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HYPERTENSION: Trends in Prevalence, Incidence, and Control

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■ **Abstract** Hypertension is the leading cause of cardiovascular disease worldwide. Prior to 1990, population data suggest that hypertension prevalence was decreasing; however, recent data suggest that it is again on the rise. In 1999–2002, 28.6% of the U.S. population had hypertension. Hypertension prevalence has also been increasing in other countries, and an estimated 972 million people in the world are suffering from this problem. Incidence rates of hypertension range between 3% and 18%, depending on the age, gender, ethnicity, and body size of the population studied. Despite advances in hypertension treatment, control rates continue to be suboptimal. Only about one third of all hypertensives are controlled in the United States. Programs that improve hypertension control rates and prevent hypertension are urgently needed.

DEFINING HYPERTENSION

The definition of hypertension has changed over time in response to better understanding of the pathophysiology, actuarial considerations of the life insurance industry, studies of blood pressure in diverse populations, consideration of the interaction of blood pressure levels and comorbid conditions, landmark studies of blood pressure–related health outcomes, and the development and evaluation of effective antihypertensive therapies. Definitions for the upper level of normal ranges of blood pressure for adults have been based on epidemiological findings relating blood pressure levels to risks for adverse outcomes in populations and evidence from clinical trials demonstrating reduced risk of adverse outcomes with antihypertensive therapies.

Epidemiological data support a continuous, incremental risk of cardiovascular disease, stroke, and renal disease across levels of both systolic and diastolic blood pressure (89, 151, 184). The life insurance industry was the first to relate mortality

outcomes to blood pressure levels in studies that clearly indicate strong and positive linear associations between blood pressure levels and mortality (77). The Multiple Risk Factor Intervention Trial (MRFIT), which included over 350,000 male participants, confirmed a continuous and graded influence of both systolic and diastolic blood pressure on coronary heart disease mortality and stroke, extending down to systolic blood pressures of 120 mm Hg (89). Data from the Framingham Heart Study indicate that cardiovascular disease risk is increased 2.5-fold in women and 1.6-fold in men with high-normal blood pressures (systolic blood pressure 130–139 mm Hg or diastolic blood pressure 85–89 mm Hg) (88, 184). Systolic blood pressure and pulse pressure (systolic minus diastolic blood pressure) are more powerful predictors of adverse cardiovascular outcomes than diastolic blood pressure, particularly among older individuals (54, 106, 157).

Any definition of hypertension should be based on the assumption that appropriate techniques are used for the measurement and that the conditions under which the measurement is obtained are described. Guidelines for defining hypertension have been modified by expert panels over time to lower blood pressure levels as more information has become available. JNC VII, published in 2003, defines normal blood pressure as <120/80 mm Hg (24). This definition is based primarily on epidemiologic data rather than on outcomes of clinical trials. Individuals with systolic blood pressure 120–139 mm Hg or diastolic blood pressure 80–89 mm Hg are considered prehypertensive, and individuals with systolic blood pressure ≥140 mm Hg and/or diastolic blood pressure ≥90 mm Hg are considered to have hypertension. These guidelines are based on the average of two or more seated blood pressure readings during each of two or more office visits. Home blood pressures and average 24-h ambulatory blood pressures are generally lower than clinic blood pressures. A blood pressure of 135/85 mm Hg has been recommended as the upper limit of normal for home and average awake ambulatory blood pressures (137). White-coat hypertension, also associated with increased cardiovascular disease risk, has been defined as a blood pressure persistently ≥140/90 mm Hg in the office or clinic and an average awake ambulatory reading <135/85 mm Hg (186). Hypertension in children and adolescents has been defined as systolic and/or diastolic blood pressure consistently above a previously determined 95th percentile for age, gender, and height; blood pressures between the 90th and 95th percentiles are termed prehypertensive (125).

From a clinical perspective, hypertension might be defined as that level of blood pressure at which the institution of therapy reduces blood pressure–related morbidity and mortality. In the late 1960s, in placebo controlled trials, the landmark VA Cooperative Studies documented reduction in cardiovascular morbidity and mortality in men with diastolic blood pressures in the range of 115–129 mm Hg, and in a subsequent study with diastolic blood pressures 90–114 mm Hg (179, 180). Approximately one decade later, based on comparison of stepped care versus usual care of hypertension, results of the Hypertension Detection and Follow-up Program (HDFP) demonstrated reduction of all-cause mortality, stroke, incidence, and cerebrovascular deaths in individuals with mild (diastolic blood pressure

90–104 mm Hg), moderate (diastolic blood pressure 105–114 mm Hg), and severe (diastolic blood pressure >114 mm Hg) hypertension (79). Since these earlier studies, numerous clinical trials have documented the benefits of antihypertensive therapy on the reduction of cardiovascular disease, stroke, and renal disease. The Hypertension Optimal Treatment (HOT) trial attempted to identify the optimum target blood pressure goals of antihypertensive therapy (67). The trial recruited 18,790 hypertensive subjects, aged 50–80 years, with diastolic blood pressure 100–115 mm Hg. The maximum protection against combined cardiovascular endpoints was observed in the range of 80–85 mm Hg for diastolic blood pressure and 130–140 mm Hg for systolic blood pressure. More aggressive blood pressure targets have been recommended for patients with diabetes, coronary heart disease, chronic kidney disease, and for patients with additional cardiovascular disease risk factors (9, 24, 162, 188).

HYPERTENSION PREVALENCE

United States

Estimates of hypertension (generally defined as systolic blood pressure ≥140 mm Hg and/or diastolic blood pressure ≥90 mm Hg, or taking antihypertensive medications) prevalence in the United States vary somewhat. In the Atherosclerosis Risk in Communities Study (ARIC) (n = 15,739, age = 45–64 years, survey conducted 1987–1989, three readings obtained but last two used in analysis) the hypertension prevalence was 35% (127). In the Woman's Health Initiative (n = 90,755 women, age = 50–79 years, survey conducted 1993–1997, two blood pressure readings) the prevalence rate of hypertension was 37.8% (189).

Trends in hypertension prevalence in the United States have, in general, been obtained from the National Health and Nutrition Examination Survey (NHANES). NHANES is a sequential stratified multistage probability sample of the noninstitutionalized U.S. population. The first survey was conducted in 1960–1962 and the latest in 1999–2002. The definition of hypertension has changed over that period. The methodology of blood pressure measurement and the number of measurements, as well as the age range of participants, have also changed (121). Despite these limitations, estimates of hypertension prevalence have been compared in these serial surveys. The age-adjusted hypertension prevalence declined between 1960–1962 and 1988–1991 from 29.7% to 20.4% (20). Similarly, in a random sample of 400 clients 65 years or older in a large HMO, hypertension (defined as ≥160/95) prevalence declined from 51% to 44% between 1967 and 1988 (12).

However, this favorable trend was subsequently reversed. Based on NHANES data (Table 1), in 1991–1994, the age-adjusted hypertension prevalence was 25% and in 1999–2002 was 28.6% (64). A similar trend was also observed in children based on the same surveys. In children 8 to 17 years of age, systolic blood pressure increased by 1.8 mm Hg and diastolic blood pressure increased by 3.3 mm Hg between 1988–1994 and 1999–2000 (123).

TABLE 1 Trends in age-adjusted hypertension prevalence, based on NHANES

	NHES-I (20)	NHANES-I (20)	NHANES-II (20)	NHANES-III phase 1 (20)	NHANES-III phase 2 (64)	NHANES-IV (23)
Year	1960–1962	1971–1974	1976–1980	1988–1991	1991–1994	1999–2002
BP threshold[a]	≥140/90	≥140/90	≥140/90	≥140/90	≥140/90	≥140/90
Age, years	18–74	18–74	18–74	≥20	≥20	≥20
Prevalence[b]	29.7	36.3	31.8	25	25	28.6

[a]Based on 3 blood pressure readings at each survey.

[b]Based on systolic blood pressure ≥140 mm Hg or diastolic blood pressure ≥90 mm Hg or receiving antihypertensive medications.

A recent analysis of NHANES data to calculate hypertension burden included those who had been told that they have high blood pressure even if their blood pressure was not elevated at screening or were receiving antihypertensive medications at the time the survey was conducted. In this analysis, it was estimated that at least 65 million individuals had hypertension in 1999–2000, an increase of 15 million from 1988–1994 (45).

Other surveys have documented similar trends. In the Behavioral Risk Factor Surveillance System (BRFSS), self-reported hypertension prevalence increased from 21.2% in 1991 to 25.7% in 2001 (1). This survey did not include blood pressure measurement and hence may underestimate the hypertension prevalence compared to NHANES. On the other hand, according to the Minnesota Heart Study, hypertension prevalence decreased from 29.6% to 25.8% between 1980–1982 and 1995–1997 (6).

International

Although increasing information is becoming available, because of limited surveillance and reporting, data about hypertension prevalence in developing countries are relatively scarce (81). The World Health Organization Monitoring of Trends and Determinants in Cardiovascular Disease (WHO MONICA) project is the largest survey to document blood pressure levels and hypertension prevalence in 22 countries (200). Many countries have recently undergone large-scale national health surveys to measure hypertension prevalence (25, 33, 36, 42, 60–62, 82, 84, 108, 111, 140, 176, 199–201). A summary of these surveys is outlined in Table 2. Given the high degree of variation of response rates, survey design, and age range of survey participants, it is difficult to draw accurate comparisons of prevalence rates in these countries.

These limitations notwithstanding, a few general conclusions can be made. In general, hypertension prevalence is high in all surveyed countries with a range from 20% to almost 50%. Except for Canada, most industrialized countries have a higher prevalence than the United States (201). Rural areas tend to have lower hypertension prevalence than urban areas, even within the same country (62, 80, 152). In developing countries, the trend is for a rapid increase in hypertension

TABLE 2 International hypertension prevalence based on selected large surveys

Country	Year	Sample size	Age range (years)	Design	BP reading number	Prevalence (%)[a]
Canada (85)	1986–1990	26,293	18–74	Population survey	4	20
Europe[b] (201)	1986–1999	40,000	16-≥80	Variable	2–3	44
Japan (8)	1980	10,897	30–74	Population survey	1	38
Australia (14)	1989	19,315	25–64	Population survey	2	21–32
China (59)	2000–2001	15,540	35–74	Stratified multistage sampling	3	27
India (60)	1999	88,653	18–60	Population survey	2	48
Egypt (80)	1991	7915	≥25	Stratified, multistage, probability design	4	26

[a]Hypertension defined as systolic blood pressure ≥140 mm Hg and/or diastolic blood pressure ≥90 mm Hg, or receiving antihypertensive medications.

[b]This includes United Kingdom, Finland, Germany, Italy, Spain, and Sweden.

prevalence, and in developed countries, the previous trend of a decrease in hypertension prevalence is actually reversing (23, 62, 64). Overall, the worldwide burden of hypertension in 2000 was estimated to be 972 million persons or 26.4% of the adult world population, with 333 million in developed and 639 million in developing countries (92). It has been estimated that by 2025 1.56 billion individuals will have hypertension, an increase of 60% from 2000 (92).

HYPERTENSION INCIDENCE

Most of the data on hypertension incidence rates in the United States come from the NHANES-I follow-up study (NHANES-FU), the Framingham Heart Study, and several other longitudinal surveys (10, 27, 35, 37, 53, 70, 174, 182, 185, 191). These data demonstrate that hypertension incidence varies by age, gender and race. Follow-up periods also vary, making incidence rates difficult to compare.

In an earlier analysis of the Framingham Heart Study cohort (n = 5209, follow-up = 30 years), the incidence of hypertension over a 30-year period increased with age in both genders (31). Between the ages of 30–39 years, the 2-year incidence rates were 3.3% in men and 1.5% in women, and between 70–79 years of age, the 2-year hypertension incidence rates were 6.2% in men and 8.6% in women. A

recent analysis of the Framingham Heart Study suggests that the lifetime risk of developing hypertension for middle-aged and elderly individuals is close to 90% (183). In the Framingham Offspring Study, men under age 40 years were twice as likely to develop hypertension compared with women (53). Because the population in the Framingham Heart Study is predominantly white, these observations are not necessarily generalizable to the U.S. population.

Results of several other surveys permit comparison of hypertension incidence in African Americans and U.S. whites. In the ARIC survey (n = 15,792, follow-up = 9 years), 27% of study participants were African Americans (173). The age-adjusted incidence of HTN (hypertension) per thousand person years was found to be lowest among white women (37 per 1000) and men (40 per 1000) and highest in black women (77 per 1000) and men (67 per 1000) (35). In the Coronary Artery Risk Development in Young Adults (CARDIA), the 10-year incidence among young adults was also higher in African Americans compared with whites but lower in women compared with men (African Americans: 16.4% in men and 13.1% in women versus whites: 7.8% in men and 3.2% in women) (94). The 5115 CARDIA participants were aged 18–30 years at the time they joined the study in 1985–1986. In the NHANES-FU study conducted in 1982–1984 about 10 years after baseline, the age-adjusted rate per 1000 person-years was 18.4 in white men, 17.0 in white women, and 23.2 in African Americans participants (55). In this analysis, hypertension was defined as either a blood pressure of 160/90 mm Hg or greater or taking antihypertensive medications. This trend was not found in those older than 40 years (69).

Taken together, these studies suggest that the incidence of hypertension is high in the United States, increases with age, and is higher in African Americans than in whites.

DEMOGRAPHIC CORRELATES OF BLOOD PRESSURE AND HYPERTENSION

Age

Blood pressure is considerably lower in children than in adults and increases steadily throughout the first two decades of life. In adults, cross-sectional and longitudinal surveys have shown that systolic and diastolic blood pressure increase progressively with age. For example, in the WHO MONICA survey, systolic blood pressure increased by about 0.29 to 0.91 mm Hg per year in men and 0.6–1.31 per year in women (200). This increase plateaus and possibly declines after age 50 for diastolic but not for systolic blood pressure (21, 49, 50, 66, 87, 156), leading to a steep increase in pulse pressure, a key risk factor for cardiovascular outcome (51, 116). These trends have been demonstrated in both genders and most ethnic groups (21, 64).

Similarly, many studies document an increase in hypertension prevalence with age (21, 23, 64, 183, 194, 200, 201). This is true in both genders, all ethnic groups,

most industrialized countries, and even in children. In the United States, based on NAHNES 1999–2002, hypertension prevalence increased from 6.7% in persons 20 to 39 years to 65.2% in persons 60 years or older (23). The greatest increase in hypertension prevalence between 1988–1991 (57.9%) and 1999–2000 (65.4%) occurred in individuals 60 years or older (64).

In contrast, many nonindustrialized countries do not experience increases of blood pressure and hypertension prevalence with age (86, 132, 136, 160, 167, 178). A common characteristic of these populations is a low dietary salt intake (43). When these populations become more industrialized or migrate to a more industrialized society, blood pressure and hypertension prevalence do increase with age (71).

Gender

Based on cross-sectional data, men demonstrate a steeper increase in blood pressure with age than women before menopause. After menopause, women demonstrate a steeper increase (90). In population-based samples of the United States, mean systolic blood pressure is higher for men than for women during early adulthood, although among older individuals the age-related rate of rise is steeper for women. Consequently, among individuals aged 60 or older, mean systolic blood pressure of women is higher than that of men (66).

In NHANES, men had higher hypertension prevalence than women between 1960–1991 (20), whereas data from 1991 onwards indicate a higher hypertension prevalence in women (64). In the NHANES 1999–2002, hypertension prevalence was 29.0% in women versus 27.8% in men (23). In addition, women demonstrated the largest increase in hypertension prevalence between 1988 and 2000 (64).

Ethnicity

African Americans have one of the highest rates of hypertension prevalence in the world (29, 167). In the 1960–1962 National Health Examination Survey, the prevalence in African Americans was 42.5% versus 28.3% in whites (20). In the ARIC survey between 1987 and 1989, African Americans had a prevalence rate of 56% versus 27% in whites (127). In the Women's Health Initiative, African American women had a prevalence of 59.3% versus 35.5% in white women (189). In the Cardiovascular Health Study, 56% of elderly African Americans had hypertension versus 46% in elderly white participants (139). In the United States, this black-white disparity decreased between the 1960s and the 1990s, then increased from 1999 to 2002 (23) (Figure 1). A number of factors have been implicated as contributing to the high hypertension prevalence in African Americans, including a high prevalence of obesity, socioeconomic stressors, diet, and possibly genetic factors.

This higher prevalence seems to be specific to African Americans since native Africans and Caribbeans, (74), foreign-born African Americans (74), and black individuals living in other countries such as the United Kingdom (28) have

hypertension prevalence similar that of to other ethnicities. In a recent comparative analysis of multiple international and U.S. surveys totaling 85,000 participants and including 3 black and 8 white populations, hypertension prevalence was higher in African Americans (44%) compared with blacks in Nigeria (13.5%) and in Jamaica (28.6%) (26).

Data on Hispanic Americans and Asian Americans are not as extensive as those for African Americans. In general, Mexican Americans have either comparable or lower hypertension prevalence than non-Hispanic whites (23, 64). In the NHANES 1999–2002, Mexican American hypertension prevalence was 25.1% versus 27.4% in non-Hispanic whites. In the Multi-Ethnic Study of Atherosclerosis (MESA) ($n = 6814$), Hispanic (42%) and Chinese (39%) had hypertension prevalence similar to that of white participants (101).

Family History

A family history of hypertension is associated with an increase in the prevalence and incidence of hypertension (52, 181). Both genetic and environmental factors appear to contribute to this association (44, 102, 138).

In a cross-sectional study of 5329 adults, a family history of hypertension was associated with higher diastolic blood pressure, BMI (body mass index), cholesterol, and obesity (181). In a nationwide screening program, a family history of hypertension was associated with hypertension prevalence double that in persons with a negative family history, independent of BMI, gender, and ethnicity (168). In a population-based ascertainment of families in Utah, a family history of hypertension was associated with a 3.5-fold increased risk of hypertension (197).

Young children of parents with hypertension are at increased risk of hypertension (103), and they show higher levels of systolic blood pressure than those of parents with no hypertension (122). In a study of 745 subjects followed for 10 years (baseline mean age = 12 years), subjects with a family history of hypertension in one or both biological parents was associated with higher systolic blood pressure, and a higher rate of increase of systolic blood pressure over time (34). Family history of hypertension is also associated with development of pregnancy-related hypertension especially if two or more first-degree relatives have hypertension (126).

Geography

Within the same country, geographic variation exists in hypertension prevalence. In many developing countries, rural areas tend to have lower hypertension prevalence than urban areas (36, 80, 152). In the United States, southern residents of all ethnicities and genders have a hypertension prevalence higher than that in other regions (94, 128). This is particularly prominent in African Americans. For example, 42.2% southern African Americans males have hypertension versus 34.1% in northern African Americans males ($p < 0.001$), and 42.7% of African American women living in the South have hypertension versus 37.2% in the north ($p = 0.002$) (74). Dietary differences may contribute to these variations. Based on the NHANES-III data, residents of the southern part of the United States consumed

higher sodium and lower potassium, calcium, and magnesium compared with other regions (63).

ANTHROPOMETRIC CORRELATES OF BLOOD PRESSURE AND HYPERTENSION

BMI is an important correlate of blood pressure and hypertension prevalence (18, 47, 124, 160). The recent increase in overweight and obesity in the United States (48, 49) both in adults and children (131) may explain, in part, the associated increase in hypertension prevalence over the past decade (64). In the NHANES-III data, obese men and women had a hypertension prevalence ranging from 49% to 64% with increasing degrees of obesity in men and from 39% to 63% with increasing obesity in women versus 27% in normal-weight men and 23% in normal-weight women (124). In children, obesity and weight gain have also been linked with increased hypertension (155, 164). Obese children are at threefold higher risk for hypertension than nonobese children (163).

In longitudinal studies, weight gain is also associated with an increase in hypertension incidence (135, 185) and the age-related rise in systolic blood pressure (7, 72, 75, 83, 166). In an analysis of four Chicago epidemiological studies, weight gain was associated with an increase in pulse pressure (38–40). In the Framingham Heart Study, a 5% weight gain was associated with a 20% to 30% increase in hypertension incidence (185). The Harvard Male Alumni study found a weight gain of 25 pounds was associated with a 60% increase in hypertension incidence (135).

Clinical trials document that weight reduction is associated with a decrease in blood pressure and hypertension incidence (72, 170, 177, 195). At a seven-year follow-up, participants in the Trials of Hypertension Prevention, the group assigned to the weight reduction arm had a statistically significant decreased risk of hypertension (72).

Obesity is associated with insulin resistance, and weight loss increases insulin sensitivity. The constellation of insulin resistance, increased serum triglyceride concentrations, decreased high-density lipoprotein cholesterol, and hypertension has been designated "syndrome X" (153). Independent of obesity, centripetal distribution of body fat is also associated with insulin resistance, elevated blood pressure, and increased cardiovascular disease risk.

DIETARY CORRELATES OF BLOOD PRESSURE AND HYPERTENSION

Sodium Chloride

Results of observational studies and clinical trials document an association between sodium chloride (NaCl) intake and blood pressure (100). The effect of NaCl on blood pressure increases with age, with the height of the blood pressure, and in normotensive persons, with a family history of hypertension (134). There may also

be a modest association between higher NaCl intake and higher blood pressure in children and adolescents (161). Among population groups, age-related increments of blood pressure and the prevalence of hypertension are related to NaCl intake (43).

Potassium

In societies with high potassium intakes, both mean blood pressure levels and the prevalence of hypertension tend to be lower than in societies with low potassium intakes (93, 120). Meta-analyses of clinical trials have concluded that oral potassium supplements significantly lower both systolic and diastolic blood pressures (22, 193). The magnitude of the blood pressure–lowering effect is greater in hypertensive than in normotensive persons and is more pronounced in persons consuming a high-NaCl diet (58, 120).

Calcium

Within and among populations, as with potassium, there is an inverse association between dietary calcium intake and blood pressure, and low calcium intake is associated with an increased prevalence of hypertension (30, 68). Meta-analyses of clinical trials have found small, statistically significant reductions of systolic, but not diastolic blood pressure with calcium supplementation (2, 19).

Alcohol

Observational studies suggest a J-shaped relationship between alcohol consumption and blood pressure (96, 97, 198). Light drinkers (one to two drinks per day) have lower blood pressures than teetotalers (187), whereas in comparison with nondrinkers, a small but significant elevation of blood pressure is seen in persons consuming three or more drinks per day. The contribution of alcohol to the prevalence of hypertension attributed to consuming more than two drinks per day has been estimated to be 5% to 7%.

Overall Diet

Results of both observational and intervention studies demonstrate that lacto-ovo vegetarian diets are associated with lower blood pressure levels and a decreased prevalence of hypertension compared with omnivorous diets (13, 113, 119). A strict lacto-ovo vegetarian diet consists of a relatively low intake of saturated fat, a high ratio of polyunsaturated to saturated fat, and a high intake of fruits, vegetables, and other fiber-containing foods. Dietary intakes of carbohydrate, potassium, magnesium, and calcium tend to be higher, and dietary protein is lower than in omnivores.

Based on a review of NHANES III data, the southern region of the United States, which includes the "stroke belt," has dietary patterns that may contribute to the high prevalence of hypertension and cardiovascular disease in that region (63). Compared with other regions of the United States, residents in the South reported the highest sodium consumption and the lowest consumption of potassium, calcium, and magnesium.

Clinical trial evidence also suggests that blood pressure is decreased by diets rich in fruits and vegetables, lower in salt, and high in nonfat dairy products (4).

MISCELLANEOUS CORRELATES OF BLOOD PRESSURE AND HYPERTENSION

Sedentary life style and low educational attainment have each been linked to the rise in blood pressure with age (83, 165). Lower socioeconomic status (35), lower occupational class (109), psychosocial factors such as hostility and time urgency/impatience (196), job strain (110), depression (32), low birth weight (11, 104), and high serum uric acid level (172) have been associated with increased hypertension incidence (171).

TRENDS IN HYPERTENSION TREATMENT AND CONTROL

Despite significant advances in hypertension treatment, the proportion of individuals with hypertension who are treated and controlled continues to be low (24). In the United States between the 1960s and 1980s there was a significant improvement in the number of people with hypertension who were aware of their disease, and who were being treated and controlled (20). These improved rates, however, have slowed and possibly reversed in the past 10 years (Table 3) (23, 64).

Different rates of hypertension control have been observed, depending on the population studied and time period of the survey conducted (12, 29, 107, 127, 139, 159, 189). In the ARIC survey in 1987–1988, 84% of participants were aware of their disease, 72% were treated, and 50% were controlled (127). In a large HMO, serial random samples demonstrated an increase in the rate of control from 8% in 1967 to 34% in 1988 (12). In the Framingham Heart Study, 48% of hypertensives were treated, and of all hypertensives, 29% were controlled (107). At baseline in the Women's Health Initiative (n = 98,705), 64% of hypertensive women were treated and 36% were controlled (189). In the Cardiovascular Health

TABLE 3 Hypertension awareness, treatment, and control (both overall and treated) rates in the United States based on the NHANES surveys

	1976–1980 (20) (%)	**1988–1991 (64) (%)**	**1991–1994 (64) (%)**	**1999–2002 (23, 64) (%)**
Aware	51	69	68	63
Treated	31	52	52	45
Treated and controlled	32	46	44	53
Controlled of all hypertensives	10	25	23	29

Study, awareness rates increased from 75% in 1990 to 88% in 1999, treatment rates improved from 66% to 88%, and control rate improved from 37% to 49% (139). At baseline, 27.4% of all ALLHAT participants (n = 33,357) were controlled (29).

Hypertension control rates are influenced by age, gender, and ethnicity. Older hypertensive patients have lower rates of hypertension control despite comparable rates of awareness and treatment compared with middle-aged hypertensives (23, 64). In the NHANES 1999–2002 data, the control rates were 31.4% in those 60 or older and 40.5% in those between 40 and 59 years (23). Similar findings were observed in the ARIC (127), WHI (189), Framingham Heart Study (107), and ALLHAT studies (29). Further, older individuals also have lower rates of improvement in hypertension control over time. Overall control rates increased by 12.7% in those 40 to 59 years versus 4.9% in those 60 years or older between 1988 and 2000 (64). Limited data on individuals between 20 and 39 years of age also suggest lower rates of control than those 40 to 59 years. However, only a relatively small number of individuals have hypertension in the youngest age group (prevalence rate was 6.7% in 1999–2002) (23).

Inconsistent gender differences of hypertension awareness, treatment, and control rates have been reported. In the NHANES 1999–2002 data, women's control rate was 35.5% versus 27.5% in men (23). Although women in ARIC were also more likely to be aware of elevated blood pressure and to be treated for hypertension, control rates were similar for women and men (127). At baseline, men in ALLHAT were more likely than women to be controlled (29).

A number of surveys have reported lower hypertension control rates in African Americans than in whites (29, 101, 127). On the other hand, control rates of non-Hispanic whites and blacks in NHANES were similar at 29.3% (23). Based on 1992–2002 NHANES data, Mexican Americans had the lowest rates of awareness, treatment, and control compared to the other ethnic groups. Hypertension was controlled in 17% of Mexican Americans; however, this estimate may not be reliable due to large sampling error (23).

BARRIERS TO HYPERTENSION CONTROL

Both at the individual patient level and at the community level, strategies for hypertension control should address overall cardiovascular disease risk, not exclusively blood pressure control. For example, increasing rates of obesity in the United States likely contribute to the recent increase of hypertension prevalence (64). Strategies to prevent obesity and promote weight loss in children and adults would be expected to have an impact on the prevalence of hypertension.

Current trends of hypertension control, however, do not reflect the significant improvement in our knowledge about hypertension prevention and control (105). Despite more evidence for the role of lifestyle modifications, the availability of more antihypertensive medications than at any previous time in history, more evidence for the potential of saving lives from better hypertension control, more national guidelines about hypertension management, the percentage of people with

hypertension who are controlled continues to be low. Barriers related to patients, providers, and health care systems have been implicated for these trends.

At the patient level, unhealthy lifestyles (70, 118), obesity (48), poor compliance (154), lack of access to health care, and lack of health care insurance interfere with achieving hypertension control. It is estimated that 45% of hypertension patients have low adherence with either medications or lifestyle interventions that lower blood pressure (190). Other factors at the patient level may be related to the effectiveness of treatment. For example, in settings where drugs are provided at no cost and frequent interaction with providers is assured, control rates are no more than 70% of those treated (29, 158). This suggests that inadequate patient compliance or suboptimal response to antihypertensive medications contribute to low control rates.

At the provider level, there is a gap between national guidelines and actual practice. Surveys of medical records have demonstrated suboptimal level of hypertension control despite adequate access to health care providers (15, 16, 56). Acceptance of suboptimal blood pressure control by providers appears to contribute to low hypertension control rates (46, 76, 95, 133, 175). Many providers are not familiar with national guidelines (78). In addition, many providers report less aggressive approaches to attain hypertension control in older than in younger patients (65). A significant number of providers also indicate that stage-1 systolic hypertension does not require treatment (78). Providers frequently do not offer recommended lifestyle counseling (114, 117, 129, 130).

INTERVENTIONS AND PROGRAMS THAT IMPROVE HYPERTENSION CONTROL

The complexity of the underlying issues hampers the achievement of better hypertension control in populations. Several studies have developed successful strategies to prevent hypertension and improve hypertension control (3, 5, 17, 57, 98, 112, 115) or prevention (73, 91, 169). However, these approaches have not been widely applied to the general population and have not been incorporated into clinical practice. Common themes for successful programs include use of multidisciplinary teams, inclusion of paraprofessionals such as community health workers, improvement in patient-physician interaction, use of physician-delivered disease and lifestyle counseling, and improvement in patients' involvement in their care, including the use of home blood pressure monitoring.

Multicomponent community-based programs to improve HTN control and lower blood pressure are scarce. In Finland, the North Karelia Project, which used a community-behavioral change model with education, mass media announcements, peer counselors, and community partnerships, led to a decrease in smoking rates (52% decreased to 31%), salt intake, and an increase in use of vegetable oil (0% to 90%) (141, 143, 145–147, 149, 150). This intervention was associated with a decrease in blood pressure by 7/7 mm Hg, decrease in stroke events, and improved life expectancy by 5 years (142, 148). The main contributors to the

program's success were its comprehensiveness and the use of a community-based model involving peer opinion leaders (144).

In two rural Kentucky counties with a high prevalence of hypertension, a community-wide high blood pressure control program was instituted and involved the public schools, the Cooperative Agriculture Extension Service, local health agencies, and community leaders. Over a five-year period, blood pressures in residents of that community decreased, hypertension control improved, and there was a decrease in the cardiovascular disease death rate compared with a control county that did not receive the intervention (99). This was a relatively inexpensive program that relied on and coordinated the efforts of existing community resources.

Additional examples of successful community programs can be cited. The Stanford Three Community Study (1972–1975, lowered blood pressure by 6.5–8.9 mm Hg), the Stanford Five-City Project (1975–1998, lowered blood pressure 5.5–7.4 mm hg), and Minnesota Heart Program (1980–1993, lowered by 0.4 mm Hg) have all been implemented in communities with good success (192). Unfortunately, these programs have generally not been implemented in other communities.

A meta-analysis of all adequately designed trials demonstrated that lifestyle programs lower blood pressure by 3 mm Hg, lower smoking rate by 4%, and decrease mortality by almost 3% (41).

CONCLUSION

Despite a greater understanding of the risks of higher blood pressures and the increasing availability of effective antihypertensive therapy, HTN continues to affect a large proportion of the world's population. If current trends in HTN prevalence, incidence, and control do not improve in the United States, the Healthy People 2010 targets for hypertension control will not be achieved. Multifaceted interventions for blood pressure control, such as those reviewed above, are urgently needed to be applied to the general population to decrease prevalence rates and improve HTN control rates. Without such interventions, HTN will continue to be a major public health problem.

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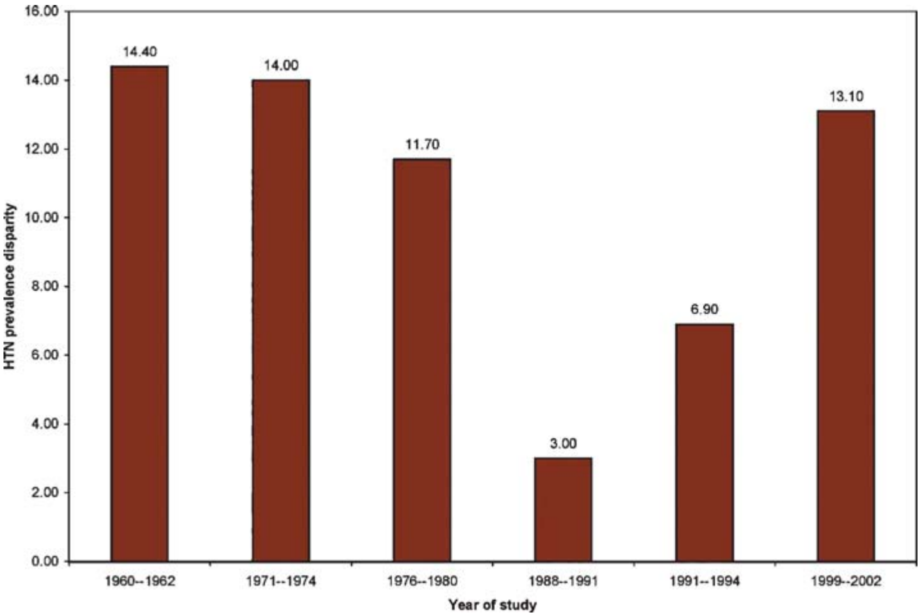

Figure 1 HTN prevalence disparity (difference) between non-Hispanic whites and non-Hispanic blacks by year surveyed.

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