

Hypertension Treatment and Control in Five European Countries, Canada, and the United States

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Abstract—Levels of hypertension treatment and control have been noted to vary between Europe and North America, although direct comparisons with similar methods have not been undertaken. In this study, we sought to estimate the relative impact of hypertension treatment strategies in Germany, Sweden, England, Spain, Italy, Canada, and the United States by using sample surveys conducted in the 1990s. Hypertension was defined as a blood pressure of 160/95 mm Hg or 140/90 mm Hg, plus persons taking antihypertensive medication. “Controlled hypertension” was defined as a blood pressure less than threshold among persons taking antihypertensive medications. Among persons 35 to 64 years, 66% of hypertensives in the United States had their blood pressure controlled at 160/95 mm Hg, compared with 49% in Canada and 23% to 38% in Europe. Similar discrepancies were apparent at the 140/90 mm Hg threshold, at which 29% of hypertensives in the United States, 17% in Canada, and $\leq 10\%$ in European countries had their blood pressure controlled. At the 140/90 mm Hg cutpoint, two thirds to three quarters of the hypertensives in Canada and Europe were untreated compared with slightly less than half in the United States. Although guidelines vary among countries, resulting in different case definitions, this does not account entirely for the varying success of different national control efforts. Low treatment and control rates in Europe, combined with a higher prevalence of hypertension, could contribute to a higher burden of cardiovascular disease risk attributable to elevated blood pressure compared with that in North America. (*Hypertension*. 2004;43:10-17.)

Key Words: hypertension, detection and control ■ antihypertensive therapy ■ blood pressure monitoring ■ models, statistical ■ cross-sectional studies

High blood pressure (BP) is estimated to account for 6% of deaths worldwide¹ and is the most common treatable risk factor for cardiovascular disease (CVD). During the last 30 years, hypertension treatment has improved dramatically, contributing to a decrease in the incidence of mortality due to stroke and coronary heart disease (CHD).² The majority of patients' BPs remain uncontrolled in all societies, and the decline in CVD, particularly stroke, has slowed in some countries.³⁻⁵

Hypertension has the unusual attribute of being sufficiently common to represent a public health concern, yet its control depends primarily on the successful treatment of individual patients by physicians. A crucial step in this process is therefore the explicit recommendations given to medical professionals and the practical consequences of these treatment strategies in particular health systems. Vigorous debate continues over appropriate thresholds for initiating treatment of high BP.⁶ During the last decade, risk stratification, with

the intent of focusing attention on persons with high levels of CVD risk, has been promoted by specialists, decision makers in health systems, and professional advisory bodies.⁷⁻¹¹ This approach has led to conflicting international treatment thresholds, however, that might in turn lead to differing levels of hypertension treatment and control. The degree of intensity of screening for target-organ damage in persons at low to medium risk will also lead to variable case definition.^{12,13} The public health impact of these various standards for evaluation and treatment urgently needs to be evaluated.

Unlike most medical conditions, community surveillance has been the most common approach to evaluating the success of efforts to treat and control high BP. Although surveys are not a perfect evaluation tool, they are necessary to obtain information about persons who are unaware that they have hypertension or are not compliant with medical advice. During the past decade, many countries have conducted large-scale, national health surveys to determine the preva-

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TABLE 1. Characteristics of Selected National Surveys in Europe and North America

	US	Canada	England	Germany	Italy	Spain	Sweden
Survey year(s)	1988–1994	1986–1992	1998	1997–1999	1998	1990	1999
Sample	National	National	National	National	National	National	Regional
N	17 530	23 129	13 586	7124	8233	2021	1823
Participation, %	82	77.5	87.5	61.4	—	73	72
Age range, y	18–80+	18–74	16–80+	18–79	35–74	35–65	25–74
Sampling method*	Multistage, population registry	Multistage, medical insurance registries	Multistage, postal code address	Population registry	Multistage, population registry	Multistage, national registry	Population registry
BP measured by	Physician	Nurse	Nurse	Trained personnel	Nurse/trained personnel	Physician	Nurse/trained personnel
No. of BP measures	6	4	3	3	2	3	2
Minutes of rest before exam	5	5	5	5	5	5	5
Minutes of rest between measures	1	10–60	1	3	3	2	1
Mean SBP/DBP in mm Hg (35–64 years; men and women combined)	120/75	124/79	135/77	138/86	130/83	131/83	131/81

*All stratified sampling methods.

lence and treatment of hypertension in addition to other CVD risk factors.^{14–17} When measurements are comparable, these national surveys can also be used to make international comparisons.¹⁸ This information might provide insights into ways to improve public health strategies to prevent target-organ damage. The aim of this study was to use original data from surveys to compare levels of hypertension treatment and control in the United States, Canada, England, Germany, Sweden, Italy, and Spain.

Methods

Study Design

We reviewed surveys on hypertension treatment and control in Europe and North America since 1990 and identified those that were either national in scope or that comprised a series of regional samples, as previously described.¹⁹ Two North American and 5 European surveys were included: England,¹⁴ Germany,¹⁵ Spain,¹⁶ Italy,²⁰ Sweden,^{21,22} United States,²³ and Canada.¹⁷ Persons 35 to 74 years were available in all surveys except Spain, for which only persons up to age 65 were enrolled. Some of the studies were based on a random probability sample of the entire nation, whereas others were a series of regional samples; none were restricted mainly to a single province or subregion within the country (Table 1).

Data Selection

BP Measurements

The mercury sphygmomanometer was used for BP measurements in every country except for England, where the Dinamap 8100 was

used. All studies had at least 2 measurements, and the second BP was used to create the mean for the age-gender groups. Further details are presented in the earlier report of the prevalence findings.¹⁹

Hypertension Treatment and Control

Hypertension was defined by 2 standard criteria, namely, systolic BP (SBP) ≥ 160 or diastolic BP (DBP) ≥ 95 mm Hg; SBP ≥ 140 or DBP ≥ 90 mm Hg; or current use of antihypertensive medication. *Awareness* was defined as answering “yes” to the question: “Have you ever been told that you had high blood pressure?” *Treatment* was defined as current use of antihypertensive medications. In England, medication use was documented, whereas in all other surveys it was based on self-report. *Control* was defined as a BP $< 160/90$ or $< 140/90$ mm Hg among medicated hypertensives. The *control rate* (or, more precisely, the proportion) was the number of treated hypertensives with a BP $< 160/90$ or $< 140/90$ mm Hg divided by the total number of hypertensives. *Control in treated hypertensives* was defined as the number of controlled hypertensives divided by the number of treated hypertensives. Nonpharmacologic therapies have begun to receive greater attention, and some individuals might have controlled their elevated BP without drugs; we had inconsistent information in these samples to incorporate those interventions into the analyses.

Treatment Guidelines

Treatment guidelines vary among the studied countries and over time (Table 2). In the United States, irrespective of risk status, persons with an SBP or DBP of 140 or 90 mm Hg or greater are presently candidates for treatment, and among patients with CVD, renal disease, or diabetes, treatment is recommended for a BP $\geq 130/85$ mm Hg (Joint National Committee IV). At the time of National Health and Nutrition Survey (NHANES) III, however, the guidelines

TABLE 2. Summary of Key Aspects of Recent Hypertension Treatment Guidelines

Drug Treatment Thresholds	Canada ⁹	JNC-VI ⁴	WHO/ISH ⁷
No target-organ damage	BP $\geq 160/100$ mm Hg (or $\geq 160/105$ mm Hg if ≥ 60 years)*	BP $\geq 140/90$ mm Hg*	BP $\geq 150/95$ mm Hg*
With risk factors (other than DM)	BP $\geq 160/90$ mm Hg	BP $\geq 140/90$ mm Hg	BP $\geq 140/90$ mm Hg
With target-organ damage	BP $\geq 160/90$ mm Hg	BP $\geq 130/85$ mm Hg	BP $\geq 140/90$ mm Hg
With DM or renal disease	BP $\geq 140/90$ mm Hg	BP $\geq 130/85$ mm Hg	BP $\geq 130/85$ mm Hg

JNC indicates Joint National Committee; WHO, World Health Organization; ISH, International Society for Hypertension; and DM, diabetes mellitus.

*After trial of lifestyle modifications (specific length varies in guidelines according to severity of BP and risk factors).

were less stringent, with less emphasis on SBP. The Canadian guidelines in force in the 1990s recommended treatment at 160/100 mm Hg in "low-risk" individuals, decreasing to 140/90 mm Hg in patients with diabetes or renal disease.⁹ A variety of European guidelines have been promulgated, although most are broadly consistent with the World Health Organization/International Society for Hypertension approach that sets 150/95 mm Hg as the threshold in low-risk individuals, decreasing to 130/85 mm Hg in those with diabetes or renal disease.^{7,8,10} Revisions of these guidelines were adopted at various points in time relative to the surveys as well. Ideally, calculation of treatment and control should be based on the guideline in force at the time of data collection. Although that approach would yield historically accurate information within a given country, it would defeat the purpose of a comparison that requires a common standard across countries. To make the analysis relevant to current practice, we have therefore chosen to use the 2 most widely applied threshold values in discussions of treatment and control. We recognize that in several instances, 140/90 mm Hg will not have been the stated goal in a given country. Contrariwise, many persons with BPs <160/95 mm Hg will have been started on treatment by physicians, thus falsely elevating the apparent control rate when 160/95 mm Hg is used as the threshold. As a sensitivity analysis of the impact of risk stratification on treatment thresholds, we applied the national guidelines in force in Canada and the risk stratification in England and Spain to the data from those countries. Finally, to estimate the burden of uncontrolled, high BP in a category of patients who were included under all guidelines, we calculated the prevalence of BP >160/95 mm Hg; these results were calculated by dividing the number of persons with BP >160 or 95 mm Hg, regardless of treatment status, by the total number of participants.

Data Analysis

Hypertension prevalence and treatment and control rates were age-adjusted by averaging the 10-year age-gender groups. To achieve maximum overlap of data from the available surveys, we restricted the analysis to 35 to 64 years for age-adjusted results and used the age range 35 to 74 for age-specific data, omitting Spain from the category >65 years. In the United States, NHANES III data on whites, blacks, and Hispanics were combined with the appropriate weighting for population size. The English sample was risk-stratified to apply the local treatment algorithm that defines subgroups of hypertensives by using a model derived from the Framingham Heart Study, and the participants were divided at a 10-year CHD risk threshold of 15%.^{24,25} The Canadian and Spanish samples were also risk-stratified by using a global risk algorithm.⁹

Results

Hypertension Prevalence

The prevalence of age-adjusted hypertension (140/90 mm Hg or treatment) for persons 35 to 64 years was substantially lower in the United States (28%) and Canada (27%) compared with the European countries (Sweden [38%], Italy [38%], England [42%], Spain [47%], and Germany [55%]). These prevalence findings have been presented in detail in a previous report.¹⁹

Hypertension Treatment

Modest heterogeneity was observed in age- and gender-adjusted treatment rates at both the 160/95 and 140/90 mm Hg cutpoints among the studied European countries (Tables 3 and 4). Based on the current standard of 140/90 mm Hg, England had the lowest level of treatment (25%), followed by Sweden and Germany (both 26%), Spain (27%), and Italy (32%). Treatment of hypertension was highest in the United States (53%), followed by Canada (36%).

Women in all countries were more likely to be treated than men; gender differences were especially strong in the United States and Canada (44% in men vs 63% in women in the United States and 28% in men vs 45% in women in Canada, based on 140/90 mm Hg; Table 4). Heterogeneity was apparent in the gender-age treatment patterns in the United States compared with all other countries (data not shown). Although low levels of treatment were noted in Europe in the younger age groups of men, they approximated those in the United States by age 65. Among women, the proportion of hypertensives receiving treatment was reasonably constant across the age range in the United States, whereas it rose rapidly in other countries, reaching 50% in the elderly.

Hypertension Control

In the United States, two thirds of the hypertensive population had their BP controlled at the 160/95 mm Hg threshold, and the corresponding figure was 49% in Canada (Table 3 and Figure 1). Within Europe, control ranged from 23% in Spain to 38% in England. Gender differences were modest overall, favoring women in all countries. The percentage of hypertensives reported to be on treatment and having a BP <140/90 mm Hg was much lower in all European countries, ie, ≤10%. In contrast, 17% and 29% of hypertensives in Canada and the United States, respectively, were at the treatment goal (Table 4 and Figure 2). Control was 2-fold higher in women compared with men in Spain, Italy, Canada, and the United States. Consistent with treatment patterns, the proportion of hypertensive men at this threshold whose BP was controlled increased markedly with age, especially in the United States, where it rose from 9% at age 35 to 44% to 30% at age >65 years (Figure 3).

Hypertension control at the 140/90 mm Hg threshold among women in the youngest age group ranged from 5% to 13% in the European countries, 21% in Canada, and 36% in the United States (Figure 4). Levels of control among older women (65 to 74 years) were highest in the United States (37%), whereas levels of control in Canada were similar to those in Europe (5% to 17%).

The primary obstacle to an unbiased comparison across countries is the large number of persons with a pretreatment BP between 140/90 mm Hg and 160/95 mm Hg. These persons will be designated as "controlled" if the threshold of 160/95 mm Hg is applied, when they did not meet the case criteria, thus falsely elevating the rate. To eliminate this source of bias, a complementary analysis was undertaken to determine the proportion of study participants whose BP was uncontrolled at the 160/95 mm Hg threshold (ie, had BP higher than this value, whether treated or not). In the United States, the prevalence of uncontrolled hypertension at this level was 5.3% compared with 7.4% in Canada and 12% to 25% in Europe.

Although differences in criteria for diagnosis and thresholds for treatment alter case definitions, less variation would be anticipated in the level of control among treated cases. In fact, this was generally the case (Tables 3 and 4). Although control in treated patients was still highest in the United States (54%), rates in Canada and England were not much lower (47% and 40%, respectively), but Germany (30%),

TABLE 3. Age-Adjusted Hypertension Awareness, Treatment, and Control in the Population and Control in Treated Hypertensive Patients Aged 35–64 Years at the 160/95 mm Hg Threshold

	Hypertension Awareness in the Population, %	Hypertension Treatment in the Population, %	Hypertension Control in the Population, %*	Hypertension Control in Treated Hypertensives, %*
US				
Total	88.0	77.9	65.5	84.1
Men	83.2	70.6	57.0	80.7
Women	92.4	84.7	73.6	86.9
Canada				
Total	82.1	62.4	49.1	79.1
Men	77.4	52.8	39.1	75.5
Women	89.6	77.0	62.9	81.7
England				
Total	58.2	51.6	37.7	73.1
Men	54.1	46.6	33.5	71.9
Women	62.4	56.6	41.8	73.9
Germany				
Total	52.7	41.0	24.8	60.5
Men	46.9	35.3	20.3	57.5
Women	58.8	46.8	29.3	62.6
Italy				
Total	73.4	54.3	33.1	61.0
Men	68.7	46.7	26.0	55.7
Women	78.1	62.0	40.2	64.8
Spain				
Total	57.5	46.4	22.9	49.4
Men	51.9	39.6	17.3	43.7
Women	63.1	53.2	28.5	53.6
Sweden				
Total	70.6	48.5	27.4	56.5
Men	57.4	39.3	23.6	60.1
Women	83.8	57.7	31.1	53.9

*BP <160/95 mm Hg.

Italy (28%), and especially Spain (19%) and Sweden (21%) had lower results at the 140/90 mm Hg threshold.

Control in Hypertensives With Low and High CVD Risk

Based on most non-US guidelines, low-risk patients—generally defined as those with a BP <150/95 mm Hg without CVD risk factors—would not be candidates for treatment. Unfortunately, not all surveys had the CVD risk measurements required to apply risk stratification algorithms. The potential impact of excluding low-risk patients was examined in Spain, England, and Canada as illustrative examples by using the definitions in force in each of the specific countries.^{14,16,17} In Spain and England, control in low-risk hypertensives was 8% and 10% at the 140/90 mm Hg threshold, whereas these values were 1% and 4%, respectively, in those classified as high risk. In Canada, on the other hand, the comparable control rate was 15% for persons at low risk and 12% among those at high risk. Thus, high-risk patients (ie,

those targeted by local guidelines) actually had lower levels of treatment and control in Spain and England compared with Canada.

Discussion

Despite universal recognition of its importance in the control of CVD, this comparative analysis demonstrates that hypertension treatment has been pursued more aggressively in North America than in Europe. Guidelines in the respective countries and the published opinions of experts reflect divergent views regarding the relative value of which BP levels require treatment and how high risk is defined.^{4,7–10} In this study, we attempted to compare the overall effectiveness of various approaches through a standardized analysis of large, representative surveys. Based on a threshold of 160/95 mm Hg, apparent control rates were 23% to 38% in Europe, compared with 49% to 66% in the Canada and United States, respectively. When using the BP threshold of 140/90 mm Hg, almost one third of patients were treated and

TABLE 4. Age-Adjusted Hypertension Awareness, Treatment, and Control in the Population and Control in Treated Hypertensive Patients Aged 35–64 Years at the 140/90 mm Hg Threshold

	Hypertension Awareness in the Population, %	Hypertension Treatment in the Population, %	Hypertension Control in the Population, %*	Hypertension Control in Treated Hypertensives, %*
US				
Total	69.3	52.5	28.6	54.5
Men	62.5	43.5	19.9	45.8
Women	77.0	62.5	38.3	61.2
Canada				
Total	63.2	36.4	17.2	47.3
Men	57.0	27.6	9.8	35.6
Women	69.4	45.1	24.5	54.3
England				
Total	35.8	24.8	10.0	40.3
Men	34.1	23.2	9.2	39.7
Women	37.5	26.4	10.7	40.5
Germany				
Total	36.5	26.1	7.8	29.9
Men	32.5	22.6	5.8	25.7
Women	40.6	29.5	9.7	32.9
Italy				
Total	51.8	32.0	9.0	28.1
Men	46.4	26.7	6.0	22.5
Women	57.2	37.3	12.0	32.9
Spain				
Total	38.9	26.8	5.0	18.7
Men	36.6	23.0	3.3	14.3
Women	41.2	30.5	6.7	22.0
Sweden				
Total	48.0	26.2	5.5	21.0
Men	40.9	23.2	5.3	22.8
Women	55.1	29.2	5.7	19.5

*BP <140/90 mm Hg.

their BP was controlled in the United States, compared with 5% to 10% in the European countries, and the Canadian value was halfway between these extremes. Acknowledging that clinical guidelines vary among countries, we estimated the percentage of the population with BP >160 or 95 mm Hg, because placebo-controlled, randomized-trial evidence provides direct support for treatment in this group and this threshold is universally accepted. Only 5.3% of the US population had BPs above this level, compared with 7.4% in Canada and much higher levels in Europe, reaching 25% in Germany. Although overall control rates are subject to competing biases, as noted earlier, the “uncontrol rate” provides a directly comparable measure of relative success across countries. The rate of control among hypertensives receiving medication varied less, although the rank order of success by country was the same. These data dramatically reinforce the impression of previous individual reports that substantial heterogeneity exists in the approach to the control of CVD through pharmacologic treatment of elevated BP between Europe and North America.^{14–17,23,26}

We were not able to determine whether treatment and control levels differed by presence of specific CVD risk factors or diabetes/kidney disease. However, we demonstrated that patients designated as high risk by the treatment guidelines in England, Spain, and Canada had lower levels of BP control compared with those at low risk. This seemingly paradoxical result demonstrates the complexity of using community surveillance as a method of assessing the success of CVD prevention strategies. At least 2 explanations can be offered. First, many of the lower-risk patients are women, who are always better treated. Second, among the high-risk are the elderly and those with higher pretreatment BPs, which are inherently more difficult to control. Previous studies have documented lower levels of control in older hypertensive men at high risk compared with those at low risk²⁷ and similarly low levels of hypertension treatment and control among high-risk patients with CHD in several European countries.²⁸ After risk stratification, patients at high risk would need to be treated at a BP threshold lower than the threshold for those at

Age- and gender adjusted hypertension control by country (35-64 years); 160/95 mmHg

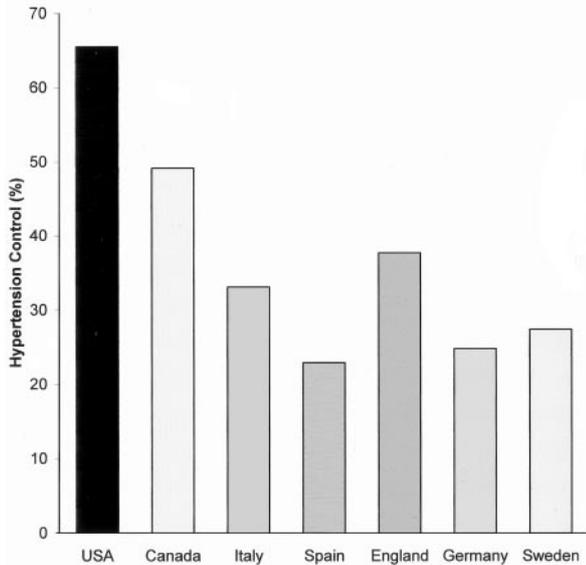


Figure 1. Age- and gender-adjusted hypertension control by country: 160/95 mm Hg.

low risk and consequently, should be better controlled. Of course, restricting treatment to only high-risk individuals is more cost-effective when measured at the level of the individual patient encounter. It might well be, however, that from the perspective of a health system that is already seeing patients for other reasons, adding treatment to those at lower risk adds little marginal cost. Concentrating only on high-risk patients will certainly limit the public health impact of BP control, because low-risk persons account for most of the

Age- and gender adjusted hypertension control by country (35-64 years); 140/90 mmHg

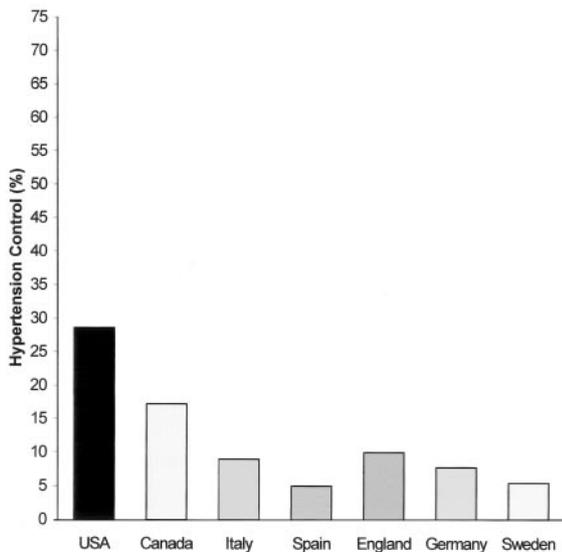


Figure 2. Age- and gender-adjusted hypertension control by country: 140/90 mm Hg.

Hypertension control for men, by age group and country; 140/90 mmHg

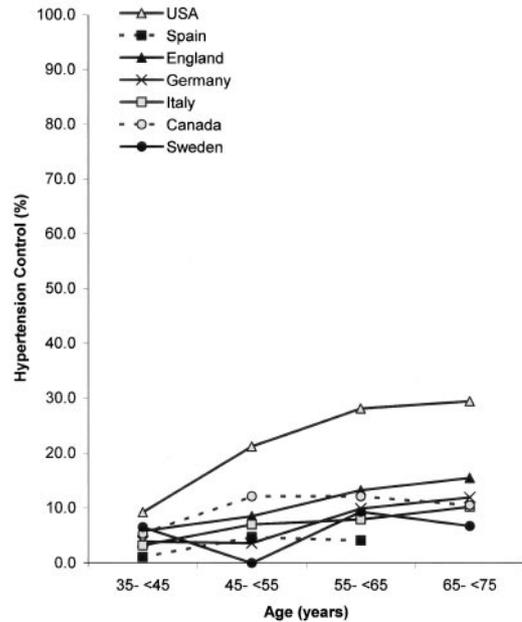


Figure 3. Hypertension control for men, by age group and country: 140/90 mm Hg.

population-attributable risk. As noted here, the United States has a much lower proportion of uncontrolled hypertensives and stroke rates that are about half of those in Europe,²⁹ which might in part be a result of a broader treatment strategy.

Hypertension control for women, by age group and country; 140/90 mmHg

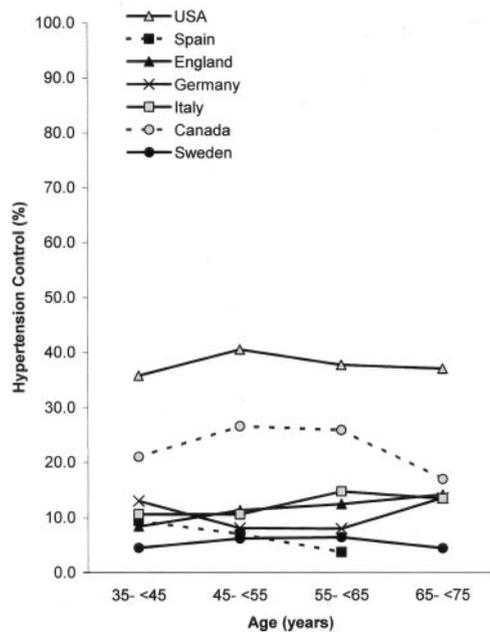


Figure 4. Hypertension control for women, by age group and country: 140/90 mm Hg.

Community surveys do not determine hypertension status on the same basis as clinical guidelines. Most surveys measure BP on only one occasion; depending on the analysis used, this has been shown to yield many false-positive hypertensive cases and a smaller number of false-negatives. However, using the BP $\geq 140/90$ mm Hg cutpoint, the net effect of misclassification is small; in NHANES III, for example, the prevalence of hypertension declined only 2% from the first to the second visit. Of course, net reduction in the number of hypertensive cases will translate into a correspondingly higher control rate. The validity of these comparisons between countries therefore depends critically on the comparability of the survey methods. Variation in mean BP levels in these surveys as a result of methodology has been discussed in detail in an earlier report.¹⁹ Moreover, the time frame over which the studies were performed varied slightly, as did the date of implementation of various guidelines. Given the timing of the surveys and the varied introduction of guidelines, however, it would not have been possible to conduct a comparative analysis without using a single standard. Future studies are needed to assess the impact of introducing new guidelines on control rates. Although these aspects limit the accuracy of our results, the overall differences between the United States, Canada, and Europe are large and unlikely to change over relatively short periods of time. Moreover, the data are consistent with other published epidemiologic literature and CVD mortality rates in the sampled countries.^{28,29}

The attributes of persons unlikely to have their hypertension controlled has been extensively examined.^{27,30–33} Lack of control was much more common in relation to SBP compared with DBP.^{30,31} The presence of other CVD risk factors was not predictive of treatment success in the Framingham Heart Study population, in conformity to our results.³² Reduction of BP to “optimal” levels could prevent up to 50% of CHD events,³³ and it is frustrating to recognize that despite enormous attention to this problem, only modest gains might have been made in treatment and control during the last decade in the United States.³⁴ The large between-country variation described here, however, provides a perspective on the range of what is feasible, suggesting that organized interventions within the health care system can yield large, positive results.

It is unlikely that any of the countries studied have reached the maximum level of treatment and control that can be attained. For example, BP control at $<140/90$ mm Hg was achieved in routine practice settings among two thirds of 33 000 participants in a recent clinical trial.³⁵ Hypertensives who are at high risk of CVD but who have not yet suffered an event represent a crucial opportunity for clinical prevention.⁵ To further reduce CVD secondary to hypertension, more efforts are needed in the public at large and among health care providers to increase the awareness of the associated risk and benefits of treatment. In addition, system-wide approaches can help physicians achieve greater success in following current guidelines. Possible ways to increase adherence to guidelines include education by respected personnel, implementation of reminder systems, outlining of vital recommen-

dations from the public health perspective, and improved presentation by user-friendly format and annual updates.³⁶

Perspectives

Much of the variation in the success rate in hypertension control reported here appears to be attributable to the treatment strategy adopted by individual countries. The structure of financial incentives within these systems could additionally play an important role in this health care outcome. Although further intervention efforts, as outlined earlier, need to be pursued within individual health systems, the implications of broader versus more restrictive guidelines also need to be examined.

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