Predictors of death in seniors

- *Chronic diseases, notably heart diseases and cancer, are the leading causes of death among seniors.*
- *Senior women who had high levels of psychological distress in 1994/95 were more likely to have died by 2002/03 than women who did not have such problems.*
- *For senior men, low education and widowhood increased the likelihood of dying over this eight-year period.*

Abstract

Objectives

This article updates information on the leading causes of death for people aged 65 or older, and examines factors associated with death in seniors over an eight-year period. The analysis focuses on psychosocial factors—psychological distress, financial and family stress—in relation to mortality.

Data sources

Data are from the Canadian Mortality Database and the 1994/95 to 2002/03 National Population Health Survey (NPHS), longitudinal file. The NPHS sample analysed contains records for 955 men and 1,445 women.

Analytical techniques

Death certificate information for 2002 and Census population estimates were used to calculate death rates and rank causes of death. NPHS data were cross-tabulated to examine selected characteristics reported in 1994/95 in relation to vital status (dead or alive) by 2002/03. Cox regression was used to calculate hazards ratios for psychological distress, financial and family-related stress in relation to subsequent mortality, while controlling for the effects of age, chronic diseases, and other potential confounders.

Main results

In senior women, psychological distress in 1994/95 was positively associated with mortality over the next eight years, even when controlling for the effects of other variables. The statistical significance of this relationship in senior men disappeared when controlling for chronic conditions.

Keywords

aged, mortality, psychological stress, risk factors, prospective studies, health surveys

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In Canada, as in all industrialized societies, most deaths occur in elderly people. This was not the case for earlier generations. In 1926—the first year for which vital statistics were centrally compiled for all provinces—only one in six deaths (17%) occurred in people aged 65 or older. By 2002, nearly four-fifths of people who died (78%) were in this age group (Chart 1).

Over the last century, fundamental changes have occurred in the causes of death and, as a consequence, in the average age at death. In 1926, cancer and diseases of the circulatory system (including stroke) accounted for only one-quarter of all deaths in Canada; by 2002, nearly two-thirds of deaths were caused by these conditions.[1,2] The likelihood of dying from tuberculosis was slightly higher than that of dying from cancer in 1926, with each accounting for 7% of all deaths. Childhood was especially perilous at that time; 29% of deaths in 1926 occurred in infants and children younger than 5, compared with less than 1% in 2002.

Methods

Data sources

Death data for 1926 were compiled from *Vital Statistics 1926,*[1] and from the Canadian Mortality Database for 2002 (the most recent year for which data from all jurisdictions are available). Death records are based on information abstracted and compiled from death certificates, and are provided to Statistics Canada by the Registrar of Vital Statistics in each province and territory.

Longitudinal analysis was based on data from the longitudinal file of the National Population Health Survey (NPHS), cycles 1 to 5 (1994/95 to 2002/03). The NPHS covers household and institutional residents in all provinces and territories, except full-time members of the Canadian Forces, and residents of Indian reserves, Canadian Forces bases and some remote areas.

In 1994/95, 20,095 respondents were selected for the longitudinal panel; the response rate was 86.0%. These 17,276 respondents were re-interviewed every two years. The response rates for subsequent cycles, based on these 17,276 individuals, were: 92.8% for cycle 2 (1996/97); 88.2% for cycle 3 (1998/99); 84.8% for cycle 4 (2000/01); and 80.6% for cycle 5 (2002/03). More detailed descriptions of the NPHS design, sample and interview procedures can be found in published reports.[3,4]

This analysis is based on data from the 2002/03 NPHS cycle 5 longitudinal "square" master file, which contains records for all 17,276 responding members of the original panel, whether or not information about them was provided in all five cycles. The longitudinal analysis was based on data for respondents who were 65 or older in cycle 1 (1994/95), who had completed the cycle 1 interview, and for whom vital status in cycle 5 (2002/03) was known. The number of respondents 65 or older in cycle 1 who provided full interview information was 2,685; 285 of them were dropped from the analysis because of unknown vital status in cycle 5. Information on vital status was unavailable for various reasons, including failure to contact the household, respondent's whereabouts unknown, and respondent moved out of Canada. The final sample numbered 2,400 seniors: 955 men and 1,445 women.

Analytical techniques

To compare the distribution of deaths according to age group between 1926 and 2002, the age groups 0 to 4, 5 to 64, and 65 or older were used. To present 2002 data by cause of death, deaths occurring in the 65-or-older age group were tabulated separately for each sex by underlying cause of death, which were combined into 113 standard groupings using the *International Statistical Classification of Diseases and Health Problems, Tenth Revision* (ICD-10).[5,6]

Bivariate tabulations were used to examine vital status in cycle 5 by the distribution of independent variables in cycle 1.

Cox proportional hazards models were used to assess the association between psychological distress in cycle 1 and duration of survival, while controlling for other respondent characteristics. The proportional hazards coefficient estimates the effect on survival time of each covariate entered in the model. For respondents who died during the follow-up period, the duration of survival was defined as the number of days from the date of the cycle 1 interview until the date of death. For people who completed the cycle 5 interview (or who were known to be alive), duration of survival was defined as the number of days elapsed between the cycle 1 and cycle 5 interviews. After the cycle 5 interview, survival time was considered censored.

Of the analysis sample of 2,400 respondents for whom vital status in cycle 5 was known, 912 died over the eight-year follow-up period, and 1,488 remained alive. Date of death was not available for 56 (6%) of the decedents because linkage to Statistics Canada's Canadian Mortality Database, routinely attempted on the records of all NPHS respondents who are reported to have died, could not be successfully completed. For 23 of these cases, contact with an NPHS interviewer had last occurred in cycle 4 and death was then reported in cycle 5 (2002/03). Linkage was not possible for these 23 cases because the death records were not yet included in the Mortality Database. For the remaining 33 respondents whose deaths had occurred earlier, failure to link with the Mortality Database resulted from inconsistencies in data; for example, date of birth, missing maiden name, and/or delays in receiving the death record at Statistics Canada.

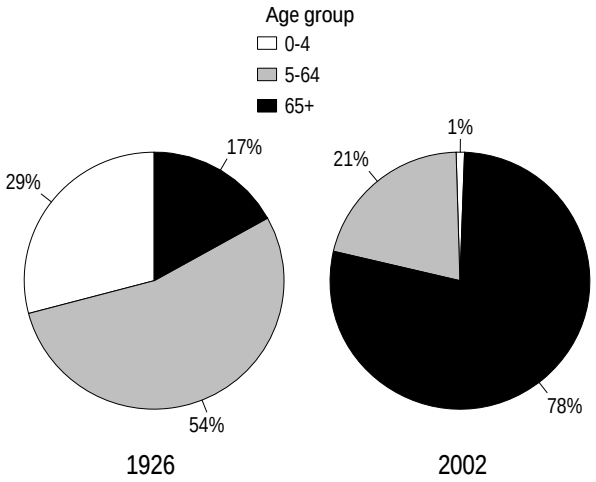
For the 56 respondents reported deceased but for whom information on date of death was unavailable in the NPHS data, a date was generated so that they could be included in the analysis. The year of death was defined as the most recent year in which the respondent's "alive" vital status had been reported by an NPHS interviewer, plus one. For example, a person contacted in 2000 who was reported deceased in cycle 5 (2002/03) was assigned 2001 as the year of death. January 1 was used for month and day of death.

Separate analyses were conducted for men and women. Selection of variables for the proportional hazards models was based on the literature, as well as on availability of information from the NPHS. Groups of variables were added sequentially to successive models. The base model (Model 1) contained age, psychological distress and financial and family stress. Education and marital status were added in Model 2; chronic conditions and functional limitation in Model 3; and behavioural risk factors (leisure-time physical activity, smoking, alcohol use and body mass index) in Model 4. As an additional measure of socio-economic status, a variable indicating main source of income was used in bivariate tabulations. To avoid multi-collinearity, the main source of income variable was not included in proportional hazards models.

Preliminary proportional hazards models were produced to examine the relationship between age and survival, using a term for age-squared. Because the hazards ratio for the age-squared term was not significant, it was dropped from subsequent models. Similarly, a variable for social support was explored in preliminary analysis, but dropped from the final analyses. To explore the negative relationship between financial stress and mortality observed in men, interaction terms of financial stress with level of income were included in proportional hazards models, but they were not significant.

The data were weighted to reflect the age and sex distribution of the household population aged 65 or older in 1994. To account for survey design effects, variance on proportion estimates, on differences between proportions and on hazards ratios was estimated using the bootstrap technique.[7-9]

Chart 1
Percentage distribution of deaths, by age group, Canada, 1926 and 2002



Data source: *Reference 1 and 2002 Canadian Mortality Database*

Although the classification systems in use internationally permit deaths to be attributed only to disease or injury,[6] the importance of social and psychological factors in the study of mortality is growing. Over the past few decades, interest has extended beyond the study of medically diagnosed disease to include socio-economic conditions and social and emotional stressors that might contribute to poor health or death.[10-16] Recent research has focused on the pathways and physiological mechanisms through which psychosocial and socio-economic factors may influence changes in health. Early findings suggest that biological changes occur in response to stress, weakening the immune response and thus increasing the mortality risk.[17,18]

For this analysis, information provided by people aged 65 or older who were followed over an eight-year period is used to study selected characteristics in relation to death; the analysis focuses specifically on a measure of emotional health (see *Definitions*). Longitudinal data from Statistics Canada's National Population Health Survey (NPHS) complement information available from administrative sources (see *Methods*). In addition to information about physical health, the NPHS collects data on a rich array of other health-related personal and social factors.

This article provides current information on the leading causes of death among seniors and examines the relationship between psychological distress and mortality.

Most die from heart diseases, cancer

In 2002, 173,971 Canadians aged 65 or older died: 82,613 men and 91,358 women (Table 1). Although the total number of deaths among senior women substantially exceeded that for senior men, the rate of death in each age group—that is, the number of deaths per surviving population—was higher for men (Chart 2).

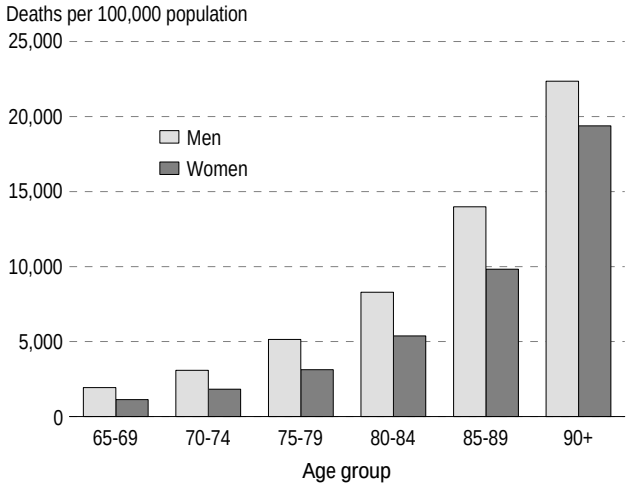
Information compiled from death certificates indicates that the top-ranking causes of death in seniors were cancer and heart diseases, followed by stroke and respiratory diseases (Table 1). Alzheimer's disease and cerebrovascular diseases accounted for

Table 1
Leading causes of death at age 65 or older, by sex, Canada, 2002

	Men			Women		
	Number	%	Rank	Number	%	Rank
All causes	82,613	100.0		91,358	100.0	
Malignant neoplasms	25,024	30.3	1	21,645	23.7	2
Lung cancer	7,294	8.8		4,760	5.2	
Prostate cancer (men) Breast cancer (women)	3,397	4.1		2,999	3.3	
Colorectal cancer	2,737	3.3		2,566	2.8	
Heart diseases	21,950	26.6	2	24,064	26.3	1
Cerebrovascular diseases (stroke)	5,632	6.8	3	8,466	9.3	3
Chronic lower respiratory diseases	5,012	6.1	4	4,096	4.5	4
Diabetes mellitus	3,080	3.7	5	3,466	3.8	6
Influenza and pneumonia	1,858	2.2	6	2,505	2.7	7
Accidents	1,850	2.2	7	2,249	2.5	8
Falls	646	0.8		761	0.8	
Alzheimer's disease	1,647	2.0	8	3,791	4.1	5
Chronic liver diseases and cirrhosis	707	0.9	9	436	0.5	10
Septicemia	556	0.7	10	672	0.7	9
Other	15,297	18.5		19,968	21.9	

Data source: *2002 Canadian Mortality Database*
Note: *Causes of death defined using Ref. 6*

Chart 2
Age-specific death rates in people aged 65 or older, by sex, Canada, 2002



Data source: *2002 Canadian Mortality Database*

higher proportions of deaths in women, while lung cancer was more important in men. However, in both sexes, lung cancer caused more deaths than any other cancer. Only 1% of deaths among seniors were attributable to diseases classified as infectious (data not shown).

Psychological distress and stress

In the NPHS sample of 2,400 respondents used for this analysis, 912 died between 1994/95 and 2002/03. By sex, the weighted proportions were 43% of the men and 31% of the women. Men survived an average of 2,338 days, and women, 2,526 days (Appendix Table A).

According to the analysis of NPHS data, psychological distress was strongly associated with death (Table 2). People who died had significantly higher average scores on the psychological distress scale (Appendix Table B). Of those reporting high levels of psychological distress in 1994/95, 62% of men and 44% of women died, compared with 37% and 25%, respectively, at lower levels of distress. These results are consistent with some earlier investigations that also found psychological distress to be predictive of mortality.[19,20]

Women with high financial stress in 1994/95—those reporting that they did not have enough money to cover necessities—had a greater likelihood of dying by 2002/03 than did women reporting sufficient means. Curiously, the relationship was reversed for men: 33% of those reporting high financial stress in 1994/95 had died by 2002/03, a significantly lower percentage than

Table 2
Percentage who died by 2002/03, by sex and selected characteristics in 1994/95, household population aged 65 or older, Canada excluding territories

	Men	Women
	%	
Total	43.1	31.1
Age group		
65-69	26.6*	17.1*
70-79	43.9*	26.5*
80+†	75.4	61.8
Education		
Less than secondary graduation	49.1*	34.7*
Secondary graduation or more†	35.4	26.9
Main source of income is social assistance		
Yes	52.8*	33.9
No†	36.0	27.7
Marital status		
Married/Living with partner†	38.6	23.6
Single/Divorced/Separated	47.9	28.5E
Widowed	64.0*	39.4*
Leisure-time physical activity level		
Moderately active/Active†	32.7	17.7
Inactive	49.1*	36.2*
Body mass index		
Underweight (<18.5)	87.2*	61.8*
Normal (18.5-24.9)†	45.7	32.4
Overweight (25.0-29.9)	35.9	25.2
Obese (≥ 30.0)	51.1	27.3
Alcohol use in past month		
Yes†	34.7	24.5
No	52.1*	34.2*
Smoking		
Never smoked/Quit ≥10 years†	39.4	28.9
Current smoker/Former, quit <10 years	52.9*	40.7*
Chronic disease in 1994/95		
Cancer	75.5*	47.1*
No cancer†	41.3	30.2
Effects of stroke	90.5*	55.7*
No effects of stroke†	40.9	30.2
High blood pressure	52.0*	32.8
No high blood pressure†	40.4	30.3
Heart disease	63.6*	47.8*
No heart disease†	37.9	28.0
Diabetes	53.3	52.7*
No diabetes	41.5	28.9
Respiratory disease	65.5*	53.0*
No respiratory disease†	40.9	29.7
Functional limitation (HUI3)		
Severe	67.1*	49.3*
None/Moderate†	35.9	25.1
Mental health, stress		
High psychological distress	61.6*	43.9*
Low psychological distress†	37.4	24.6
Worry about finances (high)	33.0*	38.3*
Worry about finances (low)†	44.1	28.1
Worry about health of family member (high)	44.2	27.5
Worry about health of family member (low)	41.5	30.0

Data source: *1994/95 to 2002/03 National Population Health Survey, longitudinal file*
Note: *Total estimates for men and women differ significantly from each other.*
† Reference category
** Significantly different from estimate for reference category for same sex ($p < 0.05$)*
E Coefficient of variation 16.6% to 33.3% (interpret with caution)

the 44% of men with low financial stress. This finding was unexpected, as it runs counter to the abundant evidence that material need is strongly related to poor health. Additional calculations revealed that, as expected, high financial stress was more likely at lower levels of income, and the likelihood of mortality was also higher at lower levels of income (data not shown). Clearly, though, financial stress and level of income reflect distinct characteristics.

No significant differences emerged for either sex between death and level of concern over a family member's health.

Educational attainment protective

For both sexes, the likelihood of dying was greater among seniors who had not completed secondary education, compared with those who had. In men, but not women, source of income was also predictive of death. More than half (53%) of the men whose main source of income in 1994/95 was the Canada or Québec pension, Old Age Security/Guaranteed Income Supplement, or provincial/municipal social assistance or welfare had died by 2002/03, compared with 36% of those relying on other sources of income. These findings were expected, and are consistent with previous research.[21]

Men and women who were widowed were more likely to die than were those who were married or living with a partner. Of course, substantially higher proportions of younger seniors were married than were their older counterparts (data not shown), so the relationship was not surprising.

Behavioural risk factors

Several health-related behaviours were related to the likelihood of dying. Seniors who were inactive in 1994/95 were more likely to have died by 2002/03, compared with those who reported at least moderate leisure-time physical activity. And those who used alcohol at least once a month were less likely to die than those who drank less frequently or who abstained. These findings were expected, as the model did not control for the effects of age.

For both sexes, smoking history was related to the likelihood of dying. Seniors who, in 1994/95, had been current smokers or who had quit for less than 10 years were at significantly higher risk of dying by 2002/03 than were those who had never smoked.

Being underweight in 1994/95, which may be an indicator of poor health and advanced age, was strongly related to the likelihood of dying. Fully 87% of men and 62% of women in this weight category had died, compared with 46% and 32%, respectively, of those in the normal BMI range. This is consistent with the findings of other prospective studies; the negative relationship between BMI and all-cause mortality was attributed to the tendency for serious disease to cause weight loss before death.[22,23]

As expected, the likelihood of dying was higher among seniors with severe functional limitation, and with most of the chronic diseases examined. Notably high proportions of men with effects of stroke (91%) or cancer (76%) had died. For women, death was most likely among those with effects of stroke (56%), diabetes (53%), or respiratory disease (53%).

Distress effects persist in women

Multivariate models were used to assess the extent to which the association between psychological distress and dying was accounted for by other variables.

In men, when controlling for age, financial and family stress, education and marital status, psychological distress remained positively associated with mortality. However, the addition of chronic diseases to the model attenuated the hazards ratio slightly so that it was no longer statistically significant (Table 3, Model 3). As well, the effect of financial stress diminished when adjusting for chronic diseases. These findings for men are consistent with previous research reporting a weakening of the effects of psychological distress in relation to mortality by adjustment for baseline morbidity.[24,25]

In women, however, a strong, positive association between psychological distress and death persisted, even when adjusting for the effects of chronic diseases and health-related behaviours (Table 4). The risk of dying by 2002/03 for women with a high level of psychological distress in 1994/95 was 60% higher than that for women whose distress level was lower (Table 4, Model 4). This persistent association between distress and subsequent mortality for women also corroborates previous research.[25]

Low education, widowhood risky for men

For men, a lower level of education remained significantly associated with mortality in the fully adjusted model (Table 3). This finding has also emerged in other research.[26]

As well, compared with men who were married or living with a partner, widowers had a strikingly higher likelihood of dying. The protective effects of marriage for men—an indicator of social support and social integration—with respect to mortality has been widely observed.[10,16,27,28]

Of the chronic conditions studied, cancer, the effects of stroke, heart disease and respiratory disease remained significantly related to mortality for men when controlling for age, psychosocial factors, education and

Table 3
Adjusted proportional hazards ratios relating selected characteristics in 1994/95 to death by 2002/03, male household population aged 65 or older, Canada excluding territories

	Model 1		Model 2		Model 3		Model 4	
	Hazards ratio	95% confidence interval	Hazards ratio	95% confidence interval	Hazards ratio	95% confidence interval	Hazards ratio	95% confidence interval
Age (continuous)	1.1*	1.1, 1.1	1.1*	1.1, 1.1	1.1*	1.0, 1.1	1.1*	1.0, 1.1
Psychological distress/Stress								
Psychological distress	2.4*	1.8, 3.3	2.4*	1.7, 3.3	1.5	1.0, 2.1	1.2	0.8, 1.9
Financial stress	0.6*	0.4, 0.9	0.6*	0.4, 0.9	0.7	0.5, 1.0	0.7	0.5, 1.0
Family health stress	0.9	0.6, 1.3	0.9	0.6, 1.4	1.0	0.7, 1.4	1.0	0.7, 1.4
Socio-economic characteristics								
Less than secondary graduation			1.3	1.0, 1.8	1.5*	1.1, 2.1	1.5*	1.1, 2.0
Secondary graduation or more†			1.0	...	1.0	...	1.0	...
Married/Living with partner†			1.0	...	1.0	...	1.0	...
Single/Separated/Divorced			1.4	1.0, 2.0	1.3	0.9, 1.9	1.3	0.9, 1.9
Widowed			1.7*	1.2, 2.4	1.9*	1.3, 2.7	1.7*	1.2, 2.5
Chronic conditions/Health status								
Cancer					2.3*	1.3, 4.2	2.2*	1.2, 4.2
Effects of stroke					2.8*	1.6, 4.8	2.5*	1.4, 4.5
Heart disease					1.5*	1.1, 2.0	1.5*	1.1, 2.0
Diabetes					1.1	0.7, 1.7	1.1	0.7, 1.7
High blood pressure					1.3	0.9, 1.7	1.3	1.0, 1.8
Respiratory disease					1.8*	1.2, 2.7	1.6*	1.0, 2.6
Functional health status (HUI3) (continuous)					0.5*	0.3, 0.9	0.6	0.3, 1.0
Body mass index								
Underweight (<18.5)							2.5*	1.2, 4.9
Normal (18.5-24.9)†							1.0	...
Overweight (25.0-29.9)							0.9	0.7, 1.2
Obese (≥ 30.0)							1.0	0.6, 1.7
Health-related behaviours								
Leisure-time physical activity level								
Moderate/Active							0.8	0.6, 1.1
Inactive†							1.0	...
Smoking								
Never smoked/Quit ≥10 years†							1.0	...
Current smoker/Quit <10 years							1.3	0.9, 1.8
Alcohol use								
At least 1 drink in past month							0.8	0.6, 1.1
None/<1 drink in past month†							1.0	...

***Data source**: 1994/95 to 2002/03 National Population Health Survey, longitudinal file*
***Note:** Models 1, 2, 3 and 4 are based on records for 868, 863, 854, and 852 men, respectively. Because of rounding, some hazards ratios with an upper or lower confidence limit of 1.0 are statistically significant.*
† Reference category. When not noted, reference category is absence of characteristic; for example, reference category for cancer is no reported diagnosis of cancer.
** Significantly different from estimate for reference category ($p < 0.05$).*

marital status. With adjustment for health-related behaviours, the associations weakened somewhat, but were still significantly elevated.

Functional impairment was significantly predictive of death when controlling for chronic conditions, but its effect was attenuated to non-significance ($p = 0.06$) by the addition of health-related behavioural factors (Table 3, Model 4). This suggests that in men, symptoms of physical or cognitive dysfunction or pain exert an effect on mortality risk that is independent of clinically diagnosed conditions, but weakly linked with health-related behaviours.

The strong association between underweight and mortality persisted for men, even with adjustment for chronic diseases and functional impairment. At higher levels of BMI, no associations with mortality emerged.

Financial stress harmful to women

In women, education level was not related to death, but financial stress remained significantly predictive

Table 4
Adjusted proportional hazards ratios relating selected characteristics in 1994/95 to death by 2002/03, female household population aged 65 or older, Canada excluding territories

	Model 1		Model 2		Model 3		Model 4	
	Hazards ratio	95% confidence interval	Hazards ratio	95% confidence interval	Hazards ratio	95% confidence interval	Hazards ratio	95% confidence interval
Age (continuous)	1.1*	1.1, 1.1	1.1*	1.1, 1.1	1.1*	1.1, 1.1	1.1*	1.1, 1.1
Psychological distress/Stress								
Psychological distress	2.2*	1.6, 2.9	2.2*	1.6, 2.9	1.7*	1.2, 2.3	1.6*	1.1, 2.3
Financial stress	1.4*	1.0, 1.9	1.4*	1.0, 1.9	1.5*	1.0, 2.0	1.4*	1.0, 2.0
Family health stress	1.0	0.6, 1.4	1.0	0.6, 1.4	0.9	0.6, 1.4	0.9	0.6, 1.4
Socio-economic characteristics								
Less than secondary graduation			1.0	0.8, 1.3	1.0	0.8, 1.4	1.0	0.8, 1.4
Secondary graduation or more†			1.0	...	1.0	...	1.0	...
Married/Living with partner†			1.0	...	1.0	...	1.0	...
Single/Separated/Divorced			1.1	0.7, 1.8	1.1	0.6, 1.8	0.8	0.5, 1.4
Widowed			1.1	0.8, 1.5	1.1	0.8, 1.5	1.0	0.7, 1.3
Chronic conditions/Health status								
Cancer					2.1*	1.3, 3.3	2.2*	1.4, 3.6
Effects of stroke					1.3	0.8, 2.4	1.3	0.7, 2.3
Heart disease					1.4*	1.0, 1.9	1.3	1.0, 1.8
Diabetes					1.7*	1.2, 2.5	1.9*	1.3, 2.8
High blood pressure					0.8	0.6, 1.1	0.9	0.7, 1.2
Respiratory disease					1.7*	1.1, 2.8	1.4	0.9, 2.2
Functional health status (HUI3) (continuous)					0.5*	0.3, 0.8	0.5*	0.3, 0.9
Body mass index								
Underweight (<18.5)							2.3*	1.5, 3.6
Normal (18.5-24.9)†							1.0	…
Overweight (25.0-29.9)							0.8	0.6, 1.2
Obese (≥ 30.0)							1.0	0.7, 1.5
Health-related behaviours								
Leisure-time physical activity level								
Moderate/Active							0.7	0.5, 1.1
Inactive†							1.0	...
Smoking								
Never smoked/Quit ≥10 years†							1.0	...
Current smoker/Quit <10 years							1.6*	1.1, 2.2
Alcohol use								
At least 1 drink in past month							1.1	0.8, 1.5
None/<1 drink in past month†							1.0	...

***Data source**: 1994/95 to 2002/03 National Population Health Survey, longitudinal file*
***Note:** Models 1, 2, 3 and 4 are based on records for 1,385, 1,385, 1,372 and 1,368, respectively. Because of rounding, some hazards ratios with an upper or lower confidence limit of 1.0 are statistically significant.*
† Reference category. When not noted, reference category is absence of characteristic; for example, reference category for cancer is no reported diagnosis of cancer.
** Significantly different from estimate for reference category ($p < 0.05$).*

of mortality, even in the fully controlled model. The persistence of the association between financial stress and the risk of death, even with psychological distress in the model, is notable, because it indicates that each of these factors exerts an independent effect.

Controlling for health-related behaviours in women diminished the lethal effects of chronic diseases to a greater degree than was the case in men. Before the effects of BMI, smoking, physical activity and alcohol use were taken into account, cancer, heart disease, diabetes and respiratory disease were associated with death (Table 4). But in the fully adjusted model, only cancer and diabetes remained significantly predictive of mortality.

Another sex difference emerged in the relationship between functional impairment and subsequent mortality. In women, the hazards ratio for functional impairment remained significant in the fully controlled model (Table 4, Model 4), suggesting the independent contribution to mortality risk of the sub-clinical symptoms, pain and dysfunction reflected in the HUI3.

Definitions

Age was determined by asking National Population Health Survey (NPHS) respondents how old they were in cycle 1. For bivariate analysis, age groups were defined as 65 to 69, 70 to 79 and 80 or older. For proportional hazards models, years of age was used as a continuous variable.

Psychological distress was based on responses to the following questions: "During the past month, that is, from (date one month ago) to yesterday, about how often did you feel:

- so sad that nothing could cheer you up?"
- nervous?"
- restless or fidgety?"
- hopeless?"
- worthless?"
- that everything was an effort?"

Potential responses were: "All of the time," "Most of the time," "Some of the time," "A little of the time," or "None of the time." Responses to each question were scored in the range of 0 (none of the time) to 4 (all of the time); the maximum possible total score was 24. The variable was dichotomized as "low distress" (score of 0 to 4) and "high distress" (5 to 24); the high distress category contained the top quintile of the population in the weighted distribution of the psychological distress variable. The six questions used to measure psychological distress (known as the "K6") are a subset of items from the Composite International Diagnostic Interview.[29]

Financial stress was based on the response to the true-false question, "You don't have enough money to buy the things you need." A response of "true" was defined as high stress over finances; 18% of the weighted distribution fell into this category.

Family health stress was based on responses to the true-false questions, "You have a parent, a child or a partner who is in very bad health and may die," and "Someone in your family has an alcohol or drug problem." Counting a "false" response as 0 and a "true" response as 1, the combined possible score for these questions ranged from 0 to 2. A "true" response to either or both questions was defined as high stress over family health; 15% of the weighted distribution fell into this category.

Education was categorized as less than high school graduation, or high school graduation or more.

Respondents were asked about their *main source of income*; those who identified Canada or Québec pension, Old Age Security/ Guaranteed Income Supplement, or provincial/municipal social assistance or welfare were categorized as receiving "social assistance" as their main income source.

Marital status was grouped as: married or living with a partner; single/divorced/separated; or widowed.

Level of *leisure-time physical activity* was based on calculations taking into account the reported frequency and duration of a respondent's leisure-time physical activities in the three months before the survey, and the estimated metabolic energy demand of each activity.[30,31] Leisure-time physical activity was classified as "active or moderate" (1.5 or more kilocalories per kilogram per day), or "inactive" (below 1.5 kcal/kg/day).

Alcohol use was defined as at least one alcoholic drink (one glass of wine, one beer, or 1.5 ounces of spirits) in the month before the cycle 1 interview.

Smoking status was dichotomized as: never smoked or quit 10 or more years ago, and current smoker or quit less than 10 years ago. The rationale for these categories stems from previous research reporting that for former smokers, the risk of mortality returns to that of a non-smoker after 10 to 15 years of abstinence.[32]

Body mass index (BMI) is a measure of weight adjusted for height, and is defined as weight (kilograms) divided by height (metres squared). Level of BMI was defined using the World Health Organization standards now adopted by Health Canada,[33] as follows:

- underweight: less than 18.5
- normal: 18.5 to 24.9
- overweight: 25.0 to 29.9
- obese class I: 30.0 to 34.9
- obese class II: 35.0 to 39.9
- obese class III: 40.0 or more.

For the analysis, the three obese categories were combined into a single category. Height and weight were self-reported by CCHS and NPHS respondents.

The presence of a *chronic condition* was established by asking respondents if a doctor had told them that they had a chronic disease that had lasted, or was expected to last, at least six months. Respondents were read a list of conditions, including cancer, respiratory disease, high blood pressure, heart disease, effects of stroke and diabetes.

The *Health Utilities Index, version 3* (HUI3) is a summary measure that incorporates functional health and societal preferences of health states.[34,35] Based on responses to 30 questions about eight aspects of functional health (vision, hearing, speech, mobility, dexterity, emotions, cognition, and pain and discomfort) together with a valuation component, an overall score, or index, is produced for each individual. Perfect health is rated 1.000, and death, 0.000; negative scores reflect health states considered worse than death. Possible response values of the HUI3 range from -0.360 to 1.000. For bivariate analysis, HUI3 scores in the lower quartile of the sex-specific weighted distribution (from -0.324 to 0.686 in men and -0.312 to 0.632 in women) were categorized as severe functional limitation, and scores for men and women above 0.686 and 0.632, respectively, as moderate to none. In multivariate analysis, the HUI3 score was used as a continuous variable.

Limitations

The National Population Health Survey (NPHS) data file used for the analysis contains full responses in cycle 1 and vital status for the same respondents in cycle 5. To ensure that all deaths that occurred after the cycle 1 interview were included in the analysis, the independent variables are based only on data reported in cycle 1; therefore, they do not reflect subsequent changes. For example, low financial stress in cycle 1 may have risen to a higher level in a later cycle, but the analysis would not reflect this change. As a result, the observed associations with death may be weaker than they would have been if transitions in the independent variables had been considered.

Of the initial NPHS sample of 2,740 people aged 65 or older in cycle 1, 55 (2%) were dropped from the analysis because of incomplete information in cycle 1, and another 285 (10%) were excluded because information on their vital status in cycle 5 was unavailable, mostly because of refusal to participate or loss to follow-up for other reasons. Selection bias may have occurred if the respondents who were dropped differed systematically from the remaining sample. To assess the effects of non-response on age composition of the sample, mean age was compared between the initial sample of 2,740 and the sample of 2,400 used in the analysis. The mean age of cycle 1 respondents included in the analysis was 73.7 years, significantly higher than the average age (73.4) of the total initial sample. Although statistically significant, this difference was so small that it probably had little effect on the observed relationships between psychosocial factors and death.

The distribution of scores on the scale measuring psychological distress was highly skewed to the left, meaning that few seniors reported high levels of distress. For this reason, a binary rather than a continuous variable for psychological distress was used in proportional hazards analysis.

Although the longitudinal NPHS data establish the chronological sequence between the independent variables measured in cycle 1 and the outcome (death), causality cannot be inferred. The observed associations may be due to factors not included in the analysis.

The presence of chronic diseases was determined by asking respondents about conditions that had been diagnosed by a health practitioner and that had lasted, or were expected to last, six months or more. No clinical validation of these self-reported conditions was carried out.

Similarly, all other independent variables used in the analysis were based on self-reports and were not validated against objective criteria or by direct observation. Variation in unmeasured subjective factors, such as willingness to admit being worried about finances or feeling stressed, may explain some of the observed differences in responses.

Information was not available about many important objective measures of health (for example, blood pressure, blood chemistry, severity of disease, or diet) that may influence survival, or about many other factors (for example, personal and genetic) that affect resistance to disease and death. Similarly, the analysis did not take account of influences originating from the community that may affect the pathways through which psychosocial factors affect health.

As was true for men, the association between underweight and dying persisted for women even when adjustments were made to control for the effects of the other factors.

Smoking remained independently predictive of death among women. Women who were current smokers or who had quit for less than 10 years had a 60% higher risk of dying, compared with non-smokers or former smokers who had quit for 10 years or more. The significant effect of smoking for women, but not for men, in the fully controlled model has been observed before. In a previous report, researchers concluded that women may be more sensitive to some of the harmful effects of smoking.[36]

Concluding remarks

In Canada today, most people die in old age. At age 65 or older, cancer is the major medical cause of death for men; for women, heart disease leads. Beyond these physical conditions, findings from this analysis of a nationally representative sample of seniors followed over eight years suggest that emotional health, specifically psychological distress, can also influence survival.

Psychological distress was strongly predictive of death in women, even when controlling for age, family and financial stress, level of education, major chronic diseases, smoking, BMI and alcohol use. This finding corroborates previous research indicating the independent contribution of psychosocial factors to mortality.

Although the relationship between psychological distress and death for men was initially similar to that for women, the strength of the association diminished when controlling for chronic diseases. The relatively stronger effect of psychological factors (distress and financial stress) on women might be a consequence of higher levels of these factors in women. It might also indicate men's greater vulnerability to the effects of chronic, degenerative conditions such as cancer, stroke, heart disease and respiratory disease, which offsets the effects of psychological factors.

The major finding of this analysis is the importance of psychological distress as a predictor of mortality among women. Currently, the mechanisms linking this factor to the risk of dying are not thoroughly understood. Poor emotional health may relate indirectly to death if resistance is lowered via neglect of physical needs. Or, the relationship may be more direct, through alterations of the immune response and other physiological defense systems. The strength of the association that emerges in this analysis underscores the need for further study.

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Appendix

Table A
Mean value for selected variables, by sex, household population aged 65 or older, Canada excluding territories, 1994/95 to 2002/03

	Men	Women
Age in 1994/95	73.2	74.1*
Duration of survival (days)	2,338	2,526

Data source: *1994/95 to 2002/03 National Population Health Survey, longitudinal file*
** Significantly different from estimate for men (p < 0.05)*

Table B
Mean value for selected variables in 1994/95, by vital status in 2002/03 and sex, household population aged 65 or older, Canada excluding territories, 1994/95 to 2002/03

	Men	Women
Psychological distress (0-24‡)		
Alive†	1.74	2.70
Dead	2.80*	4.19*
Age (years)		
Alive†	71.35	72.45
Dead	75.70*	77.86*
Health status (HUI3) (-0.360 to 1.000‡)		
Alive†	0.84	0.80
Dead	0.70*	0.61*

Data source: *1994/95 to 2002/03 National Population Health Survey, longitudinal file*
† Reference category
‡ Range of possible scores for scale used to measure variable
** Significantly different from estimate for reference category for same sex (p < 0.05)*