

Prevalence, incidence, awareness and control of hypertension in the province of Quebec: Perspective from administrative and survey data

Claudia Blais, PhD,^{1,2} Louis Rochette, MSc,¹ Denis Hamel, MSc,¹ Paul Poirier, MD, PhD^{2,3}

ABSTRACT

OBJECTIVES: Hypertension is a major risk factor for cardiovascular diseases. Nearly one adult in four was diagnosed with hypertension in 2007-2008 in Canada. One of the objectives of this study was to determine whether the prevalence of hypertension in Quebec as assessed using administrative data is comparable to that specifically measured, especially for the elderly population.

METHODS: Trends in prevalence, incidence and mortality were examined using the Quebec Integrated Chronic Disease Surveillance System built from grouping numerous administrative databases from 1996-1997 to 2009-2010. Blood pressure measurements, hypertension prevalence, awareness and control were obtained in 1,706 Quebecers in the combined cycles of the Canadian Health Measures Survey.

RESULTS: Using administrative databases, 23.6% [95% confidence interval, 23.5-23.6] of the Quebec population (n=1,433,400) aged ≥ 20 years was diagnosed with hypertension in 2009-2010, an increase of 32.1% compared to 2000-2001. The incidence decreased by 27.3%. Among people aged ≥ 65 years, the prevalence rose to 69.0% [95% CI: 68.8-69.2] in women and 61.7% [95% CI: 61.5-61.9] in men. For people aged 20-79 years, the prevalence of hypertension was lower with the administrative data compared to the survey (20.2% and 23.1%, respectively). The level of awareness, treatment and control were 84.3%, 83.1% and 67.9%, respectively.

CONCLUSION: The prevalence of hypertension derived from administrative data is comparable to that obtained with a health measured survey. Elderly women (≥ 65 years) are a very high-risk subgroup. The levels of awareness, treatment and control of hypertension in Quebec are very high.

KEY WORDS: Hypertension; public health surveillance; trends; administrative data; survey data

La traduction du résumé se trouve à la fin de l'article.

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Among modifiable risk factors associated with cardiovascular diseases, systemic hypertension is the leading one in terms of risk for mortality, responsible for 13% of deaths globally.¹ In 2009, the cost of antihypertensive treatment to the Quebec government alone was \$589 million.² The importance of this risk factor for heart, renal and vascular diseases is well known, which is why population studies are essential to assess its prevalence over time. It was recently demonstrated using administrative databases all over Canada, that nearly 6 million Canadians aged ≥ 20 years were hypertensive in 2007-2008 (crude prevalence of 23.0%).³ Moreover, according to the 2007-2009 Canadian Health Measures Survey (CHMS) and the 2007-2008 Canadian Community Health Survey (CCHS), the prevalence of hypertension was 19.5% and 18.2%, respectively, for Canadian adults aged 20 to 79 years, whereas it was 20.3% according to administrative data (2007/2008).^{4,5}

The three sources of data have their strengths and limitations. Administrative databases contain data for all Quebecers and are continually updated, however they tend to concentrate on those who are diagnosed and actively consulting physicians, and they under-report hypertension in the presence of other diseases. Survey data estimate either self-reported diagnosed or measured hypertension, the latter being expensive and limited to a few representative people, especially with direct physical measures. The aim of this study was to compare the prevalence of hypertension using both sources of data, in the province of

Quebec. We also concentrated our comparison on people at higher risk, i.e., the elderly population. The levels of hypertension awareness, treatment and control were also assessed with the CHMS since it combined information on direct measurements with self-reported diagnosis and treatment.

METHODS

Data sources

Administrative Databases

The methodology used to conduct the surveillance of hypertension is based on the Canadian Chronic Disease Surveillance System, a collaborative network of provincial and territorial surveillance systems supported by the Public Health Agency of Canada.³ The Quebec Integrated Chronic Disease Surveillance System (QICDSS) of the Institut national de santé publique du Québec was used to determine if a person has a

Author Affiliations

1. Institut national de santé publique du Québec, Québec, QC
 2. Faculté de pharmacie, Université Laval, Québec, QC
 3. Institut universitaire de cardiologie et de pneumologie de Québec, Québec, QC
- Correspondence:** Claudia Blais, Institut national de santé publique du Québec, Québec, QC, 945, avenue Wolfe, Québec (Québec) G1V 5B3, Tel: 418-650-5115, ext. 5708, Fax: 418-643-5099, E-mail: claudia.blais@inspq.qc.ca
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diagnosis of hypertension. It consists of five linked administrative databases with records dating from January 1, 1996 and updated annually; two of the databases were used for this study: 1) the physician billing database from the Régie de l'assurance maladie du Québec (RAMQ), and 2) the hospitalization database. The first database includes all procedures billed to the RAMQ, while the second is referring to the principal diagnosis and up to 15 or 25 secondary diagnoses associated with hospitalization stays, depending on whether the stay came before or after April 1, 2006. In both databases, the International Classification of Diseases (ICD) was used; dating from April 1, 2006, the 10th ICD version was used in the hospitalization database. Demographics and geographical data such as age, sex, postal code and date of death as well as information on eligibility for health insurance were obtained from the register of insured persons (FIPA). In addition, the death file was used for information on the causes of death (coded in ICD-10 since January 1, 2000). The denominator for calculating the rate was determined according to 2006 Canadian census data, specifically population estimates for 2000 to 2005 and population projections for 2006 and over.

Canadian Health Measures Survey

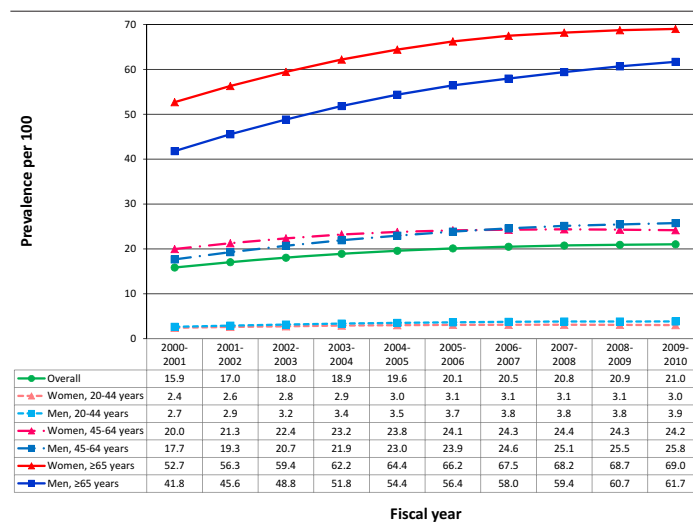
The CHMS is a cross-sectional survey from Statistics Canada that aims to collect important health information through a household interview followed by direct physical measurements at a mobile laboratory centre for individuals aged between 6 and 79 years living in privately occupied dwellings in the 10 provinces and the 3 territories of Canada. Full-time members of the Canadian Forces, and residents of Crown lands or Indian reserves, institutions and certain remote regions were excluded.⁶ The collection sites were created using the Labour Force Survey's area frame, grouped as well with respect to provincial and census metropolitan-area boundaries and population density criteria. Sites were then randomly selected using a systematic sampling method with probability proportional to the size of each site's population. Four representative sites in Quebec were interviewed in each cycle (cycle 1: 2007-2009, cycle 2: 2009-2011). Blood pressure (BP) on the right arm was measured 6 times at one-minute intervals, in the sitting position, following a 5-minute rest period according to a protocol created by the CHMS.⁷ Measurements were taken using an oscillometric BP measurement automated electronic device and the last 5 measurements were used.^{4,8} In the household interview, respondents were asked questions consistent with those in other Statistics Canada health surveys: "Do you have high BP?" (diagnosed by a health professional) and "In the past month, have you taken any medicine for high BP?" Pregnant women and people aged between 6 and 19 years were excluded from our analysis.

Definitions

Administrative Databases

To be considered hypertensive, an individual aged ≥20 years should be eligible for health insurance in Quebec, and have either ≥2 diagnoses of hypertension on the physician billing database within a two-year period, or 1 diagnosis (primary or secondary) of hypertension recorded in the hospitalization

Figure 1A. Age-standardized* prevalence of diagnosed hypertension in men and women aged 20 years and older in Quebec, by age group, 2000-2001 to 2009-2010



* Age-standardized to the 2001 Quebec population. Source: Quebec Integrated Chronic Disease Surveillance System (QICDSS) of the Institut national de santé publique du Québec.

database.³ The following diagnostic codes were used: 401 to 405 for ICD-9 and I10 to I13 and I15 for ICD-10. In order to exclude cases of gestational hypertension, all hypertension diagnoses for women aged 20 to 54 years recorded in a window 120 days before or 180 days after any obstetrical-related hospital admission were not considered. Diagnostic codes used to identify these events were: 641 to 676 and V27 for ICD-9, and O10-O19, O21-O95, O98, O99 and Z37 for ICD-10. This case definition has been validated in three Canadian provinces with sensitivity of 66-72% and specificity of 95-97%.^{9,10}

The observation period used runs from January 1, 1996 to March 31, 2010. However, a minimum of four years is necessary to distinguish incident cases from prevalent cases diagnosed before January 1996. Thus, measures are presented from 2000-2001.

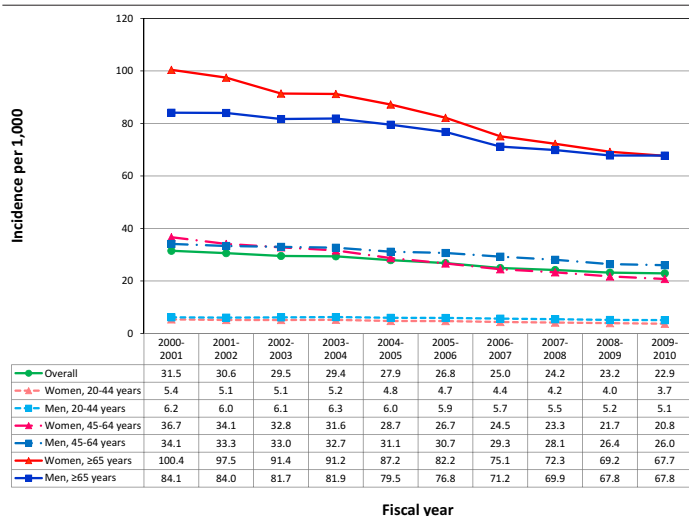
Canadian Health Measures Survey

Hypertension was defined as an average measured systolic or diastolic blood pressure (SBP/DBP) ≥140/90 mm Hg or self-reported use of BP-lowering medication in the last month. Awareness of hypertension was defined as a self-report of either medically diagnosed hypertension or BP medication use in the past month.⁴ Treatment of hypertension was defined as the self-reported use of BP-lowering medication within the last month. BP control was reported as an average currently treated (with medication) SBP/DBP <140/90 mm Hg. The three latter measures were calculated among all those with hypertension.^{4,11}

Statistical analysis

Prevalence, incidence and mortality using administrative databases were calculated as in Robitaille et al.³ Age-adjusted rates are used to analyze time trend, using the 2001 Quebec population aged ≥20 years as the standard population. Relative changes (%) of prevalence, incidence and mortality over time are obtained by dividing the difference between the first and final

Figure 1B. Age-standardized* incidence of diagnosed hypertension in men and women aged 20 years and older in Quebec, by age group, 2000-2001 to 2009-2010



* Age-standardized to the 2001 Quebec population. Source: Quebec Integrated Chronic Disease Surveillance System (QICDSS) of the Institut national de santé publique du Québec.

rates by the rate of the first year multiplied by 100. The relative difference between sexes is obtained by dividing the difference in rates by the one from men multiplied by 100. Regarding the CHMS, frequencies and means were produced to estimate the prevalence of hypertension, distribution of BP, awareness, treatment, and control by using the combined sampling weights from both cycles. Bootstrap techniques and Student t distribution (with 6 degrees of freedom for Quebec data) were used to calculate the 95% confidence intervals of estimates and the statistical t test on differences between estimates. Statistical analyses were performed with SAS Enterprise Guide version 5.1 (Cary, NC, USA). P-values <0.05 were considered significant.

RESULTS

Administrative data

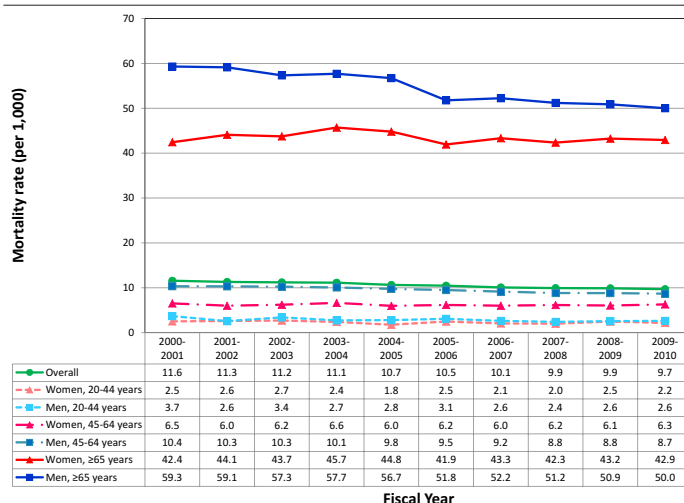
Prevalence

In 2009-2010, the number of Quebecers aged ≥20 years with diagnosed hypertension was approximately 1,433,400. This represents a crude prevalence of 23.6% [95% confidence interval (CI), 23.5-23.6] and an age-standardized prevalence of 21.0% [95% CI, 21.0-21.1]. Figure 1A shows that the age-standardized prevalence of diagnosed hypertension increased in both sexes by 32.1% between 2000-2001 and 2009-2010. In people aged ≥65 years, the prevalence was much higher among women (p<0.05). In fact, this proportion rose to 69.0% [95% CI, 68.8-69.2] and 61.7% [95% CI, 61.5-61.9] for women and men, respectively, in 2009-2010.

Incidence

Globally, there were approximately 86,900 individuals diagnosed with hypertension in each of the last 5 years of the study. In 2009-2010, the crude incidence rate was 17.2 per 1000 person-years [95% CI, 17.1-17.3]. The overall incidence decreased by

Figure 1C. Age-standardized* all-cause mortality rate of men and women aged 20 years and older with diagnosed hypertension in Quebec, by age group, 2000-2001 to 2009-2010



* Age-standardized to the 2001 Quebec population. Source: Quebec Integrated Chronic Disease Surveillance System (QICDSS) of the Institut national de santé publique du Québec.

27.3% between 2000-2001 and 2009-2010 (Figure 1B). In people aged ≥65 years, there is also a higher incidence among women, but in the final year, the incidence among men reached a comparable level.

Mortality

As shown in Figure 1C, between 2000-2001 and 2009-2010, there was a reduction of 16.4% of mortality in people with diagnosed hypertension. The mortality rate was always higher in men vs. women, particularly in the elderly group with a 14.2% higher mortality rate in men in 2009-2010.

Causes of death

Table 1 shows the 10 leading causes of death in individuals with diagnosed hypertension who died between January 1, 2000 and December 31, 2007. These causes of death explain 43.2% of all deaths. Of these, cardiovascular etiologies and cancer were responsible for 20.2% and 14.1% of deaths, respectively. When we consider all causes of death, the proportion from cardiovascular causes as the main cause (ICD-10: I00 to I99) decreased from 39.4% to 30.8% between 2000 and 2007. Cardiovascular etiologies were present (main or secondary causes) in 62.8% and 56.7% over the same period.

Canadian Health Measures Survey

BP measures were obtained in a sample of 1,706 Quebecers which is weight-representative of the Quebec population aged 20 to 79 years, excluding 13 pregnant women. Average SBP/DBP was 113/72 mm Hg [95% CI, 111-116/70-74]. As illustrated in Figure 2, in the younger age group, both the average SBP and DBP were higher among men (110/72 mm Hg [95% CI, 107-114/70-74]) than among women (103/68 mm Hg [95% CI, 101-105/66-70]), p<0.0001 and p=0.002 for SBP and DPB, respectively. However, among people aged 65-79 years, the average SBP and DBP were similar between women (126/70 mm Hg [95% CI, 123-129/69-74])

Table 1. The 10 leading causes of death in people aged 20 years and older in Quebec with diagnosed hypertension, January 1, 2000 to December 31, 2007

Rank	ICD-10 code	Description	Proportion of death (%)
1	I21.9	Acute myocardial infarction, unspecified	9.54
2	C34.9	Malignant neoplasm of bronchus or lung, unspecified	8.16
3	I25.1	Atherosclerotic heart disease	6.89
4	J44.9	Chronic obstructive pulmonary disease, unspecified	4.14
5	I64	Stroke, not specified as haemorrhage or infarction	3.80
6	F03	Unspecified dementia	2.56
7	C18.9	Malignant neoplasm of colon, unspecified	2.31
8	G30.9	Alzheimer's disease, unspecified	2.19
9	C50.9	Malignant neoplasm of breast, unspecified	2.00
10	C25.9	Malignant neoplasm of pancreas, unspecified	1.60

Source: Quebec Integrated Chronic Disease Surveillance System (QICDSS) of the Institut national de santé publique du Québec.

Table 2. Percentage of Quebecers aged 20-79 years with hypertension* according to their treatment and their blood pressure control

Treated				Untreated			
Both sexes (%)	Women (%)	Men (%)	p-value	Both sexes (%)	Women (%)	Men (%)	p-value
83.1	86.8	79.4	>0.25	16.9	13.2	20.6	>0.25
Controlled				Uncontrolled			
Both sexes (%)	Women (%)	Men (%)	p-value	Both sexes (%)	Women (%)	Men (%)	p-value
67.9	72.5	63.2	>0.4	15.2	14.3	16.2	>0.80

* SBP/DBP ≥140/90 mm Hg or self-reported current use of antihypertensive medication in the last month.

Source: Canadian Health Measures Survey Cycle 1 (2007-2009) and Cycle 2 (2009-2011).

and men (123/71 mm Hg [95% CI, 120-127/69-74]), p=0.204 and p=0.338 for SBP and DPB, respectively.

The overall crude prevalence of hypertension was 23.1% [95% CI, 20.7-25.5] for both sexes (22.6% [95% CI, 18.1-27.1] in men and 23.6% [95% CI, 19.3-27.9] in women, p>0.5). Awareness of hypertension was 84.3%. It was similar between women (87.4%) and men (81.1%); p>0.5. As the prevalence of hypertension increases with age (60.4% in people aged 65-79 years), so does the awareness (89.3%). As shown in Table 2, treatment of hypertension was 83.1% and was similar between women and men (86.8% vs. 79.4%, p>0.25). Almost 70% had their BP controlled and this was similar between men and women.

As shown in Figure 3, for both sexes and ages 20-79 years, the crude prevalence of hypertension based on administrative database (20.2% [95% CI, 20.1-20.2]) is only 3 points of a percentage lower than one obtained with the measurement/medication in the CHMS (23.1% [95% CI, 20.7-25.5], p<0.05). The prevalence of the auto-declared hypertension was lower (20.9% [95% CI, 18.2-23.6]) but not statistically different from the measurement/medication. This difference between the administrative data and measurement/medication prevalence of hypertension is not driven by the difference observed in sexes separately.

DISCUSSION

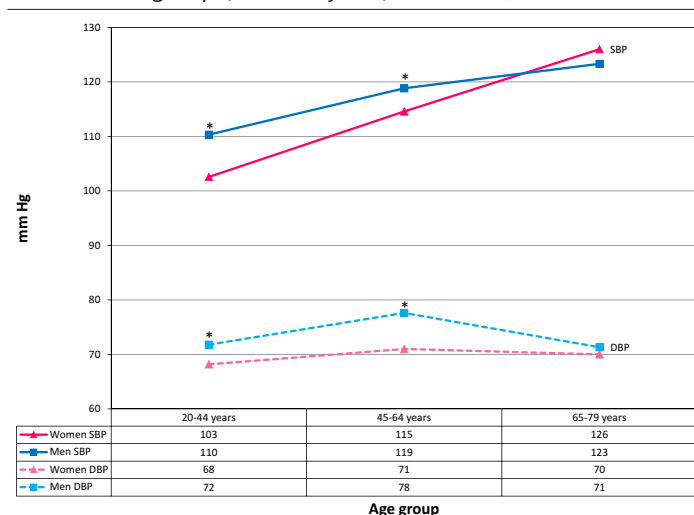
This is the first study comparing hypertension prevalence in the province of Quebec using different sources of data. For people aged 20-79 years, the prevalence determined via administrative database (20.2%) is comparable to the one auto-declared (20.9%) while the measurement/medication was 23.1%. This is also the first study that estimated trends in hypertension prevalence, incidence and mortality in Quebec. Using the most recent administrative data, hypertension was diagnosed in approximately 1,433,400 individuals aged ≥20 years in 2009-2010 in the province of Quebec (23.6%). Globally, though the

prevalence of diagnosed hypertension is increasing (a rise of 32% in the last decade), both incidence and mortality are decreasing (27% and 16%, respectively). The difference between men and women for the year 2009-2010 in the prevalence (+12% for women) and mortality (-14% for women) of hypertension was most important for patients aged ≥65 years. In fact, the prevalence of hypertension in elderly women was 69.0%, making this a very high-risk subgroup. Awareness, treatment and control of hypertension are very high in Quebec.

The relatively lower prevalence of hypertension in the administrative data compared to the measurement/medication use can be explained because hypertension is often asymptomatic and a small proportion of people could have discovered their hypertension at the mobile laboratory. This is especially true since the prevalence of the auto-declared hypertension is almost the same as that of the administrative data. However, a recent study demonstrated that in Canada, even if the prevalence of hypertension determined through the CHMS and the administrative data were similar, the one obtained with administrative data was 20.3% compared to 19.5% for the CHMS in 2007-2009.⁵ Nevertheless, both studies found that auto-declared hypertension was the lowest. Our prevalence was lower than those found in other developed countries such as England (33%), Denmark (26%), China (36%) and United States (30%).¹¹⁻¹⁴ Higher prevalence of hypertension in elderly women was also reported in China and Spain.^{13,15} Of note, the increase in prevalence of hypertension observed herein is higher than the one projected by Kearney et al.¹⁶ of 24% for developed countries between 2000 and 2025.

Awareness of hypertension (84.3%) was higher compared to many countries, such as China (43%), United States (74%), Finland (68%) and Denmark (72%).^{13,14,17,18} Drug treatment was also higher (83.1%) compared to China (36%) and Denmark (64%), with the result that control of hypertension was better (67.9% in Quebec vs. 12% in China, 46% in the United States,

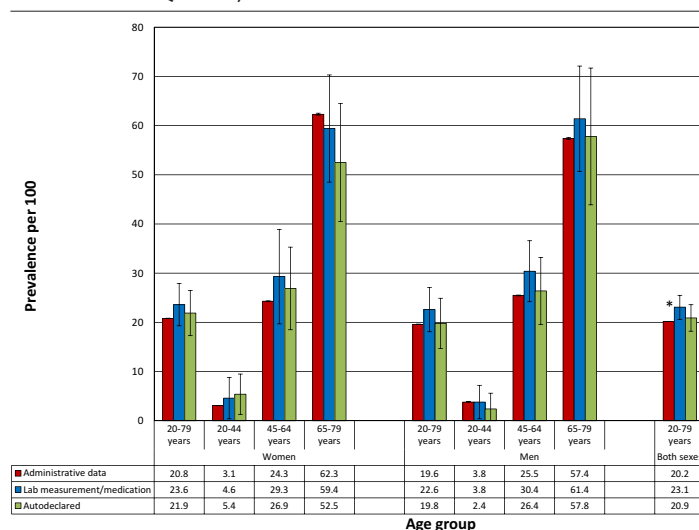
Figure 2. Mean measured systolic blood pressure (SBP) and diastolic blood pressure (DBP), by sex and age group (20 to 79 years) in Quebec, 2007-2011



* Statistically significantly different between men and women, in the same age group, $p < 0.05$.
 Source: Canadian Health Measures Survey Cycle 1 (2007-2009) and Cycle 2 (2009-2011).

and 57% in Denmark).¹¹ In fact, these results are comparable to those obtained in a different survey from our Ontario neighbours,¹⁹ which reported the highest population rates for drug treatment and control of hypertension worldwide. These high rates are compatible with the results of Gee et al. who reported that most Canadians diagnosed with hypertension are taking antihypertensive medications and are reporting adherence.²⁰ Since Canada has been recognized as a world leader in the prevention, treatment and control of hypertension, it is interesting to emphasize that Quebec, the country's second-largest province, is also observing these high rates.^{4,21} Furthermore, when looking at the population-adjusted number of antihypertensive prescriptions in 2006, Quebec had the greatest number (42,877 per 10,000 people) and was above the average Canadian level (26,486).²² Moreover, most Canadians with diagnosed hypertension are reporting sustained lifestyle modification to control their hypertension, such as limiting salt consumption (89%), changing the types of food they eat (89%), engaging in physical activity (80%), etc.²³ The greater awareness, treatment and control found in Quebecers can be seen in light of the introduction, in 1999, of the Canadian Hypertension Education Program (CHEP), an extensive national knowledge translation strategy for professionals to improve hypertension management.^{21,24,25} This program has increased the diagnosis and treatment of hypertension and is viewed as an international model regarding knowledge translation.²⁶⁻²⁸ Moreover, another study demonstrated that 46% of Canadian adults with hypertension are monitoring their BP at home, explaining in part these high numbers.²⁹ The decrease in cardiovascular deaths between 2000 and 2007 (22%) could also be seen to be a result of this program. Nonetheless, the majority of the people with diagnosed hypertension who died did so as a result of coronary heart disease (CHD: 16.4%), while stroke (3.8%) was the fifth-leading cause. These results are in agreement with those of Arima et al., underlying that CHD causes most cardiovascular deaths

Figure 3. Prevalence of hypertension based on administrative database, blood pressure measurement/medication use† and auto-declared‡, by sex and age group in Quebec, 2007-2011



* Statistically significantly different from hypertension prevalence with measurement/medication, $p < 0.05$.
 † SBP/DBP $\geq 140/90$ mm Hg or self-reported current use of antihypertensive medication in the last month.
 ‡ Questions asked: "Do you have high blood pressure?" or "In the past month, have you taken any medicine for high blood pressure?"
 Source: Quebec Integrated Chronic Disease Surveillance System (QICDSS) of the Institut national de santé publique du Québec (administrative data, year 2008-2009) and Canadian Health Measures Survey Cycle 1 (2007-2009) and Cycle 2 (2009-2011).

among hypertensive Caucasian populations of the "Western world".³⁰

Limitations

The prevalence of hypertension might have been underestimated because of the elderly population not surveyed or those living in nursing homes or other institutions not captured in either administrative or survey data. Provincial representativeness of the collection sites in Quebec produced with the CHMS may not be optimal since the sample design was nationally done. People who achieved BP control by non-pharmacological means, such as dietary and lifestyle modification, are not included, resulting in an underestimation of the "real" hypertension prevalence and control in the survey. Even when BP was measured 6 times following a standard protocol, this was performed during only a single visit. Self-reported information, particularly on the use of BP medications, might be subject to misunderstanding and/or recall bias. Information on neither dosage nor compliance are available in the survey. Statistical power is another limitation of the CHMS, especially when comparing sexes and age subgroup. Administrative data are only capturing people in contact with the health care system, and in the case of multiple associated comorbidities, such as diabetes, hypertension would not be the first diagnosis in the physician billing database. As 75% of patients with diabetes also have hypertension, this can be a frequent situation.³¹ Finally, the time comparison of hypertension prevalence between administrative and survey data was not exactly the same.

Although the prevalence of diagnosed hypertension has increased in the province of Quebec, this could be attributable in

part to a decrease in mortality and not to an increased incidence since the latter is decreasing. It is noteworthy to underline that the highest prevalence of hypertension, i.e., in elderly women, is increasing dramatically over time, while their mortality is lower compared to men. The level of awareness, treatment and control of hypertension in Quebec is one of the highest in the world. More importantly, the prevalence of hypertension obtained with administrative data is comparable to that obtained with the measurement/medication from a survey and should be used, especially to examine the burden of cardiovascular diseases in Quebec, where it is accessible, continually updated and this at a low cost and for all people, whatever their age or socio-economic status. Moreover, these linked databases allow the determination of incidence, mortality and drug consumption. Even with the strong agreement between administrative and survey data, future directions should include linking the CHMS with the QICDSS using the personal health insurance number. This linkage will allow comparison of cases identified in the CHMS with those identified using administrative data. These results on prevalence, awareness and control of hypertension are important for clinical care, health care and public health planning, and underline the need to reduce the burden of this silent killer, especially among elderly people.

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RÉSUMÉ

OBJECTIFS : L'hypertension artérielle est un facteur de risque majeur des maladies cardiovasculaires. Près d'un adulte sur quatre a été diagnostiqué hypertendu en 2007-2008, au Canada. Un des objectifs de cette étude était de déterminer si la prévalence de l'hypertension au Québec obtenue à partir de données médico-administratives est comparable à celle mesurée, en particulier chez les personnes âgées.

MÉTHODES : Les tendances de la prévalence, de l'incidence et de la mortalité ont été examinées avec le Système Intégré de Surveillance des Maladies Chroniques du Québec regroupant de nombreuses bases de données médico-administratives de 1996-1997 à 2009-2010. Des mesures de pression artérielle, de prévalence d'hypertension, de conscience et de contrôle ont été obtenus chez 1 706 Québécois dans les cycles combinés de l'Enquête canadienne sur les mesures de la santé.

RÉSULTATS : En utilisant les données médico-administratives, 23,6 % [intervalle de confiance à 95%, 23,5-23,6] de la population du Québec (n=1 433 400) âgés de ≥20 ans a été diagnostiqué hypertendu en 2009-2010, ce qui représente une augmentation de 32,1 % comparativement à 2000-2001. L'incidence a diminué de 27,3 %. Parmi les personnes âgées de ≥65 ans, cette prévalence est passée à 69,0 % [IC à 95%, 68,8-69,2] chez les femmes et à 61,7 % [IC à 95%, 61,5-61,9] chez les

hommes. Pour les personnes âgées de 20-79 ans, la prévalence de l'hypertension était inférieure avec les données médico-administratives comparativement à celles avec l'enquête (20,2 % et 23,1 %, respectivement). Les niveaux de conscience, traitement et de contrôle étaient de 84,3 %, 83,1 % et 67,9 %, respectivement.

CONCLUSION : La prévalence de l'hypertension provenant des données médico-administratives est comparable à celle obtenue avec une enquête des mesures de la santé. Les femmes âgées (≥ 65 ans) sont un sous-groupe à risque très élevé. Les niveaux de conscience, de traitement et de contrôle de l'hypertension au Québec sont très élevés.

MOTS CLÉS : hypertension; surveillance de la santé publique; tendances; données médico-administratives; données d'enquête