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Refining the Measurement of Health Inequalities in Canada – New Data, New Approaches

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Abstract

Despite the underlying philosophy of "Health for All" with regard to both access to and quality of health care in Canada, socioeconomic inequalities in health outcomes are still pervasive. In particular, mortality and morbidity rates are substantially higher among poorer relative to richer persons. However, the measurement of socioeconomically-based health inequalities has been substantially limited by the lack of (1) joint microdata on both socioeconomic status and mortality, and (2) information on morbidity in addition to mortality. In Canada, socioeconomic status and mortality indicators generally have only been available at the ecological level; while morbidity or health-related quality of life data are usually not incorporated into analyses of socioeconomic differences in mortality. The current analysis addressed both of these limitations. In particular, using on a unique new linkage of a 15% sample of Canada's 1991 population census with 11 years of death records, in combination with information on health-related quality of life from the 2000-2001 Canadian Community Health Survey, we computed health-adjusted life expectancy (HALE) for different socioeconomic groups in Canada. Building on previous research focusing primarily on mortality, analysis of the newly estimated socioeconomic gradient in HALE indicates larger disparities. Directions for future work on health inequalities in Canada are also discussed.

Refining the Measurement of Health Inequalities in Canada – New Data, New Approaches

INTRODUCTION

Within the recent history of many economically developed nations, there has been a dramatic increase in life expectancy, which stands as testimony to the cumulative success of improvements in public health policy, as well as technological advancements in medical care (Riley, 2001). Despite these encouraging large-scale gains in longevity, however, inequalities in health outcomes across different sub-populations are still pervasive within Canada and many other industrialized countries. While Canada's health care system rests on the philosophical foundations of equality in terms of both health care access and quality (i.e., "Health for All"; Canadian Public Health Association, 1997; Mhatre & Deber, 1992; Health Canada, 1986), a voluminous body of empirical evidence demonstrates that mortality rates – the most fundamental indicator of population health – exhibit a *socioeconomic gradient* (e.g., Wilkins, Tjepkema, Mustard, & Choinière, forthcoming; Wilkins, Berthelot, & Ng, 2002; Mustard, Derksen, Berthelot, Wolfson, & Roos, 1997; Wolfson, Rowe, Gentleman, & Tomiak, 1993). That is to say, irrespective of how socioeconomic status is defined and measured (e.g., income, educational attainment, or occupational prestige), observed mortality rates show a gradual but systematic increase as one looks further and further down in the socieconomic hierarchy. However, it should be noted that time series analyses for Canada suggest that, in terms of absolute differences in mortality rates, these socioeconomic differentials in mortality have been diminishing over recent decades, with the specific patterns being dependent on the particular cause of death considered and on other background factors such as gender (James, Wilkins, Detsky, Tugwell, & Manuel, 2007; Wilkins et al., 2002).

While numerous, well-executed investigations of the ubiquitous socioeconomic gradient in health outcomes have greatly enhanced our knowledge of the extent of health disparities in Canada, this area of research has been substantially limited by the lack of (1) joint microdata on both socieconomic status and mortality, and (2) information on morbidity in addition to mortality. Regarding the first point, studies of socioeconomic inequalities in health in Canada have typically relied upon small area mortality rates and life expectancy estimates sorted by ecological indicators of socioeconomic status such as neighbourhood affluence and poverty (e.g., James et al., 2007; Wilkins et al., 2002). Therefore, the strength of the association between the socioeconomic and mortality information is likely attenuated due to measurement error – using area-level variables as proxies for individuals' socioeconomic status. It should be noted here that Mustard, Derksen, Berthelot, and Wolfson (1999) found substantial correlations between average neighbourhood and individual income, and concluded that imputation of area-level for individual-level data on socioeconomic status is probably tenable in instances where the latter are unattainable. However, this study was limited to the Manitoba household population and ideally, individual-level data should be used whenever possible in research on socioeconomic disparities in health, in order to maximize precision of the estimates. Indeed, many countries have linked individual-level data from population censuses and registries to death records in order to conduct nationally representative population-based cohort studies of mortality by socioeconomic status, which has primarily been defined in terms of educational and occupational attainment (for an overview, see Wilkins et al., forthcoming). These studies have provided strong and consistent evidence for an inverse association between socioeconomic status and mortality.

Over the last three decades, a number of record-linkage based mortality follow-up studies have also been conducted in Canada (e.g., Roos, Magoon, & Gupta, 2004; Aranson, Howe, Fair, &

Carpenter, 2000; Chen, Beavon, & Wilkins, 1996; Wolfson, Rowe, Gentleman, & Tomiak, 1993; Wigle et al., 1990; Wigle, Mao, & Arraiz, 1989; Hirdes & Forbes 1989; Havens 1988; Johansen et al., 1987; Howe & Lindsay, 1983; Howe, Lindsay, & Miller, 1980; Jordan-Simpson, Fair, & Poliquin, 1980), but these have been relatively narrow in scope, focusing on particular sociodemographic groups (e.g., age, sex, occupation) or geographic areas. However, the landmark *1991 census-mortality follow-up study* (Wilkins et al., forthcoming) took a more comprehensive approach by linking a 15% sample of the 1991 census with 11 years of mortality records, providing more comprehensive, robust and policy-relevant information on Canadian socioeconomic differentials in mortality, as well as an empirical foundation for numerous future research projects.

Concerning the second point, it is now widely recognized that the measurement of population health is incomplete unless it incorporates morbidity or health-related quality of life as well as mortality and survival. In line with this view, a broad variety of summary measures have been developed that integrate information on mortality and morbidity in order to yield a more comprehensive picture of population health and its distribution (cf. Robine, Jagger, Mathers, Crimmins, & Suzman, 2003; Murray, Salomon, Mathers, & Lopez, 2002; Sullivan, 1971). Briefly, these measures combine years lost to premature death with years lost to reduced functioning or disability, allowing for an assessment of both quantity and quality of life for a given population. As recently summarized in an extensive review by Crimmins and Cambois (2003; see also Mackenbach, 2006), several investigations conducted primarily in the United States and Europe demonstrate that when the worse morbidity experience of lower socioeconomic groups is combined with their worse mortality experience, the socioeconomic disparities in health become more pronounced than those based on mortality alone.

In Canada, a number of studies have estimated summary measures of population health in order to examine broad national patterns of morbidity and mortality (e.g., Wolfson, 1996), regional variations in population health (Mayer, Ross, Berthelot, & Wilkins, 2002), the population health impact of specific diseases and risk factors (Boswell-Purdy et al., 2007; Manuel & Schultz, 2004; Manuel, Luo, Ugnat, & Mao, 2003; Manuel, Schultz, & Kopec, 2002; Belanger, Martel, Berthelot, & Wilkins, 2002), as well as whether population health has been improving over time (Martel & Belanger, 1999). However, few Canadian studies have focused on socioeconomic disparities in summary measures of population health, and those that have have mainly relied on area-level indicators of socioeconomic status (e.g., neighbourhood poverty) rather than individual-level indicators (Health Canada, 2004; Wilkins & Adams, 1983). One notable exception is a study by Nault, Roberge, and Berthelot (1996), which linked a representative sample of Manitobans from the 1986 census of Canada to seven years of vital statistics data, and derived information on morbidity from the 1994-1995 National Population Health Survey. Using a summary measure of population health known as "health-adjusted life expectancy" (HALE), this study showed that consideration of morbidity in addition to mortality accentuated socioeconomic differentials in health, with respect to both total household income and educational attainment. However, HALE was only presented for age 30, and the results cannot be generalized beyond the Manitoba household population for the study period.

In their recent time series analysis of mortality by neighbourhood income in urban Canada, Wilkins et al. (2002) articulated a number of broad recommendations for future research at the national level, including (1) the utilization of individual-level data on both socioeconomic status and mortality and (2) the examination of socioeconomic disparities in *health expectancy* indicators that include morbidity in addition to mortality. This strategy would provide estimates of the effective length of time that persons within particular socieconomic groups can expect to live in full health – in other words, the length of life unencumbered by disability or reduced health-related quality of life. The present study responds to these calls. Specifically, we use the linked file constructed in the *1991 census-mortality follow-up study* (Wilkins et al., forthcoming), coupled with information on health-related quality of life from a nationally representative population health survey, to compute health-adjusted life expectancy (HALE) for different socioeconomic groups (defined by income and educational attainment) in Canada. The analysis therefore provides more comprehensive, robust, and policy-relevant estimates of the extent of socioeconomically-based health inequalities in Canada.

METHODS

Health-Adjusted Life Expectancy (HALE)

Health-adjusted life expectancy (HALE) is a summary measure of population health based on the pioneering conceptual and empirical work of Sullivan (1971), and has been widely used to summarize the combined mortality and morbidity experiences of various populations (Health Canada, 2004; Berthelot, 2003; Mathers et al., 2004; Wolfson, 1996). Mathematically, HALE essentially re-expresses the conventional, purely mortality-driven life expectancy measure as the number of years expected to be lived in full or optimal health. More formally, life expectancy (LE) and HALE are computed, respectively, as:

$$LE_x = \frac{\sum_{i=x}^{w} L_i}{l_x} \qquad [1]$$

and

$$HALE_x = \frac{\sum_{i=x}^{w} (L_i * H_i)}{l_x}, \qquad . \quad [2]$$

where:

x is the exact age for which LE or HALE is to be estimated (25-75, by 10-year intervals were used in the current study);

i is an indicator representing the lower limit (x) of the age interval (x, $x + a$);

L_i is the number of life years lived by the age group (x, $x + a$);

l_x is the number of survivors at age x;

H_i is a score or weight representing the average level of health-related quality of life for the age group (x, $x + a$), with $H_i = 1.0$ indicating full health; and

w is the total number of age groups in the life table.

From Equations 1 and 2, it is easy to see that the higher the average level of health-related quality of life for a given age group, on a scale with an upper limit of 1.0 (full health), the closer HALE will be to life expectancy (i.e., a person at that exact age can expect to live more time in full health).

The variance of HALE can be estimated by adapting methods developed by Mathers (1991):

$$Var(HALEx) = \sum_{i=x}^{w-1} l_i^2 \left[(1 - f_i) n_i H_i + HALE_{i+1}\right]^2 Var(q_i) / l_x^2 + \sum_{i=x}^{w} L_i^2 Var(H_i) / l_x^2 \quad [3]$$

where:

Var denotes variance;

i is an indicator representing the lower limit (x) of the age interval (x, $x + a$) ;

w is the total number of age groups;

n is the length of the age interval (10 years, in the present case);

x is the exact age for which HALE is estimated;

q_i is the probability of dying during the age interval;

L_i is the number of life years lived by the age group;

l_x is the number of individuals surviving at the beginning of the age interval;

H_i is a score or weight representing the average HRQoL for the age group; and

f is the fraction of the age interval lived by individuals who die in that interval, computed as: $f\,i = \left(\left[L_i / ni\right] - l_{i+1}\right) / \left(l_i - l_{i+1}\right)$

Computation of point estimates and variance of HALE requires the assembly of several data elements, namely mortality rates and average health-related quality of life values sorted by age, sex, and any other explanatory variables of interest. The following sections describe the data sources and analysis strategy used in the current investigation. All analyses were performed using SAS Version 9.1 for Windows (SAS Institute, Cary North Carolina).

Data Sources

The 1991 census mortality follow-up study. Mortality information was obtained from the *1991 census mortality follow-up study*, which was conducted by Statistics Canada in collaboration with the Canadian Population Health Initiative (CPHI). Motivated primarily by the need for more detailed data on Canadian socioeconomic disparities in health, this unique data linkage project united a 15% sample of the 1991 Census of Canada with 11 years of follow-up data from the Canadian Vital Statistics Mortality Database. The in-scope population consisted of non-institutionalized, usual residents of Canada aged 25 and over on the census day, who completed the long-form questionnaire (N=3,576,487). Using probabilistic linkage techniques, 2,860,244 (about 80%) of the in-scope census records were successfully linked to a name file — the “bridge file”, without which follow-up in the Canadian Mortality Data Base would not have been possible. This group was then reduced to exactly 15% of the entire Canadian population of that age by randomly removing 125,092 records. The final cohort for the mortality follow-up was therefore 2,735,152, or 76% of the original in-scope sample.

The linked file contains information on various demographic characteristics, SES, activity limitations, disability, and both cause and date of death. Further methodological details on the construction and contents of the linked file are provided elsewhere (Wilkins et al., forthcoming).

The Canadian Community Health Survey (CCHS). Information on health-related quality of life was derived from the 2000-2001 Canadian Community Health Survey (CCHS, cycle 1.1; Statistics Canada, 2003; Béland, 2002). The CCHS is an ongoing, cross-sectional survey that collects information on health status, health determinants, and health care utilization. It is representative of the Canadian household population aged 12 and over in all provinces and territories, except for the exclusion of populations on Indian Reserves, Canadian Forces Bases, and certain remote areas. The Cycle 1.1 file contains 131,535 person records.

The CCHS includes a widely-used measure of health-related quality of life: the Health Utilities Index Mark 3 (HUI3; Feeny, 2005; Feeny et al., 2002). The HUI3 consists of eight basic domains or attributes of health status, namely Vision, Hearing, Speech, Ambulation, Dexterity, Emotion, Cognition, and Pain. Each attribute has five or six levels ranging from normal to severely limited functioning. For example, the Ambulation attribute has levels which range from 1 ("Able to walk around the neighbourhood without difficulty, and without walking equipment") to 6 ("Unable to walk at all"). On the CCHS, respondents were asked a standardized set of questions on usual functional ability or capacity, which can be mapped to the levels on the eight HUI3 attributes. A given individual's health status is represented by an 8-element vector listing each of the attribute levels, which are then summarized by a weighted scoring function into a single value representing overall health-related quality of life. The global score has a theoretical range of -0.36 (worst possible health state) to 1.00 (best possible health state); where 0.00 represents a health state equivalent to being dead.

Definitions of Explanatory Variables

In order to estimate HALE, both HUI3 means and mortality rates were derived for the following classificatory groups: age by sex by income decile, and age by sex by educational attainment. To accurately combine the mortality and HUI3 data, the definitions of these variables should be consistent across both the CCHS and the linked census-mortality file.

Age and sex. Beginning at age 25 (the youngest age in the census-mortality linked file), we constructed sex-specific 5-year age groups for the linked file, and sex-specific 10-year age groups for the CCHS. While 5-year age groups could also have been created for the CCHS, this approach would have resulted in smaller cells and therefore reduced stability of HUI3 mean estimates. Therefore, for computing HALE at 10-year intervals (age 25 through 75), the same mean HUI3 value for a given 10-year age group (e.g., 25 to 34) was simply applied to the L_x values for each of the two constituent 5-year age groups from the linked file (e.g., 25 to 29 and 30 to 34).

Income deciles. For the census-mortality linked file, national deciles (tenths) of population ranked by income adequacy were developed as follows. First, for each economic family or unattached individual[1], the total pre-tax, post-transfer income from all sources was pooled across all economic family members, and then divided by the weighted family size (or "equivalent person unit" scale). Under the weighting system, the first person received a weight of 1.0, the second person 0.40, and all subsequent family members 0.30.[2] Next, adjusted family income was converted into deciles. For the CCHS, income deciles were constructed in the same manner, except that total *household*

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[1] According to Statistics Canada's census definitions (Statistics Canada, 1991), an "economic family" is a grouping of two or more individuals all living in the same household or dwelling unit who are all related by blood, marriage or adoption. Unattached individuals are essentially economic families of size 1.

[2] Note that this is not the same as the equivalent person unit scale used by the Luxembourg Income Study (http://www.lisproject.org/) or the OECD, which is simply the square root of the household size, but up to size four, the two methods are very close.

income was used rather than total economic family income, and household income was based on the respondent's best estimate.

Educational attainment. For both the census-mortality linked file and the CCHS, self-reported information on educational credentials was used to derive a 4-category variable reflecting educational attainment: 1 = less than high school graduation, 2 = high school graduation or trades qualification, 3 = post-secondary certificate or diploma (short of a university Bachelor's degree), and 4 = university degree (Bachelor's or higher).

Mortality Inputs

Chiang's (1984) method was applied directly to the census-mortality linked file in order to produce period life tables, corresponding standard errors, and 95% confidence intervals for each population subgrouping of interest here: age by sex by income decile, and age by sex by educational attainment. Prior to the calculation of the life tables, it was necessary to (1) transform baseline age to age at the beginning of each year of follow-up, (2) calculate deaths and person-years at risk separately for each year (or partial year[3]) of follow-up, and (3) pool deaths and person-years at risk at the beginning of each year of follow-up.

Health-Related Quality of Life Inputs

Mean global HUI3 scores were computed from the CCHS for each population subgrouping (i.e., age by sex by income decile, and age by sex by educational attainment), using survey sampling weights to adjust the point estimates for unequal selection probabilities, and the Rao-Wu bootstrap technique to correct the standard errors and 95% confidence intervals for the effects of stratification and clustering (Rao, Wu, & Yue, 1992; Rao & Wu, 1988). The mean HUI3 scores were then combined

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[3] Since the 1991 census was on June 4, while the mortality data are organized by calendar year, the first follow-up was from June 4 to December 31st.

with the life table data in accordance with equations 2 and 3, in order to compute the point estimates of HALE and their variances.

RESULTS

Sample Characteristics

The frequency distributions of the study variables, for both the CCHS and the census-mortality linked file, are shown in Table 1. The samples are generally quite similar in structure, with the proportions in each category differing only slightly. The CCHS-based sample had considerably more missing data on income (21.4%) than did the census-based sample (1.4%), and had some missing data on educational attainment (0.8%).

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table 1

Life Expectancy

Income deciles. The life expectancy estimates (with 95% confidence intervals) by income decile are shown in tables 2 (males) and 3 (females). Also included in the tables are two measures of the magnitude of the socioeconomic differentials at each age: the absolute difference in life expectancy between the richest (decile 10) and poorest (decile 1) income groups, and the ratio of the life expectancy of the richest decile to the life expectancy of the poorest decile. For both males and females, the results showed a stair-step socioeconomic gradient in life expectancy, with very few exceptions. For males aged 25, the difference in life expectancy between the richest (decile 10) and poorest (decile 1) deciles was 7.3 years, but this difference diminished with advancing age, to 1.7 years for males aged 75. For females at age 25, the disparity in life expectancy between the richest and poorest deciles was 4.8 years, considerably smaller than the corresponding value for males. However, a similar age effect is evident: for females aged 75, the difference between deciles 1 and 10 was 1.28 years, reasonably close to the corresponding difference for males.

Of course, the age-related decline in the absolute differences in life expectancy between the highest and lowest income deciles is not surprising, because overall life expectancy declines with age. In contrast, the ratios of life expectancy from the richest to poorest deciles were quite stable across all of the selected ages, for both males and females. For males aged 25, those in the richest decile could expect to live about 10% longer than those in the poorest decile. For all of the other selected ages, those in the richest decile could expect to live about 20% longer than those in the poorest decile. For females at all of the ages examined, those in the richest decile could expect to live approximately 10% longer than those in the poorest decile.

Still, the absolute differences in life expectancy may be the more intuitive and policy-relevant measure of the socioeconomic disparities. For example, these results show that if males aged 25 in the poorest decile were subjected to the same force of mortality as their counterparts in the richest decile, they would experience a 7.3 year gain in life expectancy.

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table 2

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table 3

Educational attainment. The pattern of associations between life expectancy and educational attainment was similar to that observed for the income deciles, showing steady decreases in life expectancy at each age as one moves lower on the social ladder. For males aged 25 (figure 1), the difference in life expectancy between the highest (university bachelor's degree or higher) and lowest (less than high school graduation) education levels was 5.5 years; by age 75, this difference was reduced to 1.4 years. For females aged 25 (figure 2), the difference in life expectancy between the most and least well-educated groups was 3.4 years, notably less than corresponding difference for males. For females aged 75, the difference in life expectancy between educational levels 1 and 4 was smaller at 1.0 year, and fairly close to the corresponding difference for males.

The life expectancy ratios of the most to least well-educated groups, however, were fairly consistent across all ages for both males and females. For males aged 25, 35, and 45, those in the most well-educated group could expect to live around 10% longer than those in the least well-educated group; around 20% longer at ages 55 and 65; and approximately 10% longer at age 75. For females, those in the most well-educated group could expect to live about 10% longer than those in the least well-educated group, at all selected ages.

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figure 1

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figure 2

Probabilities of Survival

Income deciles. Since life expectancy at each age (except age 25) is conditional on survival to those ages, it is also important to present the distribution of the survival probabilities by socioeconomic status. For both males (table 4), and females (table 5), there was evidence of an income gradient in survival probabilities. For males, the difference between the richest (decile 10) and poorest (decile 1) deciles in the probability of survival to age 35 was approximately 1%, but this difference widened substantially with advancing age, to around 23% for age 75. The income differentials in survival probabilities were less pronounced for females, although the same age effect was present. For females, the disparity between the richest and poorest deciles in the probability of survival to age 35 was fairly negligible at only 0.5%; for age 75, this difference climbed to 15%. The ratios of survival probabilities from the richest to poorest deciles showed essentially the same pattern, for both males and females. Males in the richest decile were virtually no more likely to attain age 35 or 45 than those in the poorest decile, but were 1.5 times more likely to reach age 75 than those in the poorest decile. Females in the richest decile had virtually the same likelihood of attaining ages 35, 45, and 55 than those in the poorest decile, but were 1.2 times more likely to reach age 75 than those in the poorest decile.

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table 4

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table 5

Educational attainment. Probabilities of survival with respect to each level of educational attainment are shown in figures 3 (males) and 4 (females). For males, the difference between the highest (university bachelor's degree or higher) and lowest (less than high school graduation) education levels in the probability of survival to 35 was 1.0%; by age 75, this difference widened to 17.5%. A similar pattern was observed for females, although the education gradient was considerably less pronounced. For females, the difference between the most and least well-educated groups in the probability of survival to age 35 was only 0.4%, notably less than the corresponding difference for males. However, regarding the probability of survival to 75 for females, the difference between educational levels 4 and 1 was much larger at 9.6%, although this was about half of the corresponding difference for males. The ratios of survival probabilities from the most well-educated (university bachelor's degree or higher) to the least well-educated (less than high school graduation) groups showed essentially the same pattern, for both males and females. Males in the most well-educated group were virtually no more likely to attain age 35 or 45 than those in the least well-educated group, but were 1.3 times more likely to reach age 75 than those least well-educated group. Females in the most well-educated group had virtually the same likelihood of attaining ages 35, 45, and 55 than those in the least well-educated group, and were only 1.1 times more likely to reach both age 65 and 75 than those in the least well-educated group.

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figure 3

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figure 4

Health-Related Quality of Life

Income deciles. The HUI3 mean estimates are displayed by income decile in tables 4 (males) and 5 (females). For males aged 25-34, the difference in mean HUI3 between the richest group (decile 10) and the poorest group (decile 1) was 0.087, almost three times the *minimal clinically important difference* of 0.03 established for HUI3 global scores (Horsman, Furlong, Feeny, & Torrance, 2003). The difference in average HUI3 between the richest and poorest deciles rose with advancing age, peaking in men aged 55-64 at a value of 0.207, which is nearly seven times the minimal clinically important difference. For men aged 75+, the disparity in mean HUI3 between deciles 10 and 1 dropped to 0.153, which still more than five times the minimal clinically important difference. Particularly noteworthy is that the effect of low income on health-related quality of life can be described as essentially akin to premature aging: on average, men aged 75+ in the richest decile enjoy about the same level of health related quality of life (0.815) as men aged 35-44 in the poorest decile.

With regard to females in the youngest age category, the difference in average HUI3 between the richest and poorest deciles was 0.078, which was very close to the corresponding difference for males. Similar to the pattern observed for males, differences in average HUI3 between the richest and poorest deciles also rose with advancing age for females, peaking in the group aged 55-64 at 0.138, more than four times the minimal clinically important difference but still substantially smaller than the corresponding difference for males.

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table 4

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table 5

Educational attainment. The relationship between average HUI3 and educational attainment is shown in figures 5 (males) and 6 (females). For males aged 25-34, the difference in mean HUI3 between the highest (bachelor's degree or higher) and lowest (less than high school graduation) education levels is clinically important at 0.078. This difference did not increase or decrease monotonically with advancing age, and was exactly the same for those aged 75 and older. Within females aged 25-34, the difference in mean HUI3 between the most and least well-educated groups was 0.107, more than 3 times what is considered clinically important. As with males, this disparity did not smoothly increase or decrease with age, but was much smaller at age 75 and older (0.029) than it was at age 25-34, and only marginally clinically important.

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figure 5

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figure 6

Health-Adjusted Life Expectancy (HALE)

Income deciles. The HALE estimates (and 95% confidence intervals) with respect to income decile are displayed in tables 6 (males) and 7 (females). The results show that combining both mortality and morbidity accentuates income-related health disparities for both sexes, compared with the results for life expectancy alone. For males aged 25, the difference in HALE between the richest (decile 10) and poorest (decile 1) deciles was 11.2 years, which was 3.9 years more than the corresponding difference in life expectancy alone. In males aged 75, this difference was substantially smaller at 2.9 years, which was 1.2 years more than the corresponding difference in life expectancy alone. For females aged 25, the HALE disparity between deciles 10 and 1 was 8.9 years, which was almost doubled at 4.1 years more than corresponding difference in life expectancy alone. For females aged 75 , the difference in HALE between the richest and poorest deciles was 1.5 years, which was about double at 0.8 years more than corresponding difference in life expectancy alone.

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table 6

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table 7

For males, the HALE ratios of the richest to poorest deciles were generally higher and more variable across age than the same ratios for life expectancy alone. For example, at age 55, men in the richest decile could expect to live about 60% more healthy years than those in the poorest decile. For females, the HALE ratios of the richest to poorest deciles were smaller and more stable across the selected ages than those for males: females in the richest deciles could expect to live approximately 20% to 30% more healthy years than those in the poorest deciles.

Educational attainment. The association between HALE and educational attainment is shown in figures 7 (males) and 8 (females). As with the HALE results by income decile, education-related differentials in HALE were larger than those for life expectancy alone, for both sexes. For males aged 25, the difference in HALE between the highest (bachelor's degree or higher) and lowest (less than high school graduation) education levels was 9.2 years, 3.7 years more than the corresponding difference in life expectancy. At age 75, this gap narrowed to 1.9 years, which was 0.5 years more than the corresponding difference in life expectancy. This pattern of results was similar for females where, at age 25, the disparity in HALE between the most and least well-educated groups was 9.4 years, which was 6.0 years more than the corresponding difference in life expectancy. In females aged 75, the difference between educational levels 1 and 4 was quite small at 1.1 years, which was 0.1 years more than the corresponding difference in life expectancy.

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figure 7

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figure 8

The HALE ratios of the most to least well-educated groups, however, were fairly consistent across all ages for both males and females. Across the selected ages, males in the most well-educated group could expect to live 20% to 30% more healthy years than those in the least well-educated group; whereas females in the most well-educated group could expect to live 10% to 20% more healthy years than those in the least well-educated group.

DISCUSSION AND CONCLUSIONS

Comments on Primary Findings

Although universal health insurance was established in Canada almost three decades ago, there is still strong and consistent evidence of socioeconomic disparities in health. The health inequality estimates presented here are novel in that they (1) use Canadian microdata on both mortality and socioeconomic status for a large, representative sample of the Canadian household population aged 25 and older, and (2) integrate morbidity with mortality to provide a more complete picture of population health and its distribution by socioeconomic status. The largest absolute differences in life expectancy by socioeconomic status were found within the younger age groups, and tended to narrow with advancing age. On the basis of this last, one might be initially tempted to conclude that socioeconomic status has progressively less import for mortality as people age, but the observed convergence is linked to the general age-related decline in life expectancy. However, the differences in survival probabilities between the richest and poorest groups widened with advancing age, highlighting the fact that the likelihood of attaining advanced ages varies substantially by socioeconomic status. Thus it is critical to remember that the survival probabilities are complementary to the life expectancy results, demonstrating that the protective effects of higher socioeconomic status against premature mortality indeed become more salient in relation to advancing age.

Regarding health-related quality of life, socioeconomic differentials in mean HUI3 were also significant, but did not increase or decrease monotonically with age in the context of either income or education. Combining health-related quality of life and mortality into HALE demonstrated even larger socioeconomic differentials in health than were shown with respect to life expectancy alone; that is to say, the generally worse morbidity experience of the lower socioeconomic groups augmented the observed health inequalities. These findings are in line with those of other Canadian investigations using both area-level (Health Canada, 2004; Wilkins & Adams, 1983) and individual-level (Nault et al., 1996) indicators of health and socioeconomic status; and are also consistent with numerous studies of socioeconomic differentials in health expectancies conducted in the United

States and Europe (for reviews, see Crimmins & Cambois, 2003; Mackenbach 2006). This information is particularly useful, suggesting that interventions directed at the remediation of both fatal and non-fatal health outcomes have the potential to substantially reduce socioeconomically-driven health disparities in Canada.

Some additional perspective on the magnitude of the present socioeconomic effects on HALE can be provided by comparing them to the HALE impact of specific health conditions. For example, Manuel and his colleagues (Manuel et al., 2003) estimated overall HALE (at birth) and the reductions in HALE caused by selected chronic conditions (e.g., cancer, heart diseases, diabetes) in Canada. It was found that all cancers, which represent the greatest burden of disease in the population, reduced overall HALE at birth from 70.7 to 67.9 years for men (a difference of 2.8 years); and for women, from 73.6 to 71.1 years (a difference of 2.5 years). In contrast, the present analysis has estimated a gap in HALE at age 25 between the richest and poorest deciles of about 11.2 healthy years for males, and 8.9 healthy years for females – between three and four times the impact on HALE of all cancers combined. Because there are some differences in methodology and data sources, our findings and those of Manuel et al. (2003) are not completely comparable. But the methodological differences are unlikely to account for such a large difference in the roles of a major clinical disease, which has been the object of tremendous research and clinical effort for decades (e.g. the "war on cancer" in the U.S. declared in 1971; Howe & Clapp, 2004), and the role of socioeconomic factors, which remain in comparison relatively poorly understood.

Limitations

Despite the methodological strengths of this study and the high policy relevance of the results, there are some limitations that should be kept in mind when interpreting the findings. First, the results of this study cannot be generalized to the entire Canadian population but rather just to the non-institutionalized population aged 25 and older. Future work should investigate ways of incorporating institutional residents – the most disabled segment of the population – in order to get a more comprehensive picture of morbidity and mortality and its relation to socioeconomic status. Second, the CCHS component of the data may reflect a certain element of self-selection, since not everyone contacted to participate in the survey agreed to participate in the survey. Third, the HUI3 data from the CCHS may contain self-report error, and also may not perfectly reflect the health-related quality of life of the 1991 census-mortality cohort; however, a more representative and temporally consistent source of health-related quality of life data was not available.

Fourth, it should be pointed out that application of the Sullivan (1971) method entails the following strong assumptions (for a more extensive discussion, see Palloni, Guillen, Monteverde, Ayuso, & White, 2005): *stationarity* (i.e., temporal stability of age-specific mortality rates and disability prevalences), *homogeneity of risks* (i.e., the mortality risks of disabled and healthy persons are equivalent, or that there is no correlation between mortality and morbidity), and *absence of recovery* (i.e., disabled persons do not return to healthier states). Barandregt (2002) has described how violation of the *homogeneity of risk* assumption could result in underestimation of the variance of HALE using Mathers' (1991) method, which relies on independence of mortality and morbidity. However, given that individual risk functions are not known, it is not possible to estimate the correlation between morbidity and mortality from the data; rather, one would need to be assigned based on judgment. Since no clear evidence existed from which to derive a defensible value, it seemed more prudent to apply Mathers' (1991) approach here and accept some degree of bias. Further, this bias may have been reduced to some degree by assuming *conditional* independence of mortality and morbidity in the current application. That is to say, once we have taken account of age, sex, and socioeconomic status (either income decile or educational attainment group), we assume that there are no further correlations of note between health-related quality of life and mortality risk. (Again, this does not guarantee that all such correlations were accounted for). However, we lacked sufficient data to fully examine the tenability of the *stationarity* and *absence of recovery* assumptions. The cross-sectional nature of the CCHS necessitated that the mortality data from the 10-year follow-up period also be treated as cross-sectional, in order to apply the Sullivan (1971) method for HALE. With a longer observation period, as well as health-related quality of life data corresponding to each year of follow-up, a more dynamic, multi-state approach that would relax these restrictive assumptions could be applied (Palloni et al., 2005; Wolfson, 1994).

In addition, in this analysis, we are implicitly assuming that there is no income mobility over the life course; in other words, that an individual who is in the i^{th} income decile at some age x has been and remains in that group throughout his or her lifetime, with corresponding consistency of exposure to the forces of morbidity and mortality operating within that group. However, since mobility in educational attainment is almost nil, the (admittedly coarser) gradients by education provide some form of benchmark. With sufficient empirical evidence from longitudinal data, socioeconomic transitions could be accommodated within a more sophisticated and flexible statistical framework, such as microsimulation (Palloni et al., 2005; Wolfson, 1994).

Further, it is important to point out that the Sullivan (1971) approach to estimating HALE is a convenient, simplified model for summarizing the morbidity and mortality experience of a given population, and is not intended to perfectly mirror reality – the underlying system of real-world causal forces that generates the observable gradients. As Box and Draper (1987, p.424) stated in their classic work on statistical model building: “Essentially, all models are wrong, but some are useful.” Although life expectancy, survival probabilities, HUI3, and HALE were all found to be associated with the socioeconomic status variables (i.e., income and education) in the current study, we cannot infer causality. For example, it may be the case that educational attainment provides the initial foundation for an individual's lifelong flow or trajectory of income, which in turn sets the stage for risk factor exposure (e.g., lifestyle choices) and culminates in different health outcomes. In a study of the effects of poverty and material hardship on mortality in Finland, Martikainen, Mäkelä, Koskinen, and Valkonen (2001) concluded that a large part of the observed association between income and mortality is not due to a direct causal impact, but is rather a spurious connection due to the mutual dependence of mortality and income on other background factors such as educational attainment and occupational prestige. Certainly, identifying the true causal mechanisms underlying the socioeconomic gradient in health is important from a policy perspective, since the effectiveness of interventions rests on a correct understanding of the forces involved. For example, if the real drivers of health inequalities are differences in educational and occupational status, simply increasing the incomes of the poor would be insufficient to reduce disparities.

Even the general presumption that lower socioeconomic status results in worse morbidity and earlier mortality is open to challenge. An alternative hypothesis, sometimes referred to as "reverse causality", argues instead that poorer health status leads to both lower incomes and to earlier mortality, so that the widely observed inverse associations between socioeconomic status and mortality are in fact the result of an unobserved prior factor in the causal chain (see West, 1991). In Canada, the strongest evidence to date against the "reverse causality" hypothesis remains the Wolfson et al. (1993) study of male, working age public pension plan contributors. In this study, a majority of the population examined had increasing earnings (relative to their cohort average) every year up to age 65, yet amongst this sub-population there remained a significant gradient of post age 65 mortality in relation to earnings over the 45 to 64 age period. It is difficult to imagine an unobserved illness process that could be consistent with increasing relative earnings for over a decade prior to attaining age 65 that at the same time would predispose one to earlier mortality after age 65. (However, it is not known whether the reverse causality hypothesis would have been disconfirmed in other subpopulations). Nevertheless, the current analysis is agnostic with regard to the direction of causality. We are simply providing more detailed and novel estimates of the socioeconomic gradient in health for the Canadian household population age 25 and older.

Despite the aforementioned limitations, the current study still makes an important contribution to the health inequalities literature, demonstrates the value-added of record linkage, and provides important descriptive insights into the state of SES disparities in health in Canada. The present results should be helpful to health policy decision-makers seeking to identify areas in which interventions to reduce health disparities would yield maximal population health benefits.

Future work on health inequalities

There are several avenues for future work to improve on the assessment of health inequalities in the Canadian context. One is to replicate and extend the analyses of Manuel and his colleagues (Manuel et al., 2002, Manuel et al., 2003) on “cause-deleted” HALE – to estimate the effects on HALE of hypothetically eliminating both deaths and morbidity from selected major diseases and injuries. In the first instance, this would enable a strictly comparable assessment of the size of socioeconomic differences in HALE and differences associated with major diseases such as cancer and heart disease. If the comparison noted above, where the socioeconomic differences are 3 to 4 times larger than those associated with all cancers combined, it would reinforce the suggestion that there may be larger payoffs in terms of the overall health of Canadians from better understanding of the socioeconomic determinants of health than further efforts targeted at clinical disease.

Additionally, it should be possible to estimate socioeconomic gradients in HALE for major disease groups, using the census-mortality linked file in conjunction with national health survey data.

There has been little prior research focusing on socioeconomic disparities in summary measures of health *within* populations having particular health conditions; rather, the mortality and morbidity aspects have mainly been examined separately. For example, numerous studies in the US, Europe, Japan, and Australia have demonstrated socioeconomic disparities in survival for persons having various forms of cancer (for a summary, see Dickman, Auvinen, Voutilainen, & Hakulinen, 1998). In Canada, socioeconomic differentials in survival from HIV/AIDS have been investigated (Wood et al., 2002), as well as socioeconomic disparities in self-reported health status in patients with rheumatoid arthritis (Marra, Lynd, Esdaile, Kopec, & Anis, 2004). This work has shown that having a serious health condition does not equalize the mortality and morbidity experiences of patients across socioeconomic strata. However, these latter two studies were conducted with small clinical samples, and it would be useful to extend their approach to a wider variety of health conditions using the larger, nationally representative sample in the census-mortality linked file, as well as integrating the mortality and morbidity impacts of the conditions studied. To the extent that socioeconomic differences in life expectancy and HALE are larger for one disease (e.g. heart disease) than another (e.g. selected cancer sites), this would be an important pointer to more promising areas for research and policy directed toward reducing health disparities.

Finally, these data can form the basis for a more ambitious approach to the measurement of health inequalities, building on ideas proposed by Murray and his colleagues (Gakidou, Murray, & Frank, 2000; Murray, Gakidou, & Frank, 1999), subsequently challenged and recast by Wolfson and Rowe (2001). For the purposes here, Gakidou et al. (2000) proposed two ideas: conceptualizing health inequalities in terms of individuals' lifetime trajectories of health status (including life length or age at death), and using small area data to measure the key parameters underlying the variability in what is essentially individual-level HALE. Wolfson and Rowe (2001) showed that the second idea was wrong, and could not work in practice. However, they also went on to sketch out how the first idea could be operationalized, provided there were appropriate longitudinal data on mortality risks and health status dynamics, both conditioned on socioeconomic status. We now have, with the census-mortality linked file that is one of the foundations of this initial analysis of HALE inequalities in Canada, a key piece of the data required for the Wolfson and Rowe approach to a more complete measure of health inequalities. The other portion, the longitudinal dynamics of health status, can in principle be derived from the National Population Health Survey (NPHS; Tambay & Catlin, 1995; Swain, Catlin, & Beaudet, 1995), albeit with smaller sample sizes than the CCHS. This will be the subject of future work.

In sum, the newly created 1991 census – mortality linkage file has opened a wide range of opportunities for important analysis of the socioeconomic correlates of mortality, and has enabled much more powerful and probing measures of health inequality in Canada. In this analysis, it has shown that the disparities in HALE associated with income and education are larger than those in life expectancy alone, and far surpass the HALE gaps related to major disease groups (e.g., cancer) reported in other studies (Manuel et al., 2002; Manuel et al., 2003). More sophisticated approaches to measuring and modeling health inequalities could lead to new insights on the social forces which generate these inequalities, as well as inform the development of new interventions for directed toward reducing the disparities.

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References

Aronson K, Howe G, Fair M, Carpenter M. *Occupational surveillance in Canada: Cause-specific mortality among workers, 1965 to 1991* (catalogue 84-546-XCB). Ottawa, Statistics Canada, 2000.

Barendregt JJ. *Confidence intervals for health expectancy*. Presented at the 14th meeting of the International Network on Health Expectancy (REVES), Hammamet, Tunisa, April 24-26th, 2002

Béland Y. Canadian community health survey: Methodological overview. *Health Reports* 2002;13(3):9-14.

Belanger A, Martel L, Berthelot JM, Wilkins R. Gender differences in disability-free life expectancy for selected risk factors and chronic conditions in Canada. *J Women Aging* 2002;14:61-83.

Berthelot JM. Health-adjusted life expectancy. In: JM Robine, C Jagger, CD Mathers, EM Crimmins, & RM Suzman (eds.), Determining health expectancies. Chichester, England: Wiley, 2003;235-246.

Boswell-Purdy J, Flanagan WM, Roberge H, Le Petit C, White KJ, Berthelot J-M. Population health impact of cancer in Canada, 2001. Chronic Diseases in Canada 2007; 28(1-2):42-55

Box GEP, Draper NR. *Empirical Model-Building and Response Surfaces*. New York: Wiley, 1987.

Canadian Public Health Association. *Health Impacts of Social and Economic Conditions: Implications for Public Policy*. Ottawa: Canadian Public Health Association, 1997.

Chen J, Beavon D, Wilkins R. Mortality of retired public servants in Canada. *Proceedings of the Social Statistics Section, Annual Meeting of the American Statistical Association*, Chicago, 1996;86-91.

Chiang CL. *The life table and its applications*. Malabar, Florida: Robert E. Krieger, 1984.

Crimmins EM, Cambois E. Social inequalities in health expectancy. In: JM Robine, C Jagger, CD Mathers, EM Crimmins, RM Suzman (eds.), *Determining health expectancies*. Chichester, England: Wiley, 2003;111-125.

Dickman PW, Auvinen A, Voutilainen ET, Hakulinen T. Measuring social class differences in cancer patient survival: Is it necessary to control for social class differences in general population mortality? A Finnish population-based study. *J Epidemiol Community Health* 1998;52:727-734

Feeny D, Furlong W, Torrance GW, Goldsmith CH, Zhu Z, DePauw S, Denton M, Boyle M. Multi-attribute and single-attribute utility functions for the Health Utilities Index Mark 3 system. *Medical Care* 2002;40(2):113-128.

Feeny D. The Health Utilities Index: A tool for assessing health benefits. *Patient Reported Outcomes Newsletter* 2005 Spring;34:2-6.

Gadikou EE, Murray CJL, Frenk J. Defining and measuring health inequality: An approach based on the distribution of health expectancy. *Bulletin of the World Health Organization* 2000;78:42-54.

Havens B. *A case study in sample mortality: The aging in Manitoba longitudinal study*. Paper presented to the Canadian Association on Gerontology. Halifax, October 22, 1988.

Health Canada. *Achieving Health for All: A Framework for Health Promotion* (Catalogue H39-102/1986E). Ottawa: Health Canada, 1986.

Health Canada. *Healthy Canadians: A Federal Report on Comparable Health Indicators 2004*. Ottawa: Health Canada, 2004.

Hirdes JP, Forbes WF. Estimates of the relative risk of mortality based on the Ontario Longitudinal Study of Aging, *Canadian Journal on Aging* 1989;8:222-237.

Horsman J, Furlong W, Feeny D, Torrance G. The Health Utilities Index (HUI®): Concepts, measurement properties and applications. *Health and Quality of Life Outcomes* 2003;1:54.

Howe GR, Lindsay J, Miller AB. Cancer incidence and mortality in relation to occupation in 700,000 members of the Canadian labour force. *Det Prev Cancer* 1980;3:487-497.

Howe GR, Lindsay JP. A follow-up study of a ten-percent sample of the Canadian labour force: Cancer mortality in males, 1965-1973. *J National Cancer Institute* 1983;70:37-44.

Howe GK, Clapp RW. Are we winning or losing the war on cancer? deciphering the propaganda of NCI's 33-year war. *New Solutions: A Journal of Environmental and Occupational Health Policy* 2004;14(2):109-124.

James PD, Wilkins R, Detsky AS, Tugwell P, Manuel DG. Avoidable mortality by neighbourhood income in Canada: 25 years after the establishment of universal health insurance. *Journal of Epidemiology and Community Health* 2007;61:287-296.

Johansen H, Semenciw R, Morrison H, Mao Y, Verdier P, Smith ME, Wigle DT. Important risk factors for death in adults: a 10-year follow-up of the Nutrition Canada Survey cohort. *CMAJ* 1987;136:823-828.

Jordan-Simpson DA, Fair ME, Poliquin C. Canadian farm operators study: methodology. *Health Reports* 1990;2(2):141-155.

Mackenbach JP. *Health Inequalities: Europe in Profile*. COI, London, 2006.

Manuel DG, Schultz SE, Kopec JA. Measuring the health burden of chronic disease and injury using health-adjusted life expectancy and the Health Utilities Index. *J. Epidemiol. Community Health* 2002;56:843-850.

Manuel DG, Luo W, Ugnat A-M, Mao Y. Cause-deleted health-adjusted life expectancy of Canadians with selected chronic conditions. Chronic Diseases in Canada 2003;24(4): 108-115.

Manuel DG, Schultz SE. Using linked data to calculate summary measures of population health: health-adjusted life expectancy of people with Diabetes Mellitus. *Population Health Metrics* 2004;2:4.

Marra CA, Lynd LD, Esdaile JM, Kopec J, Anis AH. The impact of low family income on self-reported health outcomes in patients with rheumatoid arthritis within a publicly funded health-care environment. *Rheumatology* 2004;43:1390-1397

Martel L, Bélanger A. An analysis of the change in dependence-free life expectancy in Canada between 1986 and 1996. *In* Bélanger A, Gilbert S, *Report on the Demographic Situation in Canada 1998-1999* (Current Demographic Analysis, Statistics Canada catalogue 91-209-XPE). Ottawa, Minister of Industry, 1999;164-186 (and Erratum).

Martikainen P, Mäkelä P, Koskinen S, Valkonen T. Income differences in mortality: A registry-based follow-up of three million men and women. *International Journal of Epidemiology* 2001;30:1397-1405.

Mathers C. *Health expectancies in Australia 1981 and 1988*. Canberra: Australian Institute of Health and Welfare, AGPS, 1991.

Mathers CD, Iburg KM, Salomon JA Tandon A, Chatterji S, Ustün B, Murray CJL. Global patterns of healthy life expectancy in the year 2002. *BMC Public Health* 2004;4:66.

Mayer F, Ross N, Berthelot JM, Wilkins R. Disability-free life expectancy by health region. Health Reports 2002;13(4):49-60.

Mhatre SL, Deber RD. From equal access to health care to equitable access to health. *International Journal of Health Services* 1992;22(4):645-668.

Murray CJL, Gadikou EE, Frenk J. Health inequalities and social group differences: What should we measure? *Bulletin of the World Health Organization* 1999;77:537-543.

Murray CJL, Salomon JA, Mathers CD, Lopez AD. (eds). Summary measuresof population health: Concepts, ethics, measurement and applications. Geneva: World Health Organization, 2002.

Mustard CA, Derksen S, Berthelot J-M, Wolfson MC, & Roos LL. Age-specific education and income gradients in morbidity and mortality in a Canadian province. *Social Science and Medicine* 1997;45(3):383-397.

Mustard CA, Derksen S Berthelot J-M, Wolfson M. Assessing ecologic proxies for household income: a comparison of household and neighbourhood level income measures in the study of population health status *Health and Place* 1999;5(2):157-171.

Nault F, Roberge R, Berthelot JM. Espérance de vie et espérance en santé selon le sexe, l'état matrimonial et le statut socio-économique au Canada. *Cahiers Québécois de Démographie* 1996;25(2):241–259.

Palloni A, Guillen M, Monteverde M, Ayuso M, White R. *A microsimulation model to estimate errors in cross-sectional estimates of life expectancy in disability*. Paper presented at the Population Association of America Meetings, Philadelphia, March 31-April 3, 2005

Rao JNK, Wu CFJ. Resampling inference with complex survey data. *Journal of the American Statistical Association* 1988;83:231-241.

Rao JNK, Wu CFJ, Yue K. Some recent work on resampling methods. *Survey Methodology* 1992;18:209-217.

Riley JC. *Rising Life Expectancy: A Global History*. Cambridge, MA: Cambridge University Press, 2001.

Robine J-M, Jagger C, Mathers CD, Crimmins EM, Suzman RM. (eds). Determining Health Expectancies. Chichester, England: Wiley, 2003.

Roos LL, Magoon J, Gupta S, Chateau D, Veugelers PJ. Socioeconomic determinants of mortality in two Canadian provinces: multilevel modelling and neighborhood context. *Social Science and Medicine* 2004;59(7):1435-47.

Statistics Canada. 1991 Census Dictionary. POPLINE Document Number: 241233. Ottawa: Statistics Canada, 1992.

Statistics Canada. Canadian Community Health Survey (CCHS): Questionnaire for Cycle 1.1. Ottawa: Statistics Canada, 2002. Available at: http://www.statcan.ca/english/sdds/instrument/3226_Q1_V1_E.pdf

Sullivan DF. A single index of mortality and morbidity. *HSMHA Health Reports* 1971;86:347-354.

Swain L, Catlin G, Beaudet MP. The National Population Health Survey – Its longitudinal nature. *Health Reports*, 1999 Spring;10(4):69-81.

Tambay JL, Catlin G. Sample design of the National Population Health Survey. *Health Reports* 1995;7(1):29-38.

West P. Rethinking the health selection explanation for health inequalities. *Social Science and Medicine* 1991;32:337-384.

Wigle DT, Mao Y, Arraiz G. Mortality follow-up study: Results from the Canada Health Survey. Abstract. *Chronic Diseases in Canada* 1989;10(4):

Wigle DT, Semenciw RM, Wilkins K, Riedel D, Ritter L, Morrison HI, Mao Y. Mortality study of Canadian male farm operators: non-Hodgkin's lymphoma mortality and agricultural practices in Saskatchewan. *J National Cancer Institute* 1990;82(7):575-582.

Wilkins R, Adams O. *The Healthfulness of Life: A Unified View of Mortality, Institutionalization and Non-Institutionalized Disability in Canada, 1978*. Montreal: Institute for Research on Public Policy, 1983.

Wilkins R, Berthelot JM, Ng E. Trends in mortality by neighbourhood income in urban Canada from 1971 to 1996. *Health Reports* 2002;13 (Supplement):45-71.

Wilkins R, Tjepkema M, Mustard CA, Choinière R. The 1991 census mortality follow-up study: Cohort mortality by individual, family, household and neighbourhood characteristics, based on a 15% sample of the Canadian adult population. Forthcoming in *Health Reports*.

Wolfson MC, Rowe G, Gentleman JF, Tomiak M. Career earnings and death: a longitudinal analysis of older Canadian men. *Journal of Gerontology: Social Sciences* 1993;49(4):5167-5179.

Wolfson MC. POHEM – A framework for understanding and modeling the health of populations. *World Health Statistics Quarterly* 1994;47:157-176.

Wolfson MC. Health-adjusted life expectancy. *Health Reports* 1996;8(1):41-46.

Wolfson MC, Rowe G. On measuring inequalities in health. *Bulletin of the World Health Organization* 2001;79(6):553-560.

Wood E, Montaner JS, Chan K, Tyndall MW, Schechter MT, Bangsberg D, O'Shaughnessy MV, Hogg RS. Socioeconomic status, access to triple therapy, and survival from HIV-disease since 1996. *AIDS* 2002;16(15):2065-2072.

Table 1: Sample Sizes for Explanatory Variables, 1991 Census-Mortality Follow-up Study and Corresponding Weighted Population Estimates, 2000 – 2001 Canadian Community Health Survey

Variable	Counts (%)[1]	
	1991 CMF[2]	2000 – 2001 CCHS[3]
Sex		
Male	1,358,400 (49.7)	12.71 (49.2)
Female	1,376,800 (50.3)	13.10 (50.8)
Missing		--
Age groups (yrs)		
25-34	772,400 (28.2)	4.17 (20.4)
35-44	718,500 (26.3)	5.32 (26.0)
45-54	469,600 (17.2)	4.45 (21.8)
55-64	352,200 (12.9)	2.84 (13.9)
65-74	272,000 (9.9)	2.16 (10.6)
75+	150,400 (5.5)	1.50 (7.3)
Missing	--	--
Income deciles		
D1 (poorest)	226,600 (8.3)	2.02 (7.8)
D2	238,700 (8.7)	2.02 (7.8)
D3	256,500 (9.4)	2.02 (7.8)
D4	269,600 (9.9)	1.93 (7.5)
D5	276,500 (10.1)	1.94 (7.5)
D6	279,000 (10.2)	2.20 (8.5)
D7	283,300 (10.4)	1.79 (6.9)
D8	286,400 (10.5)	2.24 (8.7)
D9	289,300 (10.6)	2.03 (7.9)
D10 (richest)	289,800 (10.6)	2.05 (7.9)
Missing	39,600 (1.4)[4]	5.56 (21.5)
Educational level		
E1	953,500 (34.9)	7.55 (29.3)
E2	994,500 (36.4)	9.47 (36.7)
E3	421,400 (15.4)	4.53 (17.5)
E4	365,800 (13.4)	4.03 (15.6)
Missing	--	.22 (0.8)

Note. Deciles are based on the ratio: total household income (CCHS) or economic family income (census)/equivalent person unit. The first person in the household is given a weight of 1.0; the second, 0.40; and each of the remaining household (CCHS) or economic family (census) members, 0.30. D1 = poorest decile; D10 = richest decile. Educational attainment categories are: E1 = less than high school graduation; E2 = high school graduation or trades qualification; E3 = post-secondary certificate or diploma (short of a university Bachelor's degree); and E4 = university degree (Bachelor's or higher). CMF = 1991census-mortality follow-up; CCHS = Canadian Community Health Survey.
[1] Percentages may not add up to 100% due to rounding.
[2] Unweighted cohort rounded to nearest 100 (percentages calculated prior to rounding).
[3] Weighted to reflect population size, expressed in millions.
[4] Individual income information was available, but economic family size information was

not applicable to most persons living in non-institutional collective dwellings (such as rooming houses and religious convents), so the equivalent person unit, and thus the income decile, could not be determined for such persons.
Data Source: 1991 census-mortality follow-up; 2000 – 2001 Canadian Community Health Survey.

Table 2: Life Expectancy by Income Decile at ages 25-75 yrs, Males (95% Confidence intervals in parentheses)

Income Decile	Exact Age					
	25	35	45	55	65	75
D1	48.6 (48.3, 48.8)	39.4 (39.1, 39.6)	30.3 (30.1, 30.6)	22.1 (21.9, 22.3)	15.4 (15.1, 15.6)	10.0 (9.7, 10.3)
D2	49.6 (49.4, 49.8)	40.3 (40.1, 40.5)	31.0 (30.9, 31.2)	22.3 (22.2, 22.5)	15.1 (15.0, 15.2)	9.7 (9.6, 9.8)
D3	51.1 (50.9, 51.3)	41.7 (41.5, 41.9)	32.3 (32.2, 32.5)	23.5 (23.3, 23.6)	16.0 (15.9, 16.1)	10.1 (10.0, 10.2)
D4	52.1 (51.9, 52.3)	42.5 (42.4, 42.7)	33.1 (32.9, 33.2)	24.2 (24.0, 24.3)	16.5 (16.4, 16.7)	10.4 (10.3, 10.5)
D5	52.9 (52.7, 53.1)	43.3 (43.2, 43.5)	33.8 (33.6, 34.0)	24.7 (24.6, 24.9)	16.9 (16.7, 17.0)	10.6 (10.5, 10.8)
D6	53.1 (52.9, 53.3)	43.5 (43.3, 43.7)	34.0 (33.9, 34.2)	25.0 (24.8, 25.2)	17.0 (16.9, 17.2)	10.6 (10.5, 10.8)
D7	53.8 (53.6, 54.0)	44.2 (44.0, 44.4)	34.7 (34.5, 34.9)	25.6 (25.5, 25.8)	17.6 (17.5, 17.8)	11.1 (10.9, 11.2)
D8	54.3 (54.1, 54.5)	44.7 (44.5, 44.8)	35.1 (34.9, 35.3)	26.0 (25.8, 26.2)	17.8 (17.6, 18.0)	11.1 (11.0, 11.3)
D9	54.8 (54.6, 54.9)	45.1 (44.9, 45.2)	35.5 (35.3, 35.7)	26.3 (26.2, 26.5)	18.0 (17.8, 18.2)	11.1 (10.9, 11.3)
D10	55.9 (55.7, 56.1)	46.3 (46.1, 46.5)	36.7 (36.5, 36.8)	27.4 (27.3, 27.6)	19.0 (18.8, 19.1)	11.7 (11.5, 11.9)
D10 – D1	7.3 (7.0, 7.6)	6.9 (6.6, 7.2)	6.3 (6.1, 6.6)	5.4 (5.1, 5.7)	3.6 (3.3, 3.9)	1.7 (1.3, 2.0)
D10/D1	1.2 (1.1, 1.2)	1.2 (1.2, 1.2)	1.2 (1.2, 1.2)	1.2 (1.2, 1.3)	1.2 (1.2, 1.3)	1.2 (1.1, 1.2)

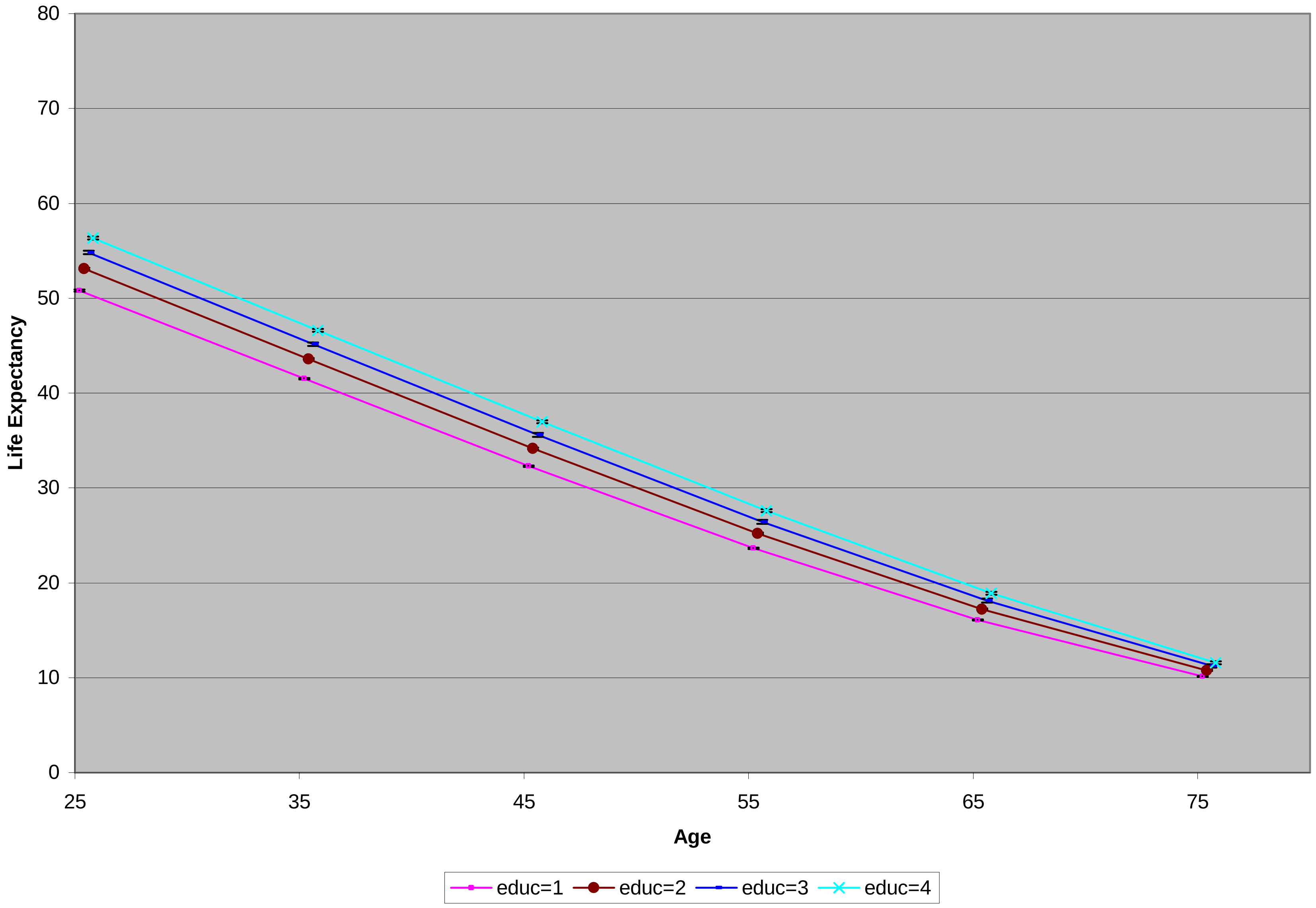
Note. Deciles are based on the ratio: total household income (CCHS) or economic family income (census)/equivalent person unit. The first person in the household is given a weight of 1.0; the second, 0.40; and each of the remaining household (CCHS) or economic family (census) members, 0.30. D1 = poorest decile; D10 = richest decile. 95% confidence intervals are in parentheses.
Data Source: 1991 census-mortality follow-up with deaths through 2001.

Table 3: Life Expectancy by Income Decile at ages 25-75 yrs, Females (95% Confidence intervals in parentheses)

Income Decile	Exact Age					
	25	35	45	55	65	75
D1	55.4 (55.2, 55.7)	45.8 (45.6, 46.0)	36.5 (36.3, 36.7)	27.8 (27.6, 28.0)	20.1 (19.9, 20.3)	13.4 (13.2, 13.6)
D2	56.4 (56.3, 56.6)	46.7 (46.5, 46.9)	37.2 (37.0, 37.4)	28.3 (28.1, 28.4)	20.1 (20.0, 20.2)	13.1 (13.0, 13.2)
D3	57.6 (57.4, 57.8)	47.8 (47.9, 48.0)	38.3 (38.1, 38.4)	29.1 (28.9, 29.2)	20.8 (20.7, 20.9)	13.4 (13.3, 13.5)
D4	58.5 (58.3, 58.7)	48.7 (48.5, 48.9)	39.1 (38.9, 39.2)	29.8 (29.7, 30.0)	21.4 (21.2, 21.5)	13.8 (13.7, 13.9)
D5	58.7 (58.5, 58.9)	48.9 (48.7, 49.1)	39.3 (39.1, 39.4)	30.0 (29.8, 30.2)	21.4 (21.2, 21.5)	13.7 (13.5, 13.8)
D6	59.1 (58.9, 59.3)	49.2 (49.0, 49.4)	39.6 (39.4, 39.7)	30.2 (30.0, 30.4)	21.5 (21.4, 21.7)	13.8 (13.6, 13.9)
D7	59.2 (59.0, 59.4)	49.4 (49.2, 49.5)	39.7 (39.5, 39.9)	30.4 (30.2, 30.6)	21.6 (21.4, 21.8)	13.7 (13.6, 13.9)
D8	59.4 (59.2, 59.6)	49.5 (49.3, 49.7)	39.8 (39.6, 40.0)	30.5 (30.3, 30.7)	21.7 (21.5, 21.9)	13.8 (13.6, 14.0)
D9	59.9 (59.7, 60.1)	50.0 (49.8, 50.2)	40.3 (40.1, 40.5)	30.9 (30.7, 31.1)	22.1 (21.9, 22.3)	14.0 (13.8, 14.2)
D10	60.2 (60.0, 60.4)	50.4 (50.2, 50.6)	40.7 (40.5, 40.9)	31.2 (31.1, 31.4)	22.3 (22.1, 22.5)	14.1 (14.0, 14.3)
D10 – D1	4.8 (4.5, 5.1)	4.6 (4.3, 4.8)	4.2 (3.9, 4.5)	3.4 (3.2, 3.7)	2.2 (1.9, 2.5)	0.7 (0.5, 1.0)
D10/D1	1.1 (1.1, 1.1)	1.1 (1.1, 1.1)	1.1 (1.1, 1.1)	1.1 (1.1, 1.1)	1.1 (1.1, 1.1)	1.1 (1.0, 1.1)

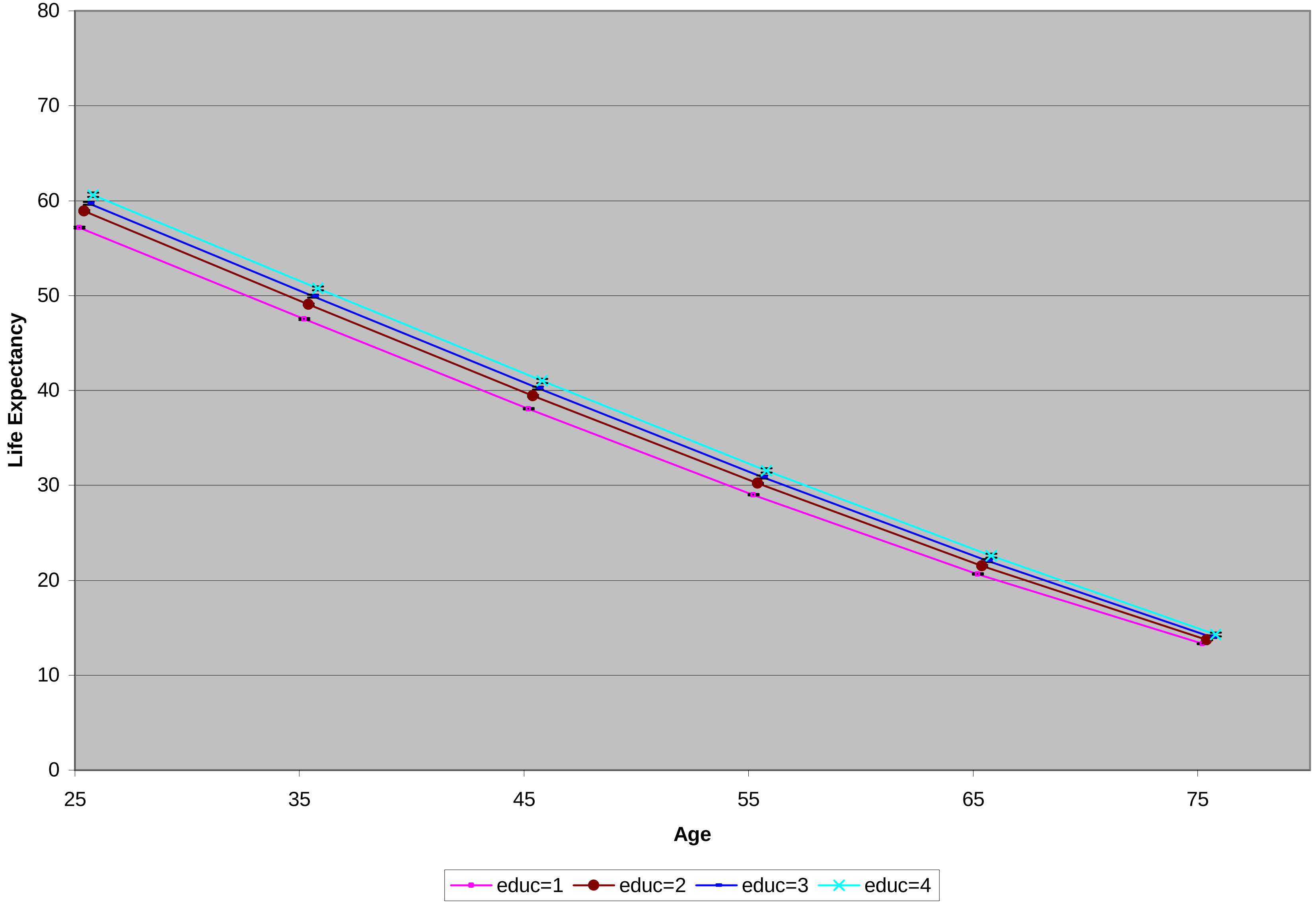
Note. Deciles are based on the ratio: total household income (CCHS) or economic family income (census)/equivalent person unit. The first person in the household is given a weight of 1.0; the second, 0.40; and each of the remaining household (CCHS) or economic family (census) members, 0.30. D1 = poorest decile; D10 = richest decile. 95% confidence intervals are in parentheses.
Data Source: 1991 census-mortality follow-up with deaths through 2001.

Figure 1: Life Expectancy by Educational Attainment at ages 25-75 yrs, Males (95% Confidence intervals included)



Note. E1 = less than high school graduation; E2 = high school graduation or trades qualification; E3 = post-secondary certificate or diploma (short of a university Bachelor's degree); and E4 = university degree (Bachelor's or higher).
Data Source: 1991 census-mortality follow-up with deaths through 2001.

Figure 2: Life Expectancy by Educational Attainment at ages 25-75 yrs, Females (95% Confidence intervals included)



Note. E1 = less than high school graduation; E2 = high school graduation or trades qualification; E3 = post-secondary certificate or diploma (short of a university Bachelor's degree); and E4 = university degree (Bachelor's or higher).
Data Source: 1991 census-mortality follow-up with deaths through 2001.

Table 4: Survival Probabilities by Income Decile at ages 25-75 yrs, Males (95% Confidence intervals in parentheses)

Income Decile	Exact Age					
	25[1]	35	45	55	65	75
D1	1.0	0.982 (0.980, 0.984)	0.955 (0.952, 0.958)	0.892 (0.888, 0.896)	0.745 (0.738, 0.751)	0.512 (0.504, 0.521)
D2	1.0	0.984 (0.982, 0.987)	0.964 (0.961, 0.967)	0.917 (0.913, 0.922)	0.786 (0.779, 0.794)	0.536 (0.527, 0.545)
D3	1.0	0.988 (0.986, 0.990)	0.971 (0.969, 0.973)	0.931 (0.927, 0.934)	0.818 (0.812, 0.824)	0.587 (0.580, 0.595)
D4	1.0	0.990 (0.989, 0.992)	0.976 (0.974, 0.978)	0.939 (0.936, 0.942)	0.833 (0.828, 0.839)	0.617 (0.610, 0.624)
D5	1.0	0.990 (0.989, 0.992)	0.978 (0.976, 0.980)	0.947 (0.944, 0.950)	0.851 (0.847, 0.856)	0.642 (0.635, 0.649)
D6	1.0	0.991 (0.990, 0.993)	0.979 (0.977, 0.980)	0.946 (0.943, 0.948)	0.855 (0.851, 0.860)	0.654 (0.647, 0.661)
D7	1.0	0.991 (0.990, 0.993)	0.979 (0.977, 0.982)	0.948 (0.946, 0.951)	0.863 (0.858, 0.867)	0.673 (0.666, 0.679)
D8	1.0	0.993 (0.992, 0.994)	0.981 (0.980, 0.983)	0.953 (0.951, 0.955)	0.876 (0.872, 0.879)	0.691 (0.872, 0.879)
D9	1.0	0.994 (0.993, 0.995)	0.983 (0.982, 0.985)	0.956 (0.954, 0.958)	0.885 (0.881, 0.888)	0.709 (0.703, 0.715)
D10	1.0	0.993 (0.991, 0.994)	0.983 (0.982, 0.985)	0.960 (0.958, 0.962)	0.898 (0.895, 0.901)	0.746 (0.740, 0.751)
D10 – D1	0	0.010 (0.008, 0.013)	0.029 (0.025, 0.032)	0.068 (0.063, 0.073)	0.153 (0.146, 0.161)	0.233 (0.223, 0.243)
D10/D1	1	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)	1.1 (1.1, 1.1)	1.2 (1.2, 1.2)	1.5 (1.4, 1.5)

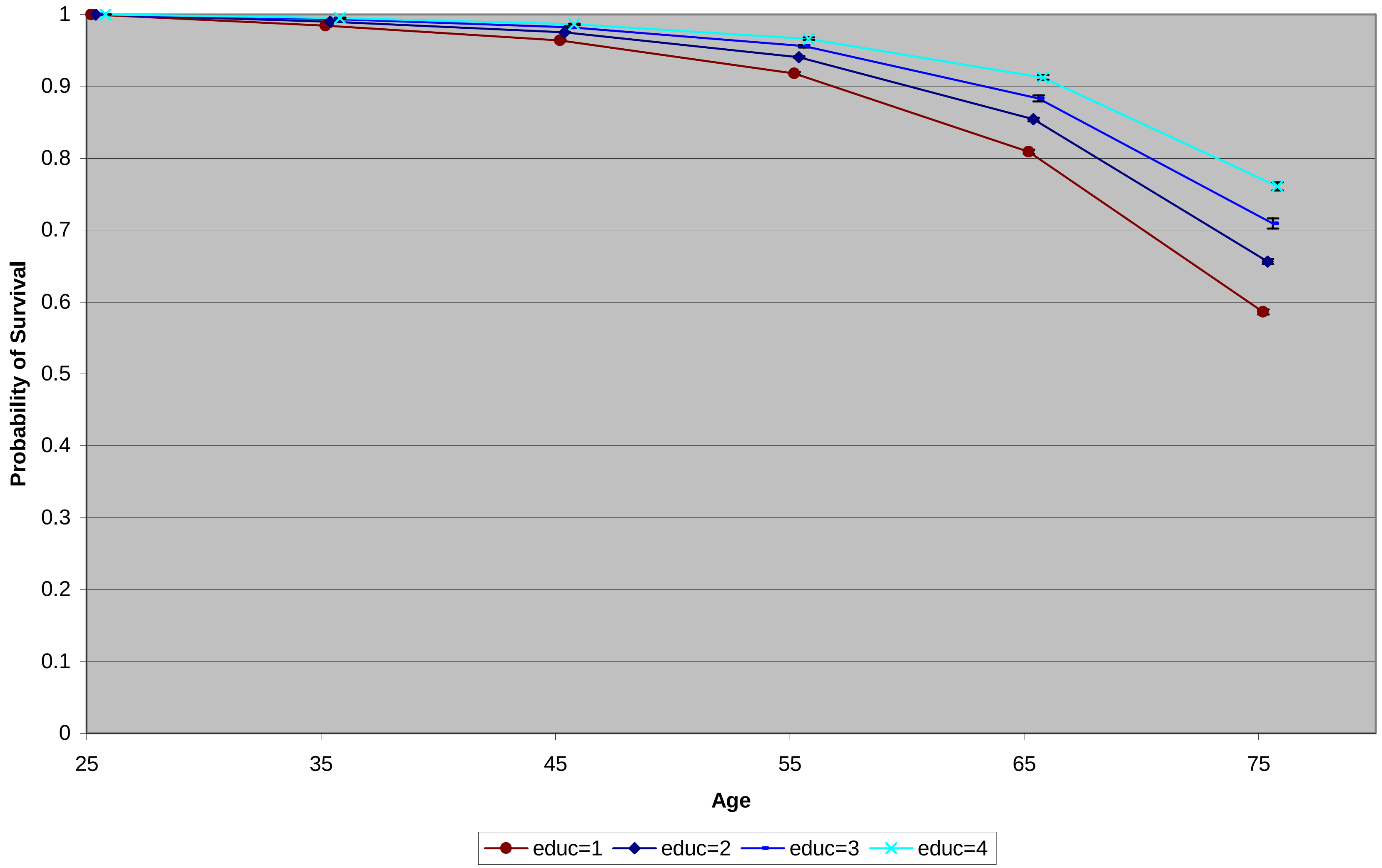
Note. Deciles are based on the ratio: total household income (CCHS) or economic family income (census)/equivalent person unit. The first person in the household is given a weight of 1.0; the second, 0.40; and each of the remaining household (CCHS) or economic family (census) members, 0.30. D1 = poorest decile; D10 = richest decile. 95% confidence intervals are in parentheses.
Data Source: 1991 census-mortality follow-up with deaths through 2001.

Table 5: Survival Probabilities by Income Decile at ages 25-75 yrs, Females (95% Confidence intervals in parentheses)

Income Decile	Exact Age					
	25[1]	35	45	55	65	75
D1	1.0	0.992 (0.991, 0.994)	0.976 (0.975, 0.978)	0.937 (0.934, 0.939)	0.850 (0.845, 0.855)	0.694 (0.687, 0.701)
D2	1.0	0.995 (0.994, 0.996)	0.983 (0.982, 0.985)	0.951 (0.948, 0.954)	0.880 (0.874, 0.885)	0.731 (0.724, 0.738)
D3	1.0	0.995 (0.994, 0.996)	0.985 (0.984, 0.987)	0.962 (0.959, 0.964)	0.896 (0.892, 0.901)	0.766 (0.759, 0.772)
D4	1.0	0.996 (0.995, 0.997)	0.988 (0.986, 0.989)	0.965 (0.963, 0.967)	0.908 (0.904, 0.913)	0.789 (0.783, 0.795)
D5	1.0	0.997 (0.996, 0.997)	0.989 (0.987, 0.990)	0.967 (0.965, 0.969)	0.915 (0.912, 0.919)	0.801 (0.795, 0.807)
D6	1.0	0.997 (0.996, 0.998)	0.990 (0.989, 0.991)	0.971 (0.969, 0.973)	0.921 (0.917, 0.924)	0.808 (0.802, 0.814)
D7	1.0	0.997 (0.997, 0.998)	0.990 (0.989, 0.991)	0.970 (0.969, 0.972)	0.924 (0.921, 0.927)	0.817 (0.811, 0.823)
D8	1.0	0.997 (0.996, 0.998)	0.991 (0.990, 0.992)	0.972 (0.970, 0.973)	0.926 (0.922, 0.929)	0.820 (0.814, 0.826)
D9	1.0	0.997 (0.996, 0.998)	0.990 (0.989, 0.992)	0.973 (0.971, 0.975)	0.932 (0.929, 0.935)	0.834 (0.828, 0.839)
D10	1.0	0.997 (0.996, 0.998)	0.991 (0.989, 0.992)	0.975 (0.973, 0.977)	0.937 (0.934, 0.940)	0.844 (0.839, 0.850)
D10 – D1	0	0.004 (0.003, 0.006)	0.014 (0.012, 0.016)	0.038 (0.035, 0.042)	0.087 (0.082, 0.092)	0.150 (0.142, 0.159)
D10/D1	1	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)	1.1 (1.1, 1.1)	1.2 (1.2, 1.2)

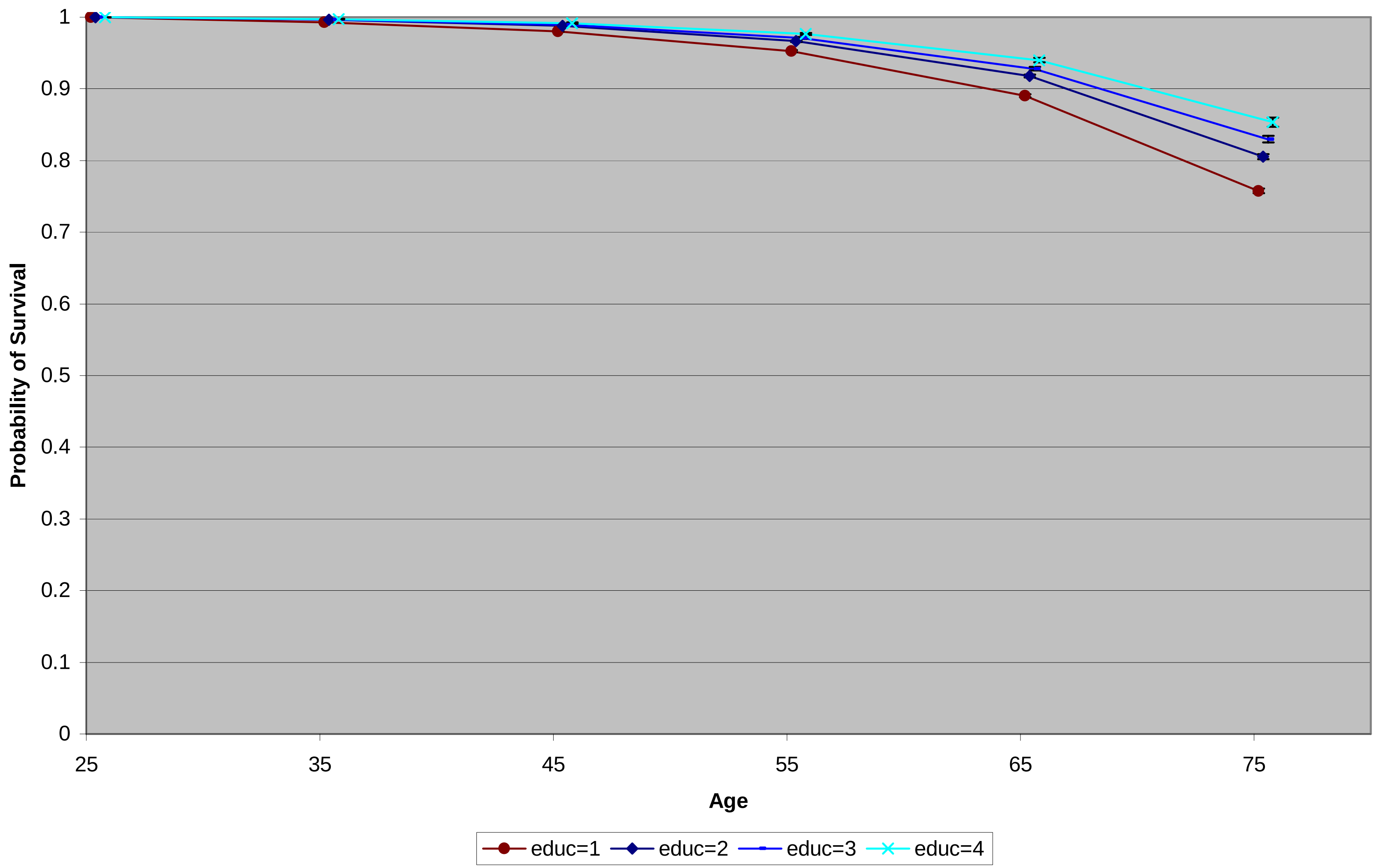
Note. Deciles are based on the ratio: total household income (CCHS) or economic family income (census)/equivalent person unit. The first person in the household is given a weight of 1.0; the second, 0.40; and each of the remaining household (CCHS) or economic family (census) members, 0.30. D1 = poorest decile; D10 = richest decile. 95% confidence intervals are in parentheses.
Data Source: 1991 census-mortality follow-up with deaths through 2001.
[1] Survivorship is perfect by construction.

Figure 3: Survival Probabilities by Educational Attainment at ages 25-75 yrs, Males (95% Confidence intervals included)


1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Probability of Survival
25
35
45
55
65
75
Age
educ=1
educ=2
educ=3
educ=4

Note. Survival to age 25 is perfect by construction. E1 = less than high school graduation; E2 = high school graduation or trades qualification; E3 = post-secondary certificate or diploma (short of a university Bachelor's degree); and E4 = university degree (Bachelor's or higher).
Data Source: 1991 census-mortality follow-up with deaths through 2001.

Figure 4: Survival Probabilities by Educational Attainment at ages 25-75 yrs, Females (95% Confidence intervals included)



Note. Survival to age 25 is perfect by construction. E1 = less than high school graduation; E2 = high school graduation or trades qualification; E3 = post-secondary certificate or diploma (short of a university Bachelor's degree); and E4 = university degree (Bachelor's or higher).
Data Source: 1991 census-mortality follow-up with deaths through 2001.

Table 6: Mean HUI3 by Income Decile and age group, Males (95% Confidence intervals in parentheses)

Income Decile	Age Group					
	25-34	35-44	45-54	55-64	65-74	75+
missing income	0.900 (0.883, 0.917)	0.899 (0.889, 0.910)	0.882 (0.870, 0.894)	0.858 (0.841, 0.875)	0.835 (0.818, 0.852)	0.716 (0.688, 0.744)
D1	0.864 (0.841, 0.886)	0.812 (0.787, 0.837)	0.767 (0.736, 0.798)	0.712 (0.670, 0.754)	0.721 (0.656, 0.786)	0.662 (0.557, 0.768)
D2	0.893 (0.874, 0.913)	0.864 (0.844, 0.883)	0.832 (0.807, 0.856)	0.770 (0.731, 0.810)	0.784 (0.752, 0.816)	0.655 (0.600, 0.710)
D3	0.907 (0.889, 0.925)	0.870 (0.853, 0.888)	0.832 (0.801, 0.862)	0.810 (0.779, 0.840)	0.788 (0.762, 0.814)	0.692 (0.644, 0.741)
D4	0.922 (0.909, 0.935)	0.910 (0.895, 0.924)	0.884 (0.865, 0.903)	0.846 (0.817, 0.874)	0.835 (0.808, 0.862)	0.733 (0.698, 0.769)
D5	0.922 (0.906, 0.937)	0.915 (0.903, 0.926)	0.867 (0.843, 0.892)	0.826 (0.794, 0.857)	0.831 (0.804, 0.858)	0.733 (0.692, 0.773)
D6	0.933 (0.922, 0.944)	0.918 (0.908, 0.929)	0.892 (0.878, 0.906)	0.871 (0.851, 0.892)	0.853 (0.825, 0.882)	0.753 (0.706, 0.800)
D7	0.927 (0.915, 0.939)	0.918 (0.906, 0.930)	0.889 (0.875, 0.902)	0.899 (0.884, 0.914)	0.838 (0.801, 0.875)	0.731 (0.681, 0.782)
D8	0.938 (0.928, 0.947)	0.924 (0.914, 0.933)	0.910 (0.900, 0.920)	0.887 (0.871, 0.903)	0.875 (0.853, 0.898)	0.767 (0.722, 0.811)
D9	0.936 (0.920, 0.951)	0.935 (0.927, 0.943)	0.909 (0.898, 0.919)	0.884 (0.865, 0.903)	0.871 (0.847, 0.896)	0.779 (0.734, 0.824)
D10	0.951 (0.942, 0.959)	0.932 (0.923, 0.941)	0.909 (0.899, 0.918)	0.916 (0.907, 0.925)	0.896 (0.872, 0.920)	0.815 (0.774, 0.856)
D10 – D1	0.087 (0.063, 0.111)	0.120 (0.094, 0.147)	0.141 (0.109, 0.174)	0.204 (0.161, 0.247)	0.175 (0.105, 0.244)	0.153 (0.039, 0.266)
D10/D1	1.1 (1.1, 1.1)	1.1 (1.1, 1.2)	1.2 (1.2, 1.2)	1.3 (1.2, 1.4)	1.2 (1.1, 1.4)	1.2 (1.0, 1.5)

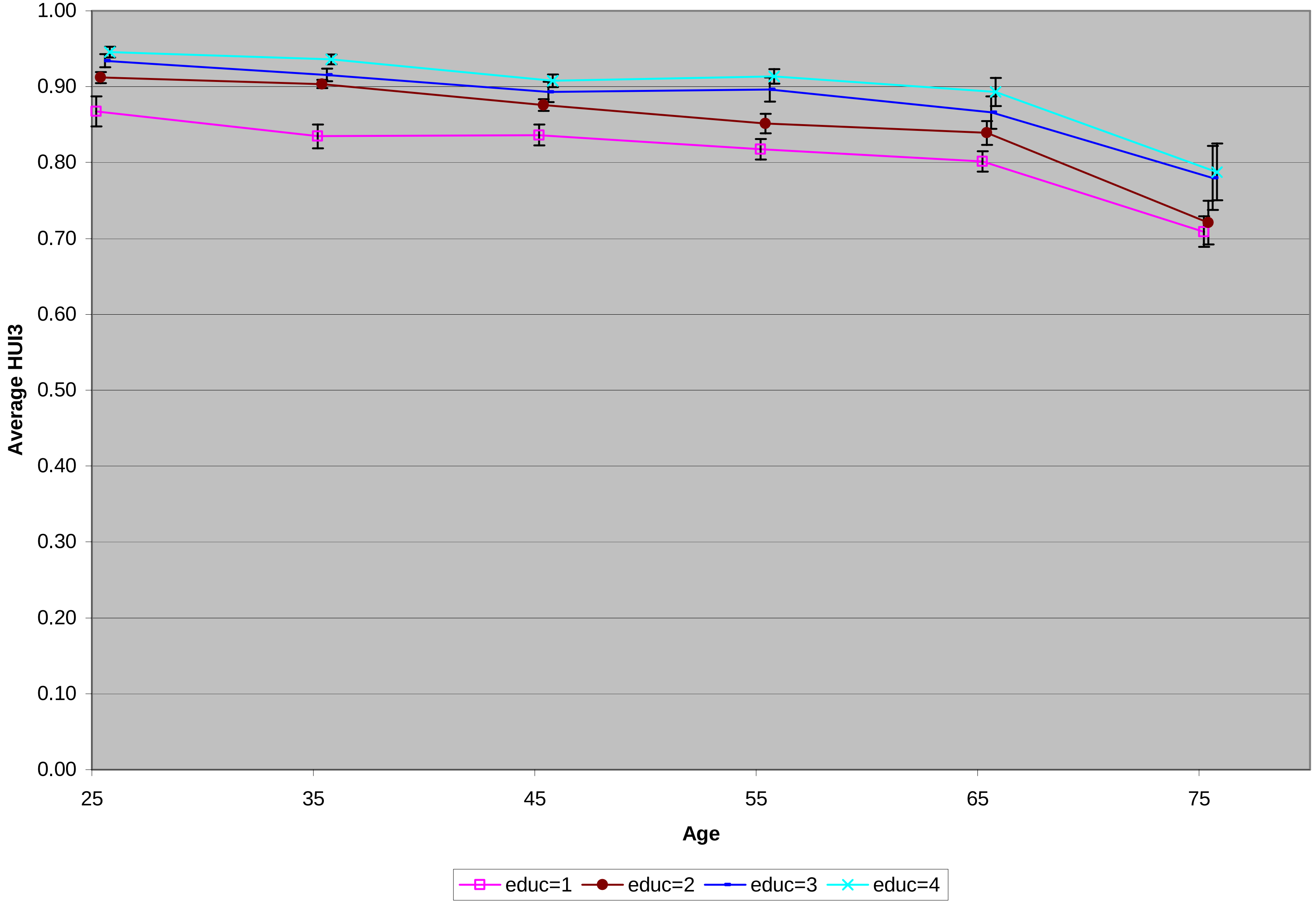
Note. Deciles are based on the ratio: total household income (CCHS) or economic family income (census)/equivalent person unit. The first person in the household is given a weight of 1.0; the second, 0.40; and each of the remaining household (CCHS) or economic family (census) members, 0.30. D1 = poorest decile; D10 = richest decile. 95% confidence intervals are in parentheses.
Data Source: 2000 – 2001 Canadian Community Health Survey.

Table 7: Mean HUI3 by Income Decile and age group, Females (95% Confidence intervals in parentheses)

Income Decile	Age Group					
	25-34	35-44	45-54	55-64	65-74	75+
missing income	0.902 (0.890, 0.914)	0.886 (0.876, 0.897)	0.865 (0.855, 0.876)	0.849 (0.837, 0.862)	0.834 (0.822, 0.846)	0.699 (0.678, 0.721)
D1	0.865 (0.850, 0.879)	0.802 (0.779, 0.825)	0.773 (0.745, 0.801)	0.758 (0.722; 0.795)	0.753 (0.699, 0.806)	0.624 (0.548, 0.701)
D2	0.885 (0.870, 0.900)	0.847 (0.830, 0.864)	0.780 (0.754, 0.806)	0.760 (0.730, 0.790)	0.785 (0.762, 0.809)	0.676 (0.650, 0.702)
D3	0.892 (0.870, 0.914)	0.884 (0.869, 0.899)	0.821 (0.796, 0.846)	0.831 (0.803, 0.859)	0.810 (0.787, 0.833)	0.692 (0.660, 0.723)
D4	0.905 (0.889, 0.920)	0.887 (0.870, 0.904)	0.826 (0.790, 0.862)	0.839 (0.813, 0.864)	0.841 (0.819, 0.862)	0.708 (0.662, 0.754)
D5	0.913 (0.898, 0.927)	0.905 (0.895, 0.916)	0.870 (0.850, 0.890)	0.862 (0.840, 0.884)	0.826 (0.797, 0.855)	0.725 (0.685, 0.765)
D6	0.915 (0.904, 0.926)	0.904 (0.893, 0.915)	0.886 (0.873, 0.899)	0.859 (0.832, 0.886)	0.819 (0.784, 0.855)	0.728 (0.669, 0.788)
D7	0.930 (0.919, 0.942)	0.914 (0.902, 0.925)	0.882 (0.866, 0.898)	0.874 (0.853, 0.894)	0.829 (0.802, 0.857)	0.750 (0.693, 0.807)
D8	0.925 (0.911, 0.939)	0.922 (0.912, 0.931)	0.886 (0.873, 0.900)	0.865 (0.846, 0.884)	0.851 (0.819, 0.883)	0.714 (0.648, 0.780)
D9	0.935 (0.925, 0.945)	0.915 (0.904, 0.926)	0.896 (0.885, 0.908)	0.875 (0.853, 0.896)	0.890 (0.866, 0.914)	0.731 (0.641, 0.820)
D10	0.943 (0.933, 0.953)	0.924 (0.913, 0.935)	0.901 (0.889, 0.912)	0.896 (0.879, 0.913)	0.874 (0.834, 0.913)	0.703 (0.628, 0.777)
D10 – D1	0.078 (0.060, 0.096)	0.122 (0.096, 0.148)	0.128 (0.098, 0.158)	0.138 (0.097, 0.178)	0.121 (0.054, 0.187)	0.078 (-0.029, 0.185)
D10/D1	1.1 (1.1, 1.1)	1.2 (1.1, 1.2)	1.2 (1.1, 1.2)	1.2 (1.1, 1.3)	1.2 (1.0, 1.3)	1.1 (0.9, 1.4)

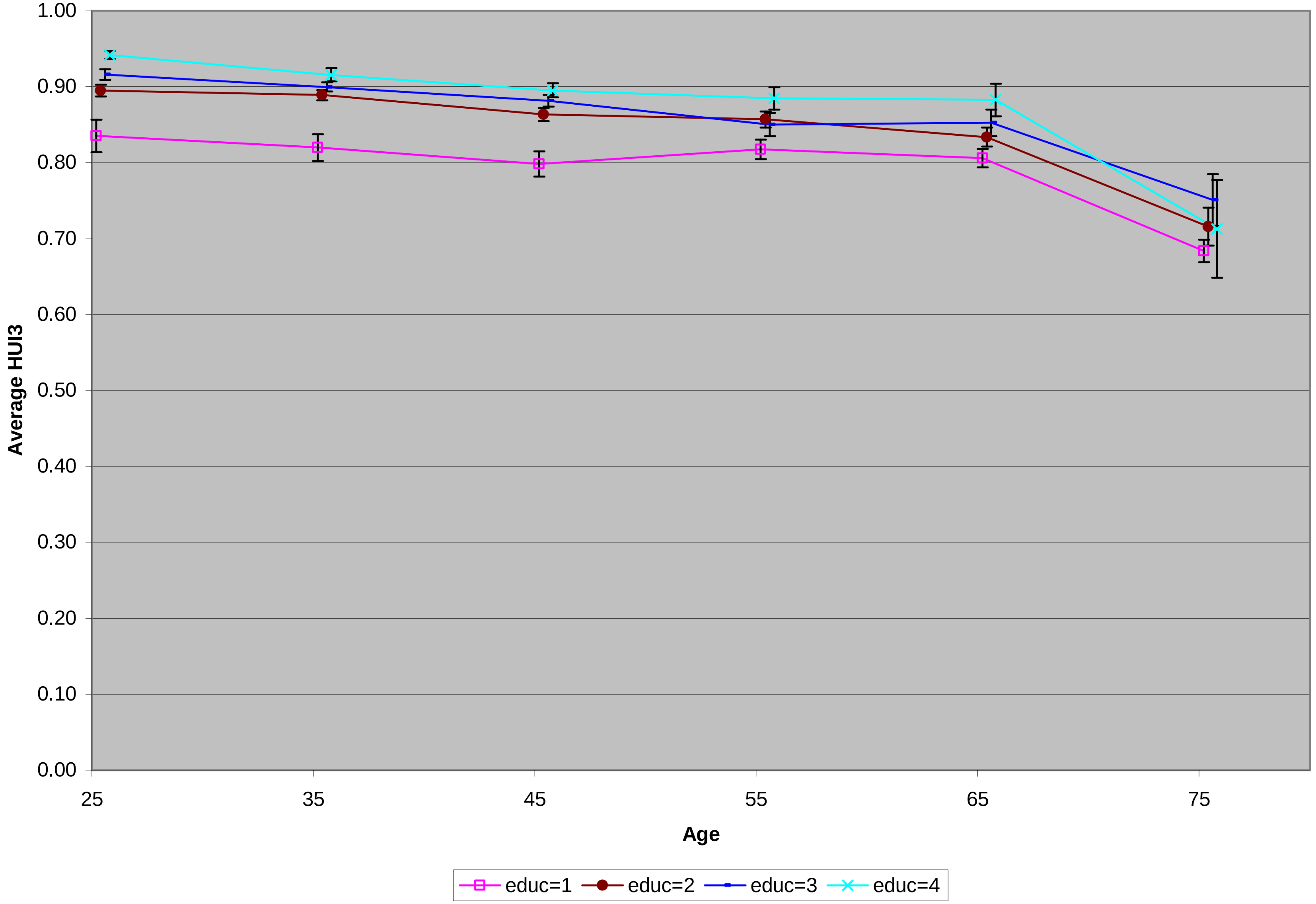
Note. Deciles are based on the ratio: total household income (CCHS) or economic family income (census)/equivalent person unit. The first person in the household is given a weight of 1.0; the second, 0.40; and each of the remaining household (CCHS) or economic family (census) members, 0.30. D1 = poorest decile; D10 = richest decile. 95% confidence intervals are in parentheses.
Data Source: 2000 – 2001 Canadian Community Health Survey.

Figure 5: Average HUI3 by Educational Attainment and age group, Males (95% Confidence intervals included)



Note. E1 = less than high school graduation; E2 = high school graduation or trades qualification; E3 = post-secondary certificate or diploma (short of a university Bachelor's degree); and E4 = university degree (Bachelor's or higher).
Data Source: 2000 – 2001 Canadian Community Health Survey.

Figure 6: Average HUI3 by Educational Attainment and age group, Females



Note. E1 = less than high school graduation; E2 = high school graduation or trades qualification; E3 = post-secondary certificate or diploma (short of a university Bachelor's degree); and E4 = university degree (Bachelor's or higher).
Data Source: 2000 – 2001 Canadian Community Health Survey.

Table 8: HALE by Income Decile at ages 25-75 yrs, Males (95% Confidence intervals in parentheses)

Income Decile	Exact Age					
	25	35	45	55	65	75
D1	42.0 (40.5, 43.4)	32.0 (30.5 33.4)	23.3 (21.8, 24.7)	15.7 (14.3, 17.2)	11.1 (9.7, 12.5)	6.6 (5.3, 7.9)
D2	44.3 (43.5, 45.1)	34.8 (34.0, 35.6)	25.8 (25.0, 26.6)	17.2 (16.4, 18.0)	11.9 (11.1, 12.6)	6.3 (5.7, 7.0)
D3	46.4 (45.6, 47.1)	36.3 (35.6, 37.0)	26.9 (26.2, 27.6)	19.0 (18.4, 19.7)	12.6 (12.0, 13.2)	7.0 (6.4, 7.6)
D4	48.0 (47.4, 48.6)	38.7 (38.1, 39.3)	29.2 (28.7, 29.8)	20.4 (19.9, 21.0)	13.8 (13.3, 14.3)	7.6 (7.2, 8.1)
D5	48.7 (48.1, 49.4)	39.6 (39.0, 40.3)	29.3 (28.7, 29.9)	20.4 (19.8, 21.0)	14.0 (13.5, 14.6)	7.8 (7.3, 8.3)
D6	49.5 (48.9, 50.2)	40.0 (39.3, 40.6)	30.3 (29.7, 31.0)	21.8 (21.2, 22.4)	14.6 (13.9, 15.2)	8.0 (7.4, 8.6)
D7	49.8 (49.1, 50.5)	40.6 (39.9, 41.3)	30.8 (30.1, 31.5)	23.1 (22.4, 23.7)	14.8 (14.1, 15.4)	8.1 (7.5, 8.7)
D8	50.9 (50.3, 51.5)	41.2 (40.7, 41.8)	32.0 (31.3, 32.5)	23.1 (22.5, 23.7)	15.6 (15.0, 16.2)	8.5 (8.0, 9.1)
D9	51.2 (50.6, 51.9)	42.1 (41.5, 42.7)	32.3 (31.6, 32.9)	23.3 (22.7, 23.9)	15.7 (15.1, 16.3)	8.7 (8.1, 9.2)
D10	53.2 (52.6, 53.7)	43.2 (42.6, 43.7)	33.3 (32.8, 33.9)	25.1 (24.6, 25.7)	17.0 (16.5, 17.5)	9.5 (9.1, 10.0)
D10 – D1	11.2 (9.6, 12.8)	11.2 (9.6, 12.8)	10.0 (8.5, 11.6)	9.4 (7.9, 10.9)	5.9 (4.4, 7.4)	2.9 (1.5, 4.3)
D10/D1	1.3 (1.2, 1.3)	1.4 (1.3, 1.4)	1.4 (1.3, 1.6)	1.6 (1.4, 1.8)	1.5 (1.3, 1.8)	1.4 (1.1, 1.9)

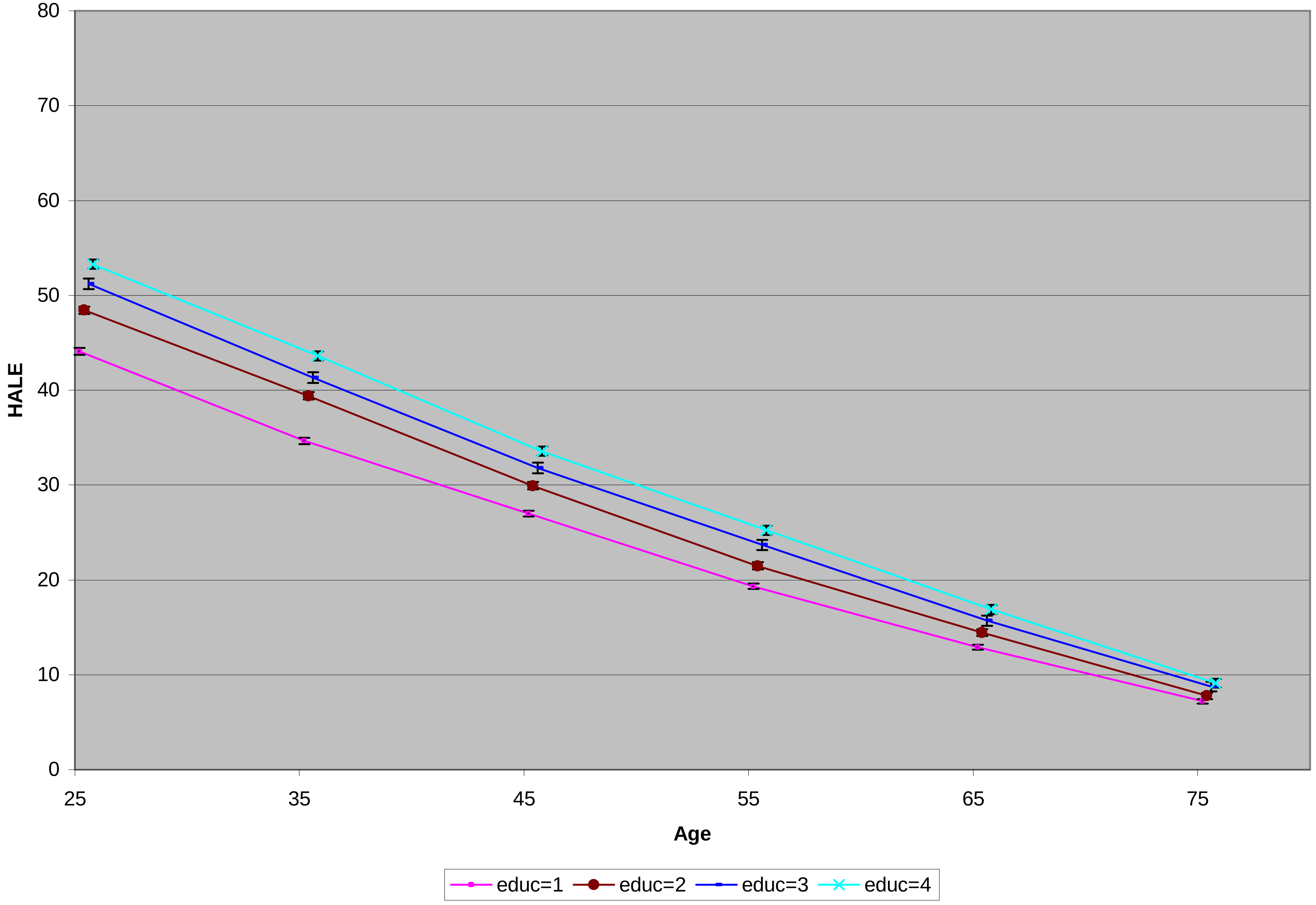
Deciles are based on the ratio: total household income (CCHS) or economic family income (census)/equivalent person unit. The first person in the household is given a weight of 1.0; the second, 0.40; and each of the remaining household (CCHS) or economic family (census) members, 0.30. D1 = poorest decile; D10 = richest decile. 95% confidence intervals are in parentheses.
Data Sources: 2000 – 2001 Canadian Community Health Survey; 1991 census-mortality follow-up with deaths through 2001.

Table 9: HALE by Income Decile at ages 25-75 yrs, Females (95% Confidence intervals in parentheses)

Income Decile	Exact Age					
	25	35	45	55	65	75
D1	47.9 (47.0, 48.9)	36.8 (35.8, 37.7)	28.2 (27.3, 29.2)	21.1 (20.2, 22.0)	15.1 (14.2, 16.0)	8.4 (7.6, 9.1)
D2	50.0 (49.5, 50.4)	39.6 (39.1, 40.0)	29.0 (28.6, 29.4)	21.5 (21.1, 21.9)	15.8 (15.5, 16.1)	8.9 (8.6, 9.1)
D3	51.4 (50.9, 51.9)	42.3 (41.8, 42.8)	31.4 (30.9, 31.9)	24.2 (23.7, 24.6)	16.8 (16.4, 17.2)	9.3 (8.9, 9.6)
D4	52.9 (52.3, 53.5)	43.2 (42.6, 43.8)	32.3 (31.7, 32.9)	25.0 (24.5, 25.6)	18.0 (17.5, 18.5)	9.8 (9.3, 10.2)
D5	53.6 (53.0, 54.2)	44.3 (43.7, 44.8)	34.2 (33.6, 34.7)	25.9 (25.4, 26.4)	17.7 (17.2, 18.1)	9.9 (9.5, 10.3)
D6	54.1 (53.3, 54.8)	44.5 (43.8, 45.2)	35.0 (34.3, 35.8)	25.9 (25.2, 26.6)	17.6 (17.0, 18.3)	10.0 (9.4, 10.6)
D7	55.1 (54.4, 55.8)	45.1 (44.4, 45.8)	35.0 (34.3, 35.6)	26.5 (25.9, 27.2)	17.9 (17.3, 18.6)	10.3 (9.7, 10.9)
D8	54.9 (54.1, 55.7)	45.6 (44.9, 46.4)	35.3 (34.5, 36.0)	26.4 (25.6, 27.1)	18.5 (17.8, 19.2)	9.9 (9.2, 10.5)
D9	55.9 (55.0, 56.9)	45.8 (44.8, 46.7)	36.1 (35.2, 37.1)	27.1 (26.1, 28.0)	19.6 (18.7, 20.6)	10.2 (9.3, 11.1)
D10	56.8 (55.9, 57.6)	46.6 (45.7, 47.4)	36.6 (35.8, 37.5)	28.0 (27.2, 28.8)	19.5 (18.6, 20.3)	9.9 (9.2, 10.7)
D10 – D1	8.8 (7.5, 10.1)	9.8 (8.5, 11.1)	8.4 (7.2, 9.7)	6.9 (5.7, 8.1)	4.3 (3.1, 5.5)	1.6 (0.5, 2.6)
D10/D1	1.2 (1.1, 1.2)	1.3 (1.2, 1.3)	1.3 (1.2, 1.4)	1.3 (1.2, 1.4)	1.3 (1.2, 1.4)	1.2 (1.0, 1.4)

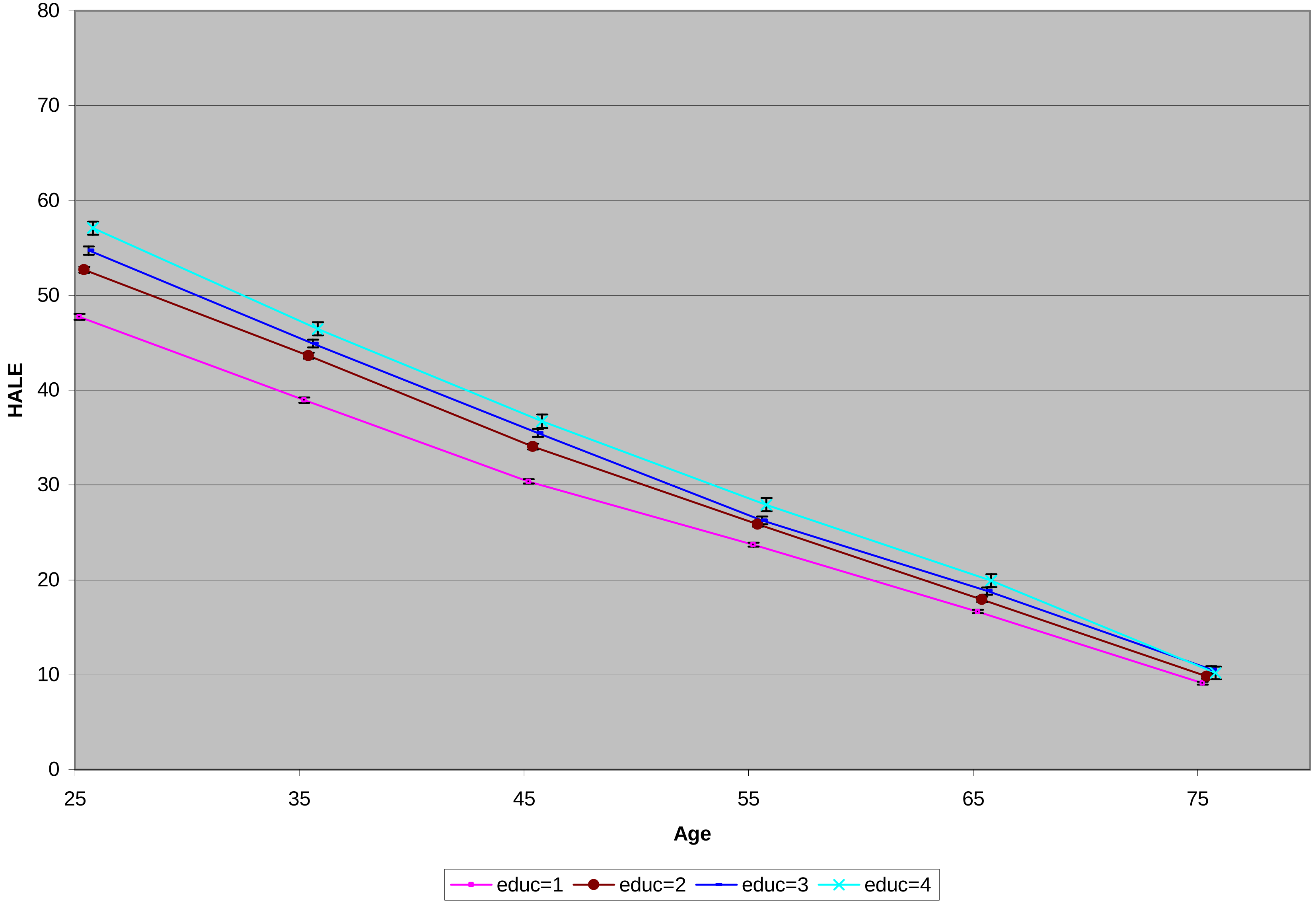
Deciles are based on the ratio: total household income (CCHS) or economic family income (census)/equivalent person unit. The first person in the household is given a weight of 1.0; the second, 0.40; and each of the remaining household (CCHS) or economic family (census) members, 0.30. D1 = poorest decile; D10 = richest decile. 95% confidence intervals are in parentheses.
Data Sources: 2000 – 2001 Canadian Community Health Survey; 1991 census-mortality follow-up with deaths through 2001.

Figure 7: HALE by Educational Attainment at ages 25-75 yrs, Males (95% Confidence intervals in parentheses)



Note. E1 = less than high school graduation; E2 = high school graduation or trades qualification; E3 = post-secondary certificate or diploma (short of a university Bachelor's degree); and E4 = university degree (Bachelor's or higher).
Data Sources: 2000 – 2001 Canadian Community Health Survey; 1991 census-mortality follow-up with deaths through 2001.

Figure 8: HALE by Educational Attainment at ages 25-75 yrs, Females (95% Confidence intervals in parentheses)



Note. E1 = less than high school graduation; E2 = high school graduation or trades qualification; E3 = post-secondary certificate or diploma (short of a university Bachelor's degree); and E4 = university degree (Bachelor's or higher).
Data Sources: 2000 – 2001 Canadian Community Health Survey; 1991 census-mortality follow-up with deaths through 2001.