Mortality among patients with hypertension from 1995 to 2005: a population-based study

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∞ See related articles, pages 1429, 1441 and 1458

Abstract

Background: We have reported that the prevalence of diagnosed hypertension increased by 60% from 1995 to 2005 in Ontario. In the present study, we asked whether this increase is explained by a decrease in the mortality rate.

Methods: We performed a population-based cohort study using linked administrative data for Ontario, a Canadian province with over 12 million residents. We identified prevalent cases of hypertension using a validated case-definition algorithm for hypertension, and we examined trends in mortality from 1995 to 2005 among adults aged 20 years and older with hypertension.

Results: The age- and sex-adjusted mortality among patients with hypertension decreased from 11.3 per 1000 people in 1995 to 9.6 per 1000 in 2005 ($p < 0.001$), which is a relative reduction of 15.5%. We found that the relative decrease in age-adjusted mortality was higher among men than among women (–22.2% v. –7.3%, $p < 0.001$).

Interpretation: Mortality rates among patients with hypertension have decreased. Along with an increasing incidence, decreased mortality rates may contribute to the increased prevalence of diagnosed hypertension. Sex-related discrepancies in the reduction of mortality warrant further investigation.

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High blood pressure is the leading risk factor for mortality around the world.[1,2] Over a decade ago, the Canadian Heart Health Survey reported that 42% of Canadian adults with hypertension were unaware that they had the condition and that only 16% of cases were treated and controlled.[3] More recent studies in the United States[4] and England[5] have reported improved awareness, treatment and control among adults with hypertension. In addition, increased initiation of hypertensive medications among elderly patients[6] and increased use of polytherapy for treating hypertension have been reported.[7] Given that blood pressure control has been shown to reduce mortality, one might expect that enhanced awareness and treatment of hypertension has led to improvements in mortality among patients with this condition. Greater survival of patients with hypertension would contribute to an overall increase in the prevalence of hypertension.

In another article in this issue of *CMAJ*, we report that the prevalence of diagnosed hypertension among adults increased by 60% from 1995 to 2005, which greatly surpassed prior projections for the developed world.[8] Previous projections may have underestimated prevalence[9] because researchers did not adequately account for the contribution of increased survival. Indeed, the increased prevalence cannot be explained by increased incidence alone, because the incidence of hypertension increased by 25.7% between 1997 and 2004 whereas prevalence increased by 35.5% during that same period. In the present study, our objective was to examine the mortality rates among patients with hypertension to determine whether declining mortality also contributed to the rising prevalence of hypertension.

Methods

Study population and data sources

Ontario is Canada's most populous province, with over 12 million residents. Ontario has high ethnic diversity, and 85% of its residents live in urban areas.[10] Ontario has a universal single-payer health care system that covers all physician and hospital services. We identified patients with hypertension from 1995 to 2000[8] through linked administrative databases using a validated algorithm for identifying patients with hypertension.[11]

We obtained annual mortality rates for patients with hypertension from the Registered Persons database, which contains death-certificate information as well as demographic and residential information for all Ontario residents eligible for health coverage. We confirmed deaths using the hospitalization database from the Canadian Institute for Health Information and data from the Ontario Cancer Reg-

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istry. In cases where discrepancies about the date of death occurred, the Canadian Institute for Health Information or Ontario Cancer Registry date was used.

This study received ethics approval from the institutional review board at Sunnybrook Health Sciences Centre, Toronto, Ont.

Statistical analysis

We calculated annual mortality rates by dividing the number of deaths among patients with hypertension by the number of people with hypertension (annual incident and prevalent cases from the previous year). Mortality rates are presented according to the end of the fiscal periods. To compare hypertension mortality rates in 1995 to those in 2005, we standardized all rates by age and sex according to the 2001 Canadian census data.[12] For comparison of rates between men and women, we standardize all rates by age using 2001 Canadian census data. We calculated the percentage change in mortality rates between years by dividing the difference between the 2 rates by the earlier rate and multiplying by 100.

We used logistic regression to test for differences in mortality for each fiscal year and to examine the effect of age and sex on mortality. The effects of fiscal year, age and sex were assessed using multivariable logistic regression. We compared mortality rates between men and women and age using χ^2 analyses. Cochran–Mantel–Haenszel and Breslow–Day tests were used to compare mortality changes between age and sex strata. We used the Cochran–Armitage Trend test to examining the declining trend of crude mortality over time.

To examine comorbidities that may have affected mortality rates, we identified patients with diabetes using the Ontario Diabetes Database.[13] We identified patients who were listed in this database before the start of the fiscal year for patients who were alive, and we identified those who were listed in the database before their date of death for patients who died in the fiscal years 1995, 2000 and 2005. Similarly, we calculated Charlson Comorbidity Index scores[14] in the 1-year period before the start of the fiscal year for patients who were alive. For patients who had died, we calculated this score in the 1-year before the date of death. In addition, using previously developed methods[15] we compared mortality among patients with a history of cardiovascular disease (including acute myocardial infarction, angina, congestive heart failure, coronary artery bypass graft surgery, coronary catheterization or percutaneous transluminal coro-

Table 1: Mortality rate per 1000 people with prevalent hypertension in 1995, 2000 and 2005

	Age, yr					All ages	
Year	20–34	35–49	50–64	65–74	≥ 75	Crude* mortality rate	Adjusted† mortality rate
1995‡							
No. of deaths	86	627	3 439	7 669	15 291	27 112	
People with hypertension	45 655	192 807	366 487	312 372	222 157	1 139 478	
Death rate (per 1000)	1.9	3.3	9.4	24.6	68.8	23.8	11.6
2000‡							
No. of deaths	83	859	4 327	9 757	27 346	42 372	
People with hypertension	59 066	284 630	541 991	427 692	382 430	1 695 809	
Death rate (per 1000)	1.4	3.0	8.0	22.8	71.5	25.0	10.7
2005‡							
No. of deaths	88	1 015	5 412	10 136	36 823	53 474	
People with hypertension	71 917	388 329	768 283	530 588	551 925	2 311 042	
Death rate (per 1000)	1.2	2.6	7.0	19.1	66.7	23.1	9.6
Change from 1995 to 2005,‡ %							
No. of deaths	2.3	61.9	57.4	32.2	140.8	97.2	
People with hypertension	57.5	101.4	109.6	69.9	148.4	102.8	
Death rate (per 1000)	-35.1	-19.7	-24.9	-22.2	-3.1	-2.8	-15.5§
Change in death rage from 1995 to 2005,‡ %							
Women	-33.3	-16.7	-20.6	-18.4	3.3	4.6	-7.3¶
Men	-36.4	-20.0	-27.9	-28.2	-14.5	-10.6	-22.2¶

*Significant interaction between age-group, sex and year ($p < 0.01$).
†Death rates were age- and sex-adjusted by use of 2001 consensus data.
‡By March 31 of the year shown.
§Significant change ($p < 0.001$) in the death rate after data were adjusted for age and sex.
¶Significant change ($p < 0.001$) in mortality rate after the data were adjusted for age.

nary angioplasty) in the 5 years before the fiscal year or 5 years before the date of death for the fiscal years 1995, 2000 and 2005. We examined the effect of socioeconomic status on mortality rates using neighbourhood income quintiles according to 2001 census data derived from postal code census geography,[16,17] and we examined the effect of residence location (rural v. urban) on mortality rates using definitions from Statistics Canada.[18]

We used a logistic-regression model to adjust for history of diabetes, Charlson score, 5-year history of cardiovascular diseases, residence location and socioeconomic status. We used Pearson correlation to examine trends in annual multivariable-adjusted mortality rates.

Results

Overall, the age- and sex-adjusted mortality rate among people with hypertension decreased from 11.3 per 1000 adults with hypertension in 1995 to 9.6 per 1000 in 2005, resulting in a relative decrease in mortality of over 15.5%. Among both men and women, the largest decrease was among those aged 20–34 years and the smallest decrease was among those aged 75 years and older (Table 1). The difference between the changes in mortality rates from 1995 to 2005 between men and women increased with age, with a 3.0% difference in the youngest age category and a 17.8% difference in the oldest age category. Mortality rates were higher among men than among women throughout the study period. There was a larger decrease in multivariable-adjusted mortality among men than among women from 1995 to 2005 (Figure 1).

Among patients with hypertension (including both those who died and those who were alive in 1995, 2000 and 2005), we found an increase in the rate of comorbidities over time (Table 2). We found increases in the number of patients with diabetes, a Charlson score of 2+ and with a history of cardiovascular disease. Among patients who died, more were in the lower socioeconomic income quintiles; however, the difference in mortality rates between income quintiles decreased over time. The mortality rate among patients living in rural areas decreased minimally (Table 2).

Interpretation

In this population-based study, we found a 15.5% relative reduction in mortality rates between 1995 and 2005 among patients with hypertension. Our findings suggest that the rise in hypertension prevalence reported in our other study[8] was because of an increase in incidence and a decline in mortality. It is also possible that physicians are improving their detection of hypertension and are detecting it earlier, thereby also contributing to the increasing prevalence. Previous projections for increasing prevalence in developed countries[9] were likely underestimated because they did not take into account the contribution of all of these factors.

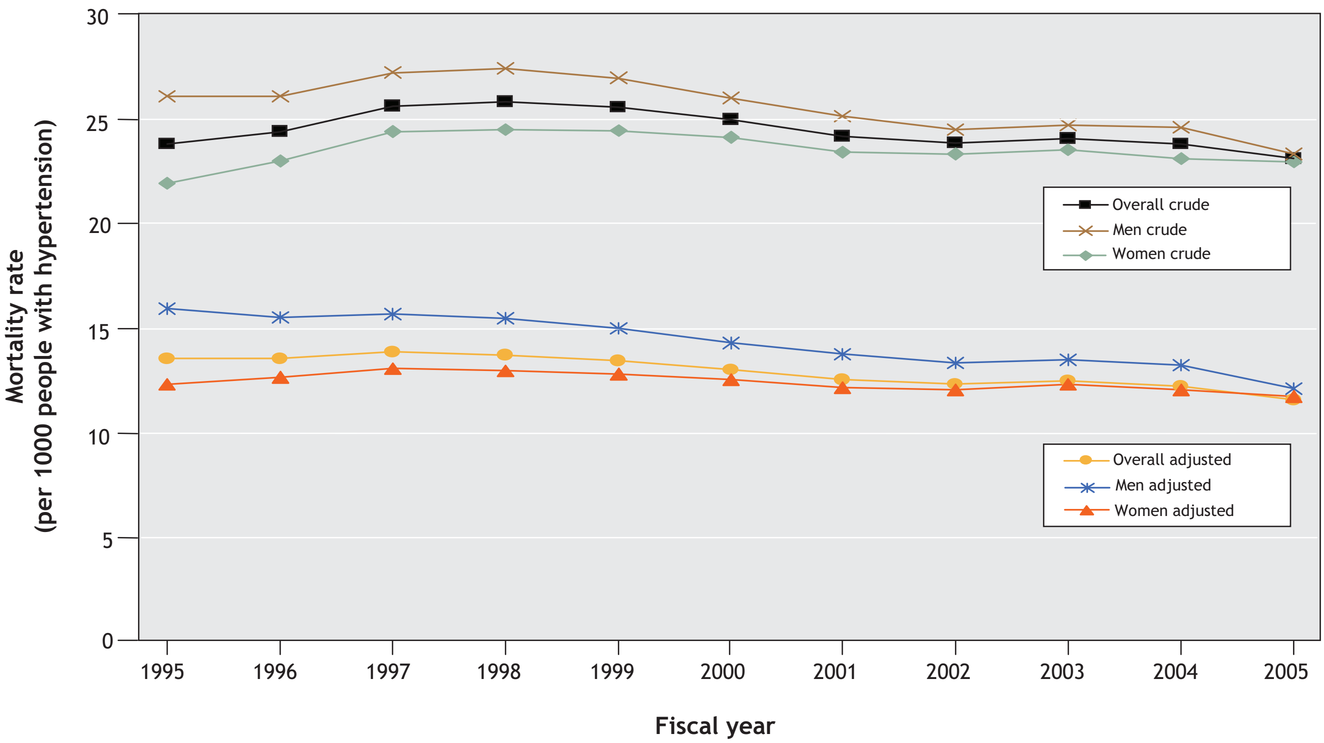

Figure 1: Annual crude and multivariable adjusted mortality rates among people with hypertension. Yearly rates are based on death by Mar. 31 of each year. Data were adjusted by logistic regression for age, sex, rural residence location, socioeconomic status, diabetes, 5-year history of cardiovascular disease, Charlson score and interaction between age and sex. The adjusted trends for overall and men were significant ($p < 0.001$), as was the adjusted trend for women ($p < 0.012$).

Table 2: Characteristics of patients with prevalent hypertension in 1995, 2000 and 2005, by survival status

Characteristic	Year; no. (%) of people					
	1995* *n* = 1 112 356		2000* *n* = 1 653 408		2005* *n* = 2 257 566	
Diabetes						
Alive (prior to the start of the fiscal year)†	182 867	(16.4)	293 313	(17.7)	452 562	(20.0)
Dead (prior to date of death)†	7 589	(28.0)	13 016	(30.7)	18 388	(34.4)
Total (prior to date of death)	190 456	(17.1)	306 329	(18.5)	470 950	(20.9)
Charlson Comorbidity Index score						
Alive (one year prior to start of the fiscal year)†						
0	1 082 026	(97.3)	1 591 359	(96.2)	2 149 403	(95.2)
1	17 015	(1.5)	34 642	(2.1)	55 637	(2.5)
2+	13 315	(1.2)	27 407	(1.7)	52 526	(2.3)
Dead (one year prior to date of death)†						
0	6 343	(23.4)	11 649	(27.5)	16 039	(30.0)
1	4 507	(16.6)	6 298	(14.9)	7 855	(14.7)
2+	16 272	(60.0)	24 454	(57.7)	29 582	(55.3)
Cardiovascular disease						
Alive (five years prior to start of the fiscal year)†	83 090	(7.5)	150 706	(9.1)	216 381	(9.6)
Dead (five years prior to date of death)†	11 461	(42.3)	19 407	(45.8)	23 330	(43.6)
Total (five years prior to date of death)	94 551	(8.3)	170 113	(10.0)	239 711	(10.4)
Socioeconomic status						
Alive†						
1st (lowest)	245 168	(22.0)	343 951	(20.8)	432 083	(19.1)
2nd	246 972	(22.2)	356 478	(21.6)	462 994	(20.5)
3rd	220 436	(19.8)	332 307	(20.1)	457 768	(20.3)
4th	195 972	(17.6)	304 908	(18.4)	451 040	(20.0)
5th (highest)	195 490	(17.6)	303 654	(18.4)	436 529	(19.3)
Undefined	8 318	(0.7)	12 110	(0.7)	17 152	(0.8)
Dead†						
1st (lowest)	7 035	(25.9)	10 509	(24.8)	12 064	(22.6)
2nd	6 302	(23.2)	9 700	(22.9)	11 927	(22.3)
3rd	5 186	(19.1)	8 453	(19.9)	10 725	(20.1)
4th	4 290	(15.8)	6 707	(15.8)	9 596	(17.9)
5th (highest)	4 190	(15.4)	6 868	(16.2)	8 967	(16.8)
Undefined	119	(0.4)	164	(0.4)	197	(0.4)
Rural residence location						
Alive						
Yes†	160 682	(14.4)	236 854	(14.3)	318 338	(14.1)
Undefined	5 061	(0.5)	7 340	(0.4)	10 423	(0.5)
Dead						
Yes†	4 452	(16.4)	6 796	(16.0)	8 407	(15.7)
Undefined	31	(0.1)	48	(0.1)	41	(0.1)
Total	165 134	(14.5)	243 650	(14.4)	326 745	(14.1)

*By March 31.
†$p < 0.0001$ for all categories (Cochran-Armitage Trend test) except for death among rural residents ($p = 0.009$).

Despite the increasing presence of comorbidities among patients with hypertension, the decrease in mortality rates suggests that patients with hypertension are increasingly receiving appropriate treatment, thus preventing death. Although we were unable to include prescribing data for patients aged 65 years or less, studies examining prescribing patterns and rates among elderly patients[6,7] support the likelihood that these patients are increasingly receiving antihypertensive medications that improve survival.

Whether the observed decrease in mortality among patients with hypertension was caused by decreased cardiovascular mortality cannot be determined with the available administrative data because cause of death is not reliably recorded.[19]

Although mortality rates among men with hypertension are higher than among women, the gap between the rates has narrowed over time. The differences in mortality rates between men and women were more pronounced in the older age groups. Studies have reported undertreatment of hypertension among older people after acute myocardial infarction[20] and more aggressive treatment in men with acute myocardial infarction compared with women; however, no previous study has found a difference in long-term mortality.[21] Whether hypertension in men or younger people is being treated more aggressively or managed differently warrants further investigation.

The overall decrease in mortality rates among patients with diagnosed hypertension is encouraging. Future research should focus on determining whether sex-related discrepancies in treatment account for the substantially lower decrease in mortality rates among women with hypertension.

This article has been peer reviewed.

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