without an occupation, reaching a high of 6.2 among those aged 35 to 44 at baseline. RRs among women without an occupation were elevated, but not nearly as much.

Table 4
Age-standardized mortality rates (ASMR) per 100,000 person-years at risk, showing rate ratios (RR) and rate differences (RD), by selected socio-economic characteristics, non-institutionalized men aged 25 or older at baseline, Canada, 1991 to 2001

Characteristic	Baseline population	Deaths	ASMR	95 % confidence interval from	to	RR	95 % confidence interval from	to	RD	95 % confidence interval from	to
Education											
University degree[†]	204,700	11,100	900.9	882.9	919.2	1.00	...	...	0.0	...	...
Postsecondary diploma	168,300	9,279	1,017.4	994.4	1,040.9	1.13	1.10	1.16	116.5	87.0	146.0
Secondary graduation	510,500	42,378	1,168.1	1,156.1	1,180.0	1.30	1.27	1.33	267.2	245.6	288.9
Less than secondary graduation	474,900	90,795	1,392.0	1,382.7	1,401.4	1.55	1.51	1.58	491.1	470.7	511.5
Occupation: Boyd-NP socio-economic quintile											
Quintile 5 - highest[†]	255,200	9,879	877.6	847.7	908.6	1.00	...	...	0.0	...	...
Quintile 4	242,400	10,814	940.2	910.5	970.8	1.07	1.02	1.12	62.5	19.7	105.3
Quintile 3	184,000	9,029	1,037.6	1,002.1	1,074.4	1.18	1.13	1.24	160.0	112.7	207.2
Quintile 2	215,300	11,617	1,083.6	1,047.1	1,121.4	1.23	1.18	1.30	206.0	158.0	254.0
Quintile 1 - lowest	218,400	15,658	1,068.0	1,046.0	1,090.3	1.22	1.17	1.27	190.3	152.7	228.0
No occupation	243,000	96,555	1,836.2	1,813.4	1,859.2	2.09	2.02	2.17	958.5	920.4	996.6
Occupation: skill-based categories											
Professional[†]	146,000	5,479	834.9	802.0	869.1	1.00	...	...	0.0	...	...
Managerial	159,000	7,094	930.4	893.6	968.6	1.11	1.05	1.18	95.5	45.2	145.8
Skilled/Technical/Supervisory	391,600	20,386	979.4	959.7	999.5	1.17	1.12	1.23	144.5	105.5	183.5
Semi-skilled	303,400	16,028	1,086.6	1,057.1	1,117.0	1.30	1.24	1.37	251.7	206.8	296.7
Unskilled	115,500	8,010	1,141.1	1,099.8	1,183.9	1.37	1.29	1.44	306.2	252.5	359.9
No occupation	243,000	96,555	1,836.2	1,813.4	1,859.2	2.20	2.11	2.29	1,001.3	960.7	1,041.9
Income adequacy quintile											
Quintile 5 - richest[†]	309,900	23,638	980.8	966.9	994.9	1.00	...	...	0.0	...	...
Quintile 4	302,600	24,326	1,099.5	1,084.5	1,114.7	1.12	1.10	1.14	118.7	98.0	139.3
Quintile 3	287,800	28,476	1,183.5	1,169.4	1,197.8	1.21	1.18	1.23	202.7	182.7	222.6
Quintile 2	260,800	41,273	1,334.3	1,321.0	1,347.7	1.36	1.34	1.38	353.5	334.1	372.8
Quintile 1 - poorest	197,300	35,839	1,650.2	1,633.0	1,667.7	1.68	1.65	1.71	669.4	647.1	691.7
Visible minority status											
Not visible minority[†]	1,257,200	148,660	1,251.9	1,245.5	1,258.4	1.00	...	...	0.0	...	...
Black	16,900	873	975.7	902.7	1,054.5	0.78	0.72	0.84	-276.3	-352.4	-200.2
Southwest Asian or Arab	12,700	659	895.9	825.2	972.6	0.72	0.66	0.78	-356.1	-430.0	-282.2
South Asian	21,800	872	720.8	665.1	781.2	0.58	0.53	0.62	-531.1	-589.5	-472.8
East Asian	33,000	1,897	791.9	755.1	830.4	0.63	0.60	0.66	-460.1	-498.3	-421.9
Southeast Asian or Pacific Islander	11,000	435	686.2	619.8	759.7	0.55	0.49	0.61	-565.8	-635.9	-495.6
Latin American	4,400	91	481.8	367.8	631.1	0.38	0.29	0.50	-770.1	-900.3	-639.9
Multiple visible minorities	1,500	65	785.0	565.7	1,089.2	0.63	0.45	0.87	-467.0	-724.1	-209.8
Aboriginal origins											
No Aboriginal origins[†]	1,307,800	149,335	566.7	563.5	570.0	1.00	...	...	0.0	...	...
Any Aboriginal origins	50,600	4,217	797.7	774.0	822.2	1.41	1.37	1.45	231.0	206.7	255.3
Registered Indian status											
Not Registered Indian[†]	1,333,800	151,175	569.6	566.3	572.8	1.00	...	...	0.0	...	...
Registered Indian	24,600	2,377	886.5	851.5	923.1	1.56	1.49	1.62	317.0	281.0	352.9
Place of birth											
Same province as residence[†]	860,300	95,514	1,322.1	1,313.5	1,330.7	1.00	...	...	0.0	...	...
Different province	207,400	24,316	1,238.8	1,222.9	1,254.9	0.94	0.92	0.95	-83.3	-101.5	-65.1
Foreign	290,700	33,722	1,008.7	997.9	1,019.7	0.76	0.75	0.77	-313.4	-327.2	-299.5
Year of immigration											
Non-immigrant[†]	1,070,700	120,185	1,304.6	1,297.0	1,312.1	1.00	...	...	0.0	...	...
Before 1971	160,900	27,762	1,054.4	1,041.1	1,068.0	0.81	0.80	0.82	-250.1	-265.6	-234.7
1971 to 1980	63,200	3,429	914.1	881.3	948.0	0.70	0.68	0.73	-390.5	-424.7	-356.3
1981 to 1985	21,500	1,046	785.8	736.8	837.9	0.60	0.56	0.64	-518.8	-569.9	-467.7
1986 to 1991	34,600	873	651.5	597.7	710.2	0.50	0.46	0.54	-653.0	-709.7	-596.3
Non-permanent resident	7,400	257	982.7	855.5	1,128.8	0.75	0.66	0.87	-321.9	-458.3	-185.5

Table 4
Age-standardized mortality rates (ASMR) per 100,000 person-years at risk, showing rate ratios (RR) and rate differences (RD), by selected socio-economic characteristics, non-institutionalized men aged 25 or older at baseline, Canada, 1991 to 2001 (continued)

Characteristic	Baseline population	Deaths	ASMR	95 % confidence interval from	to	RR	95 % confidence interval from	to	RD	95 % confidence interval from	to
Residence 1 year before											
Same address†	1,163,500	139,671	1,215.1	1,208.7	1,221.6	1.00	....	...	0.0	...	...
Different address in same province	154,400	9,097	1,358.1	1,327.7	1,389.2	1.12	1.09	1.14	143.0	111.6	174.5
Different province	12,900	561	1,111.0	1,009.2	1,223.2	0.91	0.83	1.01	-104.1	-211.1	3.0
Foreign	7,400	184	620.4	516.0	745.9	0.51	0.42	0.61	-594.7	-709.2	-480.2
Not applicable	20,100	4,039	1,786.8	1,731.1	1,844.4	1.47	1.42	1.52	571.7	514.7	628.7
Marital status											
Legally married†	982,900	110,696	1,135.6	1,128.7	1,142.6	1.00	....	...	0.0	...	...
Common-law	93,900	4,629	1,352.7	1,298.4	1,409.3	1.19	1.14	1.24	217.1	161.2	272.9
Widowed	27,400	14,045	1,670.3	1,575.9	1,770.2	1.47	1.39	1.56	534.6	437.3	632.0
Separated	26,200	3,592	1,622.6	1,568.1	1,679.1	1.43	1.38	1.48	487.0	431.1	542.9
Divorced	45,800	6,452	1,612.2	1,566.6	1,659.0	1.42	1.38	1.46	476.5	429.8	523.2
Never married	182,200	14,138	1,620.0	1,591.9	1,648.7	1.43	1.40	1.45	484.4	455.2	513.7
Living arrangements											
With relatives†	1,179,500	123,110	1,169.8	1,163.1	1,176.5	1.00	...	...	0.0	...	...
With non-relatives	40,700	4,012	1,657.4	1,604.9	1,711.6	1.42	1.37	1.46	487.6	433.9	541.4
Alone	119,300	22,434	1,629.5	1,607.8	1,651.5	1.39	1.37	1.41	459.7	436.9	482.6
Not applicable	18,900	3,996	1,832.8	1,774.9	1,892.6	1.57	1.52	1.62	663.1	603.8	722.3
Mother tongue											
English†	776,100	87,637	1,258.1	1,249.7	1,266.5	1.00	...	...	0.0	...	...
French	335,400	38,269	1,350.4	1,336.5	1,364.5	1.07	1.06	1.09	92.3	76.0	108.7
English and French	4,200	653	1,421.0	1,314.1	1,536.7	1.13	1.04	1.22	163.0	51.5	274.4
Neither English nor French	242,600	26,993	1,020.8	1,008.5	1,033.3	0.81	0.80	0.82	-237.2	-252.2	-222.3
Knowledge of official languages											
English only†	921,600	106,013	1,211.7	1,204.4	1,219.1	1.00	...	...	0.0	...	...
French only	170,000	21,275	1,396.2	1,377.2	1,415.5	1.15	1.14	1.17	184.5	164.0	205.0
Both English and French	253,000	23,823	1,210.0	1,193.9	1,226.3	1.00	0.98	1.01	-1.7	-19.5	16.1
Neither English nor French	13,800	2,441	976.1	934.8	1,019.1	0.81	0.77	0.84	-235.7	-278.4	-192.9
Community size											
1 million or more†	411,300	42,962	1,171.9	1,160.7	1,183.3	1.00	...	...	0.0	...	...
500,000 to 999,999	216,700	21,783	1,208.0	1,191.7	1,224.6	1.03	1.01	1.05	36.1	16.2	56.1
100,000 to 499,999	205,200	24,093	1,240.2	1,224.5	1,256.2	1.06	1.04	1.08	68.3	48.9	87.8
10,000 to 99,999	190,000	23,218	1,301.5	1,284.7	1,318.6	1.11	1.09	1.13	129.6	109.3	150.0
Less than 10,000 (rural and small town)	335,200	41,496	1,263.5	1,251.4	1,275.9	1.08	1.06	1.09	91.6	75.0	108.3
Metropolitan influence zone											
CMA or CA†	1,027,900	112,441	1,218.1	1,210.9	1,225.3	1.00	...	...	0.0	...	...
Rural and small town											
Strong metropolitan influence	74,100	8,604	1,234.4	1,208.0	1,261.2	1.01	0.99	1.04	16.3	-11.3	43.8
Moderate metropolitan influence	118,500	15,950	1,269.6	1,249.9	1,289.6	1.04	1.02	1.06	51.5	30.3	72.6
Weak metropolitan influence	116,200	13,845	1,264.0	1,243.1	1,285.4	1.04	1.02	1.06	45.9	23.6	68.3
No metropolitan influence	21,700	2,712	1,352.9	1,302.8	1,405.0	1.11	1.07	1.15	134.9	83.3	186.4
Activity limitation											
No activity limitation†	1,204,900	102,474	1,029.8	1,023.3	1,036.3	1.00	...	...	0.0	...	...
Any activity limitation	146,700	49,760	2,219.7	2,197.6	2,241.9	2.16	2.13	2.18	1,189.9	1,166.8	1,213.0
Not applicable	6,800	1,318	1,699.9	1,608.7	1,796.3	1.65	1.56	1.74	670.1	576.2	764.1

† reference category
... not applicable
Note: Reference population (person-years at risk) was taken from the total cohort age distribution for all variables except Aboriginal variables, for which the Aboriginal age distribution was used.
Source: Census mortality follow-up study, 1991 to 2001.

Income adequacy

Men and women in the richest income adequacy quintile had the lowest ASMRs. RRs rose in each successively poorer quintile, but the change was greatest between quintiles 1 and 2.

As shown in the last panel of Appendix Table A, RRs varied by age group within each income adequacy quintile. For each sex and all age groups except the oldest (men) or the two oldest (women), RRs rose in each successively poorer income quintile. However, the greatest increase was between the poorest and next-poorest quintiles. RRs peaked among people aged 45 to 54 at baseline in the poorest income quintile, at nearly 2.5 for men and 2.3 for women.

Table 5

Age-standardized mortality rates (ASMR) per 100,000 person-years at risk, showing rate ratios (RR) and rate differences (RD), by selected socio-economic characteristics, non-institutionalized women aged 25 or older at baseline, Canada, 1991 to 2001

Characteristic	Baseline population	Deaths	ASMR	95 % confidence interval from	to	RR	95 % confidence interval from	to	RD	95 % confidence interval from	to
Education											
University degree[†]	161,100	4,656	549.2	532.7	566.2	1.00	....	...	0.0	...	...
Postsecondary diploma	253,100	11,292	602.6	591.4	614.1	1.10	1.06	1.14	53.4	33.2	73.6
Secondary graduation	484,000	26,517	666.5	658.5	674.6	1.21	1.17	1.25	117.3	98.7	135.9
Less than secondary graduation	478,600	64,803	781.3	774.8	787.8	1.42	1.38	1.47	232.0	214.1	250.0
Occupation: Boyd-NP socioeconomic quintile											
Quintile 5 - highest[†]	151,500	2,566	534.0	489.5	582.5	1.00	....	...	0.0	...	...
Quintile 4	186,900	3,691	586.7	554.5	620.8	1.10	0.99	1.22	52.8	-4.3	109.8
Quintile 3	221,200	5,254	583.8	560.3	608.3	1.09	0.99	1.20	49.9	-2.4	102.2
Quintile 2	169,200	4,545	606.3	578.2	635.7	1.14	1.03	1.25	72.3	17.7	126.9
Quintile 1 - lowest	218,700	6,894	620.4	598.7	642.8	1.16	1.06	1.28	86.4	35.0	137.8
No occupation	429,300	84,318	823.7	816.2	831.3	1.54	1.41	1.68	289.7	242.7	336.8
Occupation: skill-based categories											
Professional[†]	160,300	2,697	484.9	450.5	521.8	1.00	....	...	0.0	...	...
Managerial	65,800	1,486	590.2	535.9	650.0	1.22	1.08	1.37	105.3	38.1	172.5
Skilled/Technical/Supervisory	260,100	6,689	598.5	578.7	619.0	1.23	1.14	1.34	113.7	72.8	154.6
Semi-skilled	360,600	8,848	601.6	579.8	624.1	1.24	1.14	1.35	116.7	74.8	158.7
Unskilled	100,600	3,230	649.9	614.2	687.7	1.34	1.22	1.47	165.1	113.9	216.2
No occupation	429,300	84,318	823.7	816.2	831.3	1.70	1.58	1.83	338.9	302.4	375.3
Income adequacy quintile											
Quintile 5 - richest[†]	277,500	12,955	592.3	581.7	603.1	1.00	....	...	0.0	...	...
Quintile 4	278,200	13,612	633.1	622.3	644.0	1.07	1.04	1.10	40.8	25.5	56.0
Quintile 3	277,700	16,182	666.5	656.3	677.0	1.13	1.10	1.15	74.3	59.4	89.1
Quintile 2	270,300	25,129	722.0	712.7	731.4	1.22	1.19	1.25	129.7	115.5	143.8
Quintile 1 - poorest	273,000	39,390	884.3	874.3	894.4	1.49	1.46	1.53	292.0	277.4	306.6
Visible minority											
Not visible minority[†]	1,272,800	103,973	713.3	708.9	717.7	1.00	....	...	0.0	...	...
Black	20,000	729	555.2	514.0	599.7	0.78	0.72	0.84	-158.1	-201.1	-115.0
Southwest Asian or Arab	9,600	356	574.8	513.5	643.3	0.81	0.72	0.90	-138.5	-203.4	-73.6
South Asian	19,000	464	573.2	514.3	638.8	0.80	0.72	0.90	-140.1	-202.4	-77.8
East Asian	34,000	1,266	471.7	446.0	498.8	0.66	0.63	0.70	-241.6	-268.3	-214.9
Southeast Asian or Pacific Islander	14,900	359	440.7	392.7	494.5	0.62	0.55	0.69	-272.6	-323.6	-221.6
Latin American	4,800	78	458.7	353.7	594.9	0.64	0.50	0.83	-254.6	-373.9	-135.2
Multiple visible minorities	1,700	43	498.5	334.1	743.6	0.70	0.47	1.04	-214.8	-414.2	-15.4
Aboriginal origins											
No Aboriginal origins[†]	1,316,500	103,890	318.9	316.5	321.3	1.00	....	...	0.0	...	...
Any Aboriginal origins	60,200	3,378	559.8	541.2	579.0	1.76	1.70	1.82	240.9	221.8	259.9
Registered Indian status											
Not Registered Indian[†]	1,344,700	105,139	321.2	318.8	323.5	1.00	....	...	0.0	...	...
Registered Indian	32,100	2,129	623.7	597.7	650.8	1.94	1.86	2.03	302.5	275.9	329.2
Place of birth											
Same province as residence[†]	883,400	66,810	734.2	728.6	739.8	1.00	....	...	0.0	...	...
Different province	210,600	17,131	717.3	706.6	728.2	0.98	0.96	0.99	-16.9	-29.0	-4.7
Foreign	282,800	23,327	611.9	603.9	620.1	0.83	0.82	0.85	-122.3	-132.1	-112.4
Year of immigration											
Non-immigrant[†]	1,096,800	84,181	730.8	725.8	735.8	1.00	....	...	0.0	...	...
Before 1971	149,500	18,825	637.2	627.0	647.5	0.87	0.86	0.89	-93.6	-105.0	-82.3
1971 to 1980	65,300	2,495	547.7	525.8	570.5	0.75	0.72	0.78	-183.1	-206.0	-160.2
1981 to 1985	23,400	799	526.1	490.1	564.8	0.72	0.67	0.77	-204.7	-242.3	-167.0
1986 to 1991	35,000	665	454.4	417.8	494.1	0.62	0.57	0.68	-276.4	-314.8	-238.0
Non-permanent resident	6,800	303	721.4	633.5	821.7	0.99	0.87	1.12	-9.4	-103.3	84.6

Table 5
Age-standardized mortality rates (ASMR) per 100,000 person-years at risk, showing rate ratios (RR) and rate differences (RD), by selected socio-economic characteristics, non-institutionalized women aged 25 or older at baseline, Canada, 1991 to 2001 (continued)

Characteristic	Baseline population	Deaths	ASMR	95 % confidence interval from	to	RR	95 % confidence interval from	to	RD	95 % confidence interval from	to
Residence 1 year before											
Same address[†]	1,179,000	94,654	698.7	694.3	703.2	1.00.	...	...	0.0	...	...
Different address in same province	155,700	6,452	779.6	760.2	799.6	1.12	1.09	1.15	80.9	60.7	101.1
Different province	12,500	412	680.4	613.4	754.8	0.97	0.88	1.08	-18.3	-89.0	52.4
Foreign	7,400	125	428.7	349.8	525.4	0.61	0.50	0.75	-270.0	-357.3	-182.7
Not applicable	22,100	5,625	785.4	750.6	821.9	1.12	1.07	1.18	86.7	50.8	122.7
Marital status											
Legally married[†]	864,800	37,176	610.4	603.3	617.5	1.00	....	...	0.0	...	...
Common-law	88,900	2,012	822.3	750.1	901.5	1.35	1.23	1.48	212.0	136.1	287.9
Widowed	144,800	47,074	842.5	811.4	874.7	1.38	1.33	1.44	232.1	199.7	264.6
Separated	39,000	2,362	798.4	763.7	834.7	1.31	1.25	1.37	188.0	151.9	224.2
Divorced	79,800	5,461	830.1	804.0	857.0	1.36	1.31	1.41	219.7	192.3	247.1
Never married	159,500	13,183	808.4	793.1	823.9	1.32	1.30	1.35	198.0	181.1	215.0
Living arrangements											
Living with relatives[†]	1,136,800	57,804	674.6	669.0	680.3	1.00	....	...	0.0	...	...
Living with non-relatives	32,000	2,394	874.1	839.2	910.4	1.30	1.24	1.35	199.5	163.5	235.5
Living alone	187,200	41,481	817.7	806.7	828.8	1.21	1.19	1.23	143.1	130.7	155.5
Not applicable	20,700	5,589	808.6	769.4	849.8	1.20	1.14	1.26	134.0	93.4	174.6
Mother tongue											
English[†]	794,100	64,432	748.1	742.3	753.9	1.00	.....	...	0.0	...	...
French	345,900	25,727	666.3	658.1	674.6	0.89	0.88	0.90	-81.8	-91.9	-71.7
English and French (rare)	4,400	448	783.0	711.4	861.8	1.05	0.95	1.15	34.9	-40.4	110.2
Neither English nor French	232,400	16,661	616.5	607.1	626.0	0.82	0.81	0.84	-131.6	-142.7	-120.5
Knowledge of official languages											
English only[†]	925,200	75,326	728.6	723.4	733.8	1.00	.....	...	0.0	...	...
French only	209,100	17,175	675.0	664.7	685.4	0.93	0.91	0.94	-53.6	-65.2	-42.0
Both English and French	221,700	12,139	628.4	617.2	639.7	0.86	0.85	0.88	-100.2	-112.6	-87.8
Neither English nor French	20,800	2,628	601.5	576.1	628.1	0.83	0.79	0.86	-127.1	-153.6	-100.5
Community size											
1 million or more[†]	433,000	32,050	662.1	654.9	669.5	1.00	....	...	0.0	...	...
500,000 to 999,999	225,200	16,544	687.5	677.0	698.1	1.04	1.02	1.06	25.4	12.5	38.2
100,000 to 499,999	212,100	18,096	733.1	722.3	744.0	1.11	1.09	1.13	70.9	57.9	84.0
10,000 to 99,999	191,900	15,906	727.0	715.6	738.5	1.10	1.08	1.12	64.8	51.3	78.4
Less than 10,000 (rural and small town)	314,600	24,672	734.9	725.7	744.2	1.11	1.09	1.13	72.7	61.0	84.5
Metropolitan influence zone											
CMA or CA[†]	1,066,500	82,827	693.6	688.8	698.3	1.00	.....	...	0.0	...	...
Rural and small town											
Strong metropolitan influence	67,800	4,686	695.2	675.6	715.4	1.00	0.97	1.03	1.6	-18.9	22.1
Moderate metropolitan influence	111,700	9,686	722.6	708.1	737.3	1.04	1.02	1.06	29.0	13.7	44.4
Weak metropolitan influence	109,800	8,468	756.8	740.7	773.3	1.09	1.07	1.12	63.3	46.3	80.2
No metropolitan influence	21,000	1,601	844.5	803.8	887.3	1.22	1.16	1.28	151.0	108.9	193.0
Activity limitation											
No activity limitation[†]	1,228,600	65,852	577.3	572.9	581.8	1.00	....	...	0.0	...	...
Any activity limitation	141,100	39,745	1,330.1	1,312.9	1,347.5	2.30	2.27	2.34	752.8	734.9	770.6
Not applicable	7,100	1,671	989.5	926.4	1,056.9	1.71	1.60	1.83	412.2	346.8	477.6

[†] reference category
... not applicable
Note: Reference population (person-years at risk) was taken from the total cohort age distribution for all variables except Aboriginal variables, for which the Aboriginal age distribution was used.
Source: Census mortality follow-up study, 1991 to 2001.

Visible minorities

All visible minority groups had lower ASMRs, compared with Canadians who were not part of any visible minority. A large part of this difference could be explained by the "healthy immigrant" effect (as evident in the mortality hazard ratios for visible minorities compiled separately for Canadian-born and foreign-born, data not shown). For the Canadian-born, visible minority status was significantly protective only for ethnic Chinese, both men and women.

Aboriginal origins

Persons with any Aboriginal origins (First Nations, Métis, Inuit) had higher ASMRs (standardized to the Aboriginal population structure) than did persons with no Aboriginal ancestry. RRs were greater for Aboriginal women (1.76) than men (1.41). Mortality rates were highest among Registered Indians (a subset of First Nations), with RRs of 1.56 for men and 1.94 for women, compared with all other residents of Canada.

Immigration and mobility

Compared with the Canadian-born population, mortality rates were substantially lower among immigrants, particularly recent immigrants. However, immigrants' mortality advantage lessened as the number of years since immigration increased.

Mortality rates did not vary greatly by mobility (excluding those who had lived in a foreign country the year before the census), except for people who had lived at a different address in the same province the year before to the census, who had slightly higher mortality rates than did non-movers.

Marital status and living arrangements

Currently married men and women had lower mortality rates than did unmarried or previously married people. The results also revealed somewhat higher mortality for people in common-law unions, compared with those who were legally married.

Language

Men whose mother tongue was French had a somewhat higher mortality rate than did men whose mother tongue was English; the reverse was true among women. However, regardless of sex, Allophones (neither English nor French) had considerably lower mortality rates than other Canadians—due, in large part, to the "healthy immigrant" effect.

Results by knowledge of official languages (reported ability to converse in English or French, even if not fluently) revealed that, compared with the "English only" reference group, men able to converse only in French had somewhat higher mortality rates, while women able to converse only in French had somewhat lower mortality rates. For people able to converse in both English and French, the mortality rate for men was the same as that of the reference group, while the rate for women was somewhat lower. Men unable to converse in either English or French had considerably lower mortality rates, and women, somewhat lower rates (about the same as for bilingual females), compared with the "English-only" reference group.

Community size and metropolitan influence zone

Mortality rates varied by community size and metropolitan influence zone. Rates were lowest in metropolitan areas with a population of one million or more (Montreal, Toronto and Vancouver CMAs), and next lowest in metropolitan areas with a population of 500,000 to less than one million. Rates were somewhat higher in smaller urban areas and rural areas. However, in rural and small-town areas with strong metropolitan influence (30% to 49% of the workforce commuting to any CMA or CA), mortality rates were not significantly higher than those in all CMAs and CAs. By contrast, rates were substantially elevated in areas where the metropolitan influence was weak, particularly in zones with no metropolitan influence (none of the workforce commuting to a CMA or CA).

Activity limitations

People who reported an activity limitation had higher mortality rates than those who did not. Mortality rates during the follow-up period among people with an activity limitation were more than double the rates among people without an activity limitation.

Why is this study important?

◼ An important first step to monitor progress toward reducing or eliminating socio-economic inequalities in health is to determine the distribution of mortality rates across various groups.

◼ Until now, no nationally representative Canadian population-based cohort studies have examined mortality by socio-economic status.

What else is known on this topic?

◼ Results from other countries have consistently shown lower education levels and lower-status occupational categories (and the economically inactive) to have the highest mortality rates.

What does this study add?

◼ These results provide important baseline information on the nature and extent of socio-economic inequalities in mortality in Canada.

◼ A much greater disparity was revealed by individual and family income compared with neighbourhood income, especially for women.

Discussion

In this analysis, mortality rates were much lower among people of higher socio-economic status, regardless of whether socio-economic status was determined by education, occupation or income. The findings reveal a clear stair-stepped gradient in mortality, with

wider steps nearer the bottom as compared with the top of the socio-economic hierarchy.

The lowest mortality rates were among the university-educated, the employed, those in professional and managerial occupations, and those in the top income brackets. The highest mortality rates were among people with less than secondary graduation, those who were unemployed or not in the labour force, those in unskilled jobs, and those in the lowest income brackets.

Mortality rates also varied by ascribed characteristics such as ethnic origin, Aboriginal ancestry and mother tongue, and by achieved characteristics such as knowledge of official languages, mobility and marital status. Mortality rates also differed by the presence of activity limitations.

The census mortality follow-up study data provide a new set of reference mortality rates for occupational mortality studies, based on people with an occupation, or those gainfully employed at baseline. Previously, the use of reference mortality rates for the total population (including many people not in the labour force) may sometimes have prevented detection of moderately elevated mortality rates among workers.

Compared with life tables by neighbourhood income quintiles for urban Canada[71] (unpublished annexes available on request), life tables based on individual and family income quintiles revealed a 2.0-year greater inter-quintile disparity in remaining life expectancy at age 25 for men (6.8 years in this cohort versus 4.8 years in the neighbourhood data), and a 2.9-year greater disparity for women (4.3 versus 1.4 years). In terms of the expected probability of survival from ages 25 to 75, this analysis revealed a 6.5 percentage-point greater inter-quintile disparity for men (21.7 versus 15.2) and a 5.7 percentage-point greater disparity for women (12.3 versus 6.6). By either measure, a much greater inter-quintile disparity was revealed by individual and family income compared

to neighbourhood income, especially for women.

Although international comparisons were not included in these initial results, it should now be possible to make such comparisons with the findings of census mortality follow-up studies in other countries.

Strengths and limitations

The study was limited to people aged 25 or older at the time of the 1991 census, and it excluded institutional residents, non-tax-filers and persons missed by the census. Thus, the cohort had somewhat lower mortality rates than the Canadian population, especially at older ages.

Because of the reasonably high "response" rate (80%) and the large number of people followed (about 2.7 million, including 260,000 deaths), the study was broadly representative of most groups in the Canadian population. However, some groups were over- or under-represented (notably, Aboriginal people) in the sample that could be followed for mortality. Use of more comprehensive nominal list files as sources of names for subsequent encryption might have improved the probabilistic matching rate from census to the name file. Nevertheless, for those records that were matched, the accuracy of the match from census to the name file was very high (99%).

All of the socio-economic variables were only known at baseline (1991), although any achieved characteristic may change over time. For most of the census variables except age, occupation and language, imputed values could not be distinguished from non-imputed values, but records based on "hot deck" imputation were not included. Information on behavioural risk factors such as smoking and physical activity was not available from the census.

After matching to the Canadian Mortality Data Base, a single underlying cause of death was available for people determined to have died during the study period, but contributing causes of death were not available.

All comparisons were age-standardized or adjusted for age.

Implications for future research

The results of the 1991-to-2001 census mortality follow-up study can help to inform future research that examines socio-economic differences in health outcomes and health care use in Canada. The results provide detailed baseline data on the nature and extent of socio-economic inequalities in mortality, which is the most fundamental health outcome and the essential starting point for a true understanding of the impact of socio-economic disparities on population health.

Because of the rich detail of the Canadian census with respect to socio-economic characteristics, the findings of the census mortality follow-up study are pertinent to the consideration of various policy alternatives. When clear relationships have been established connecting mortality not only to income (and sources of income), but also to education, employment and housing (among other variables), the evidence base for informed policy decisions is widened considerably. This study thus broadens the evidence base for informed decisions.

These findings provide fundamentally important baseline data on the nature and extent of socio-economic inequalities in mortality in Canada at the end of the 20th century. However, this report is only an initial profile of the results, examining the variables one by one. Future analyses should determine how the various dimensions are connected—for example, to what extent are inequalities in mortality across income brackets (or Aboriginal or visible minority groups) explained by inequalities in education and occupation, and which causes of death contribute most to the disparities? ■

Acknowledgements

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Appendix

Table A

Mortality rate ratios, by sex, age group, education, occupation and income adequacy, non-institutionalized population aged 25 or older, Canada, 1991 to 2001

Category	Age at baseline							
	Total	25 to 34	35 to 44	45 to 54	55 to 64	65 to 74	75 to 84	85 or older
Baseline population								
Men (number)	1,358,400	371,900	353,700	243,000	190,500	135,700	55,300	8,200
Women (number)	1,376,800	400,500	364,700	226,600	161,700	136,400	71,600	15,300
Deaths								
Men (number)	153,552	4,481	8,122	14,804	31,674	50,359	36,877	7,235
Women (number)	107,268	2,449	5,368	8,264	14,726	29,871	34,796	11,794
Education								
Men								
University degree[†]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Postsecondary diploma	1.13	1.33	1.32	1.40	1.27	1.13	1.04[‡]	0.91[‡]
Secondary graduation	1.30	1.88	1.75	1.75	1.54	1.31	1.10	0.95[‡]
Less than secondary graduation	1.55	2.86	2.39	2.29	1.94	1.53	1.19	1.09[‡]
Women								
University degree[†]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Postsecondary diploma	1.10	1.24	1.29	1.18	1.22	1.11	1.05[‡]	0.92[‡]
Secondary graduation	1.21	1.54	1.46	1.39	1.40	1.24	1.11	0.97[‡]
Less than secondary graduation	1.42	2.42	2.06	1.78	1.75	1.44	1.19	0.99[‡]
Occupation								
Men								
Professional[†]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Managerial	1.11	1.04[‡]	1.11	1.10	1.22	1.09	1.13[‡]	0.99[‡]
Skilled/Technical/Supervisory	1.17	1.40	1.50	1.47	1.38	1.11	1.05[‡]	0.98[‡]
Semi-skilled	1.30	1.79	1.85	1.73	1.54	1.18	1.16	1.00[‡]
Unskilled	1.37	2.17	2.13	1.99	1.68	1.19	1.17	0.97[‡]
No occupation	2.20	5.85	6.15	4.69	2.58	1.62	1.35	1.37
Women								
Professional[†]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Managerial	1.22	1.01[‡]	1.15[‡]	1.21	1.20	1.32	0.97[‡]	2.22
Skilled/Technical/Supervisory	1.23	1.13[‡]	1.23	1.24	1.25	1.23	1.13[‡]	1.77
Semi-skilled	1.24	1.42	1.35	1.28	1.26	1.18	1.17[‡]	1.57
Unskilled	1.34	1.59	1.65	1.42	1.44	1.29	1.20[‡]	1.60
No occupation	1.70	2.58	2.42	2.40	2.01	1.67	1.22	1.77
Income adequacy quintile								
Men								
Quintile 5 - richest[†]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Quintile 4	1.12	1.12	1.17	1.16	1.20	1.14	1.06	1.06[‡]
Quintile 3	1.21	1.25	1.23	1.31	1.39	1.23	1.09	1.05[‡]
Quintile 2	1.36	1.51	1.44	1.59	1.60	1.42	1.16	1.12
Quintile 1 - poorest	1.68	2.34	2.40	2.45	2.18	1.61	1.29	1.13
Women								
Quintile 5 - richest[†]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Quintile 4	1.07	1.02[‡]	1.06[‡]	1.15	1.18	1.11	1.01[‡]	0.95[‡]
Quintile 3	1.13	1.12[‡]	1.20	1.30	1.29	1.14	1.04[‡]	0.95[‡]
Quintile 2	1.22	1.39	1.44	1.48	1.54	1.27	1.03[‡]	0.91
Quintile 1 - poorest	1.49	2.05	2.15	2.34	2.01	1.50	1.11	0.95[‡]

[†] reference category
[‡] not significantly different from reference category ($p < 0.05$)
Notes: Rate ratios were calculated from age-standardized mortality rates (ASMRs) standardized to the cohort age structure of person-years at risk. The ASMRs for each 10-year age group were standardized on 5-year age groups.
Source: Census mortality follow-up study, 1991 to 2001.

Statistics Canada, Catalogue no. 82-003-XPE • Health Reports, Vol. 19, no. 3, September 2008
The Canadian census mortality follow-up study • Special Research Article

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Table B

Mortality hazard ratios, by sex, age group, education, occupation, income adequacy and activity limitation, non-institutionalized population aged 25 or older, Canada, 1991 to 2001

Category	Total	Age at baseline						
		25 to 34	35 to 44	45 to 54	55 to 64	65 to 74	75 to 84	85 or older
Baseline population								
Men (number)	1,358,400	371,900	353,700	243,000	190,500	135,700	55,300	8,200
Women (number)	1,376,800	400,500	364,700	226,600	161,700	136,400	71,600	15,300
Deaths								
Men (number)	153,552	4,481	8,122	14,804	31,674	50,359	36,877	7,235
Women (number)	107,268	2,449	5,368	8,264	14,726	29,871	34,796	11,794
Education								
Men								
University degree[†]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Postsecondary diploma	1.17	1.33	1.32	1.40	1.28	1.14	1.04[‡]	0.89[‡]
Secondary graduation	1.42	1.89	1.76	1.74	1.55	1.32	1.11	0.95[‡]
Less than secondary graduation	1.71	2.86	2.39	2.26	1.94	1.55	1.21	1.10
Women								
University degree[†]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Postsecondary diploma	1.13	1.24	1.29	1.18	1.21	1.11	1.04[‡]	0.90[‡]
Secondary graduation	1.26	1.55	1.46	1.37	1.39	1.24	1.11	0.95[‡]
Less than secondary graduation	1.45	2.41	2.05	1.75	1.74	1.44	1.19	0.98[‡]
Occupation								
Men								
Professional[†]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Managerial	1.12	1.03[‡]	1.10	1.09	1.23	1.09	1.14	0.95[‡]
Skilled/Technical/Supervisory	1.34	1.41	1.50	1.46	1.39	1.11	1.06[‡]	1.03[‡]
Semi-skilled	1.53	1.80	1.86	1.72	1.56	1.21	1.18	0.89[‡]
Unskilled	1.72	2.18	2.15	1.97	1.70	1.24	1.18	1.08[‡]
No occupation	2.29	5.89	6.17	4.56	2.47	1.62	1.38	1.67
Women								
Professional[†]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Managerial	1.19	1.01[‡]	1.15[‡]	1.20	1.21	1.33	0.97[‡]	2.14
Skilled/Technical/Supervisory	1.26	1.13[‡]	1.23	1.24	1.24	1.21	1.13[‡]	2.03
Semi-skilled	1.28	1.42	1.35	1.27	1.25	1.19	1.18[‡]	1.69
Unskilled	1.45	1.60	1.65	1.41	1.45	1.34	1.21[‡]	1.67
No occupation	1.85	2.56	2.44	2.37	1.96	1.64	1.22	2.20
Income adequacy quintile								
Men								
Quintile 5 - richest[†]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Quintile 4	1.15	1.12	1.18	1.17	1.20	1.15	1.06	1.07[‡]
Quintile 3	1.27	1.25	1.25	1.33	1.38	1.24	1.11	1.06[‡]
Quintile 2	1.45	1.51	1.46	1.61	1.58	1.42	1.18	1.12
Quintile 1 - poorest	1.76	2.34	2.45	2.47	2.15	1.64	1.31	1.15
Women								
Quintile 5 - richest[†]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Quintile 4	1.09	1.02[‡]	1.07[‡]	1.15	1.18	1.12	1.02[‡]	0.93[‡]
Quintile 3	1.16	1.12[‡]	1.22	1.31	1.28	1.15	1.05	0.93[‡]
Quintile 2	1.27	1.39	1.47	1.48	1.52	1.27	1.04[‡]	0.90
Quintile 1 - poorest	1.47	2.07	2.20	2.34	2.00	1.49	1.11	0.94[‡]
Income adequacy decile								
Men								
Decile 10 - richest[†]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Decile 9	1.11	1.03[‡]	1.05[‡]	1.12	1.18	1.15	1.05[‡]	1.04[‡]
Decile 8	1.18	1.09[‡]	1.20	1.19	1.25	1.19	1.10	1.07[‡]
Decile 7	1.24	1.18	1.22	1.28	1.34	1.25	1.07	1.09[‡]
Decile 6	1.30	1.21	1.27	1.35	1.43	1.31	1.13	1.07[‡]
Decile 5	1.36	1.31	1.30	1.46	1.56	1.32	1.14	1.08[‡]
Decile 4	1.47	1.41	1.41	1.62	1.63	1.46	1.18	1.14
Decile 3	1.55	1.69	1.61	1.79	1.79	1.56	1.22	1.15
Decile 2	1.72	2.08	2.07	2.18	2.11	1.72	1.33	1.19
Decile 1 - poorest	2.13	2.65	2.89	2.92	2.47	1.82	1.32	1.08[‡]
Women								
Decile 10 - richest[†]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Decile 9	1.07	0.84[‡]	1.02[‡]	1.10	1.20	1.06[‡]	1.04[‡]	0.98[‡]
Decile 8	1.12	0.94[‡]	1.04[‡]	1.23	1.24	1.14	1.04[‡]	0.93[‡]
Decile 7	1.13	0.92[‡]	1.11[‡]	1.18	1.32	1.15	1.04[‡]	0.90[‡]
Decile 6	1.18	0.98[‡]	1.26	1.33	1.37	1.13	1.07[‡]	0.95[‡]
Decile 5	1.22	1.06[‡]	1.20	1.42	1.43	1.22	1.08	0.89
Decile 4	1.26	1.23	1.38	1.48	1.59	1.28	1.00[‡]	0.91[‡]
Decile 3	1.34	1.32	1.61	1.62	1.71	1.32	1.09	0.87
Decile 2	1.44	1.52	1.86	2.04	1.93	1.49	1.12	0.94[‡]
Decile 1 - poorest	1.67	2.15	2.52	2.72	2.36	1.67	1.17	0.92[‡]
Activity limitation								
Men								
Not limited[†]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Limited	2.09	4.17	3.69	3.10	2.39	2.00	1.71	1.58
Women								
Not limited[†]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Limited	2.04	5.18	3.77	3.32	2.68	2.14	1.70	1.48

[†] reference category
[‡] not significantly different from reference category (p < 0.05)

Notes: Mortality hazard ratios were adjusted for age in single years. Census population counts were rounded to nearest 100.
Source: Census mortality follow-up study, 1991 to 2001.