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Abstract The purpose of this study was to estimate the current prevalence and distribution of hypertension and to determine the status of hypertension awareness, treatment, and control in the US adult population. The study used a cross-sectional survey of the civilian, noninstitutionalized population of the United States, including...
an in-home interview and a clinic examination, each of which included measurement of blood pressure. Data for 9901 participants 18 years of age and older from phase 1 of the third National Health and Nutrition Examination Survey, collected from 1988 through 1991, were used. Twenty-four percent of the US adult population representing 43 186 000 persons had hypertension. The age-adjusted prevalence in the non-Hispanic black, non-Hispanic white, and Mexican American populations was 32.4%, 23.3%, and 22.6%, respectively. Overall, two thirds of the population with hypertension were aware of their diagnosis (69%), and a majority were taking prescribed medication (53%). Only one third of Mexican Americans with hypertension were being treated (35%), and only 14% achieved control in contrast to 25% and 24% of the non-Hispanic black and non-Hispanic white populations with hypertension, respectively. Almost 13 million adults classified as being normotensive reported being told on one or more occasions that they had hypertension; 51% of this group reported current adherence to lifestyle changes to control their hypertension. Hypertension continues to be a common finding in the general population. Awareness, treatment, and control of hypertension have improved substantially since the 1976-1980 National Health and Nutrition Examination Survey but continue to be suboptimal, especially in Mexican Americans. Consideration should be given to revision of the criteria for classification of hypertension to reflect the widespread use of lifestyle modification for treatment of hypertension.

**Key Words:** hypertension, essential • blood pressure • prevalence • cross-sectional studies • NHANES

### Introduction

High blood pressure is one of the most important modifiable risk factors for cardiovascular disease. It is an extremely common finding in the community and a risk factor for myocardial infarction, stroke, congestive heart failure, end-stage renal disease, and peripheral vascular disease.\(^1\)\(^2\)\(^3\)\(^4\)\(^5\)

Pharmacological treatment of hypertension has been shown to decrease the risk of cardiovascular disease complications, including stroke, coronary heart disease, and renal insufficiency.\(^6\)\(^7\)\(^8\) Nonpharmacological intervention provides an effective means to lower blood pressure and has been emphasized increasingly as a useful method for both prevention and treatment of high blood pressure.\(^9\)\(^10\)

For more than 20 years, the National High Blood Pressure Education Program has been working with health professionals and the public to increase rates of detection, treatment, and control of high blood pressure in the general community and in subgroups of the population who bear a disproportionate burden of hypertension-related cardiovascular disease. The conduct of periodic national surveys provides the best means to assess the success of these efforts.

The National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention has conducted a series of such surveys, beginning with the 1960-1962 National Health Examination Survey.\(^11\) In this article, we report hypertension prevalence results from the first phase of the third

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National Health and Nutrition Examination Survey (NHANES III), conducted from 1988 through 1991. In addition, we provide estimates of awareness, treatment, and control of high blood pressure in the general population and in major subgroups of the population.

Methods

NHANES III Sample Design
The NHANES III was designed to estimate the prevalence of common chronic conditions and associated risk factors for a representative sample of the civilian, noninstitutionalized population of the United States. The first phase was conducted by the NCHS from 1988 through 1991.

The NHANES III component on adult blood pressure was designed to provide estimates of the prevalence, awareness, treatment, and control of hypertension in the general population and in the non-Hispanic black, non-Hispanic white, and Mexican American population subgroups. Persons 60 years of age and older in the non-Hispanic black and Mexican American populations and those 60 to 69, 70 to 79, and 80 years of age and older in the non-Hispanic white population were oversampled to improve the precision of estimates in these older age groups.

Eighty-two percent (9901) of a national sample of 12,138 adults 18 years of age or older agreed to be interviewed in their home; 71% (8618) agreed to an extensive medical examination at the Mobile Examination Center (MEC). Table 1 gives the composition of the interviewed sample. Those in the "all other" category were included in estimates for the total population but are not presented separately because of insufficient sample size. Age-specific estimates for non-Hispanic blacks and Mexican Americans 80 years of age and older are presented but should be interpreted with caution because these groups had an insufficient sample size to yield precise estimates.

View this table:  
Table 1. Number of Adults 18 Years and Older Interviewed in NHANES III by Self-Reported Race/Ethnic Group

Blood Pressure Measurement
Participants were initially evaluated during a 1-hour visit in their home. Most of the home visit was devoted to administration of an interview focused on health conditions and associated risk factors. The interview included four questions related to the diagnosis and treatment of high blood pressure (Fig 1). At the end of the interview, the participant's blood pressure was measured three times. A second set of blood pressure measurements was obtained during the 4-hour physical examination at the MEC. This second set of measurements was obtained by a physician, usually at the beginning of the physician's examination, which could be performed at any time during the visit. In both settings, blood pressures were measured with the participant in the sitting position after 5 minutes of rest.
A standard mercury sphygmomanometer (W.A. Baum Co, Inc) was used, and one of four cuff sizes (pediatric, regular adult, large, or thigh) was chosen on the basis of the circumference of the participant's arm, as indicated by the manufacturer's guidelines. The cuff was placed on the participant's right arm and inflated in 10 mm Hg increments until the cuff pressure was 30 mm Hg above the level at which the radial pulse disappeared. Three blood pressure measurements were obtained, with a 60-second interval between each cuff inflation (30 seconds for physicians). Subjects were referred for follow-up according to the recommendations of the 1984 Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure. All the blood pressure observers were required to participate in a period of specialized training in the use of a standardized protocol for measurement of blood pressure. This consisted of a 3-day training for interviewers and a 1½-day training for physicians. Satisfactory performance during a standardized videotape examination and during concordant measurements of blood pressure with an instructor was a requirement for certification as a NHANES III blood pressure observer.

Hypertension or high blood pressure was defined as mean systolic blood pressure (SBP) ≥140 mm Hg, mean diastolic blood pressure (DBP) ≥90 mm Hg, or current treatment for hypertension with prescription medication. Awareness of hypertension reflects any prior diagnosis of hypertension or high blood pressure by a health professional among the population defined as having high blood pressure (Fig 1, question 2). Treatment of hypertension was defined as use of a prescription medication for management of high blood pressure at the time of the interview. Control of hypertension was defined as pharmacological treatment of hypertension associated with SBP <140 mm Hg and DBP <90 mm Hg. Control rates were calculated separately for all participants with hypertension and for the subgroup of individuals being treated with antihypertensive medications. Additional treatment-related information collected during the home interview (Fig 1) is presented in the "Results" section.

Six blood pressure measurements (three in the home and three in the MEC) were available for 7747 (78.2%) of the 9901 participants; three of the six blood pressure readings were available for an additional 1746 (17.6%) participants; and partial data on one or two occasions were available for 248 (2.5%) participants. No blood pressure measurements and no report of current antihypertensive therapy status were available for 160 (1.6%) participants. Missing data increased with age. The mean of the available blood pressures (1 to 6) was used for all analyses presented.
The content and conduct of the NHANES III were subject to an institutional review board. All individuals participating in the MEC examination were required to sign an informed consent document.

**Statistical Methods**
Estimates were weighted to represent the total civilian, noninstitutionalized population of the United States. The weights were adjusted to reduce bias from nonresponse at the interview stage. Standard errors (SEs) were calculated by a technique appropriate to the complex survey design and estimation procedure. Estimates of prevalence and mean SBP and DBP were standardized by the direct method to the age distribution of the 1990 adult, civilian, noninstitutionalized population of the United States. Estimates for the black and white populations, including Hispanics, did not differ significantly from the corresponding estimates for the more restrictive non-Hispanic black and white populations; therefore, only the latter are presented.

**Results**

**Prevalence**
Twenty-four percent, or an estimated 43 million, of the adult, civilian, noninstitutionalized population of the United States had hypertension (Table 2). The overall prevalence of hypertension was slightly higher among men than women. Non-Hispanic black men and women had higher crude and age-adjusted prevalence rates of hypertension than their non-Hispanic white or Mexican American counterparts. The crude overall prevalence rate for non-Hispanic whites (24.6%) was much higher than that for Mexican Americans (14.3%). After age adjustment, however, non-Hispanic whites and Mexican Americans had similar overall prevalence rates of hypertension (23.3% and 22.6%, respectively).

**View this table:** Table 2. Prevalence of Hypertension in US Adult Population

Fig 2 presents age-specific estimates of the prevalence of hypertension in the adult population of the United States. Non-Hispanic black men and women had a higher prevalence of hypertension than their non-Hispanic white or Mexican American counterparts in all but the oldest age range for men. For every age-race group up to 59 years of age, men had a higher age-specific rate of hypertension than women. However, the reverse was true for non-Hispanic black and Mexican American men and women 60 years of age and older and non-Hispanic white men and women 70 years of age and older. In the oldest group (80 years and older), the overall age-specific prevalence of hypertension was 14.2% higher in women than in men.

**Figure 2.** Prevalence of high blood pressure by age and race/ethnicity for men and women, US population 18 years of age and older. *Estimate based on sample size not meeting
Mean Blood Pressure Levels

Table 3 presents age-adjusted and gender- and race-specific mean blood pressure values for the overall sample and for three subgroups defined by treatment status. Non-Hispanic black men and women had the highest average SBP and DBP. Non-Hispanic white men and women had the lowest average blood pressures. The mean values for SBP and DBP in the normotensive subjects were similar for each of the racial/ethnic groups. In each group, men had average SBPs and DBPs that were 6 to 7 and 3 to 5 mm Hg higher, respectively, than the average values in women.

Overall, the average SBP of participants with untreated hypertension was 27 mm Hg higher than the corresponding value for the normotensive group. The equivalent difference for DBP was 17 mm Hg. The average blood pressures of participants treated for hypertension were lower than those seen in their untreated counterparts. For SBP, differences ranged from 6 mm Hg in non-Hispanic white men to 17 mm Hg in Mexican American men. For DBP, differences ranged from 4 mm Hg in non-Hispanic white men to 9 mm Hg in Mexican American men.

In every race-sex group except Mexican American men, there was a greater difference between the average blood pressures in normotensive subjects and those receiving treatment than between treated and untreated participants with hypertension. Overall, the average SBP and DBP for normotensive subjects were 18 and 12 mm Hg, respectively, lower than the corresponding values for those treated for hypertension. In contrast, the overall SBP and DBP differences between treated and untreated participants with hypertension were only 9 and 5 mm Hg, respectively.

Fig 3 shows the mean SBP and DBP values for succeeding decades of life in non-Hispanic black, non-Hispanic white, and Mexican American men and women. There was a general tendency for SBP to rise progressively in both men and women throughout adult life. The mean values for SBP were lower in women than men during early adulthood. However, the subsequent rate of rise in blood pressure was steeper for women than men. As a result, average SBPs for women in each of the three racial/ethnic groups were as high as or higher than the corresponding values for men during and after the seventh decade.
In both men and women, non-Hispanic blacks had the highest and non-Hispanic whites had the lowest average SBPs until the end of the fifth decade. In the sixth and later decades, among men, Mexican Americans tended to have the highest average SBPs, although the differences among the three racial/ethnic groups were small. In women, non-Hispanic blacks continued to have the highest and non-Hispanic whites continued to have the lowest average SBPs during the sixth decade. By the seventh decade, however, the three racial/ethnic groups had similar average SBP values. For both men and women, average DBP increased from early adulthood until the end of the fifth decade. However, the rate of increase was more gradual than for SBP. Mean DBP was lower from the sixth decade on, and pulse pressure became increasingly greater with advancing age.

Throughout adult life, men had a slightly higher average level of DBP than women. Non-Hispanic black women had a higher average DBP than non-Hispanic white or Mexican American women. The same was true in men until the end of the fifth decade. Thereafter, DBPs were similar in the three racial/ethnic groups.

**Distribution of Blood Pressure**

Table 4 provides age-, race-, and gender-specific estimates of the distribution of blood pressure according to the classification system recommended by the Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure. Overall, nearly half (47%) of the adult population had blood pressures within the optimal range (SBP <120 mm Hg and DBP <80 mm Hg). Within each racial/ethnic group, at least 19% more women than men had blood pressures within the optimal range. Virtually all of this difference was accounted for by those participants 18 to 49 years of age.

The majority of those surveyed within this age range had blood pressures that were within the optimal or normal range (SBP <130 mm Hg and DBP <84 mm Hg). For example, this was the case for 71% and 85% of 18- to 49-year-old non-Hispanic black men and women, respectively. The corresponding percentages were even higher for non-Hispanic white men and women (75% and 91%, respectively) and Mexican American men and women (78% and 91%, respectively).
In each of the six sex-race groups, aging was associated not only with an increasing prevalence of hypertension but also with an increasing severity of hypertension. For example, 49% of Mexican American men 70 years of age and older with high blood pressure had hypertension at stages 2 through 4.

**Awareness, Treatment, and Control of High Blood Pressure**

Table 5 displays the percentages of participants with hypertension in each of the three racial/ethnic groups who were aware of their high blood pressure, who were being treated with antihypertensive medications, and who were being both treated and controlled. Among non-Hispanic blacks and non-Hispanic whites, approximately two thirds of the men and three quarters of the women were aware of their high blood pressure. The corresponding percentages were lower for Mexican American men and women (44% and 64%, respectively).

Awareness varied by age, but there was no fixed pattern to this variation across the six race-sex groups. For all three racial/ethnic groups, women were more aware of their hypertension than men. The discrepancy in knowledge between men and women was greatest among Mexican Americans (20%) and lowest among non-Hispanic blacks (10%). Treatment and control of hypertension were also more common among women than men and among non-Hispanic blacks and non-Hispanic whites than Mexican Americans.

Except for non-Hispanic black and non-Hispanic white women, fewer than 50% of those with hypertension in each race-sex group reported that they were taking antihypertensive medication for their high blood pressure. Fewer than one third (28%) of Mexican American men were being treated in this fashion, and the percentage was even lower for Mexican Americans 18 to 49 years of age (17%). Even when the analysis was confined to those who were being treated, fewer than 50% were being controlled in each of the six race-sex groups; the percentage was as low as 38% for Mexican American men. There was less discrepancy between the percentage of participants treated for hypertension who were being controlled in each of the six race-sex groups than between the percentage who reported being treated per se.

**Nonpharmacological Interventions**

The current standard definition of hypertension excludes those individuals who have lowered their blood pressure below 140/90 mm Hg by nonpharmacological interventions.9 10 Tables 6 and 7 present data on those who reported a history of hypertension during the interview component of the survey (Fig 1, questions 2 through 5). Only those persons in the sample who reported a prior diagnosis of hypertension by a health care provider were asked about past or current prescribed therapies for high blood pressure.

*View this table: Table 5. Percentage of Persons With Hypertension Who Are Aware, Treated, and Controlled and Percentage of Treated Persons With Hypertension Who Are Controlled in US Population*

Awareness varied by age, but there was no fixed pattern to this variation across the six race-sex groups. For all three racial/ethnic groups, women were more aware of their hypertension than men. The discrepancy in knowledge between men and women was greatest among Mexican Americans (20%) and lowest among non-Hispanic blacks (10%). Treatment and control of hypertension were also more common among women than men and among non-Hispanic blacks and non-Hispanic whites than Mexican Americans.

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*View this table: Table 6. Estimates of Nonpharmacological Therapies Prescribed by Health*
Table 6 provides information on reported prescription of the following four nonpharmacological therapies by health care providers: weight control or weight loss, reduction in salt intake, exercise, and reduced alcohol consumption. Overall, more than three quarters (76%) of those with a reported diagnosis of hypertension reported a prior prescription or current use of one or more of the nonpharmacological therapies identified in Table 6. More than two thirds (67%) reported that they were currently using one or more of these therapies to treat their hypertension. Reduction in salt intake was reported as the most common and decreased alcohol consumption as the least common form of these nonpharmacological therapies. The majority of those persons currently receiving antihypertensive medication reported previous prescription or current use of a nonpharmacological therapy to treat their hypertension.

Among the participants who reported nonpharmacological intervention as the sole means of treatment for their hypertension, the percentage using this form of therapy was greater for those with an average blood pressure ≥140/90 mm Hg than for their counterparts whose average blood pressure was <140/90 mm Hg (73% versus 63% for prior prescription and 55% versus 51% for current use of a nonpharmacological therapy).

More than 7% of the population who were not classified as having hypertension according to the current definition of hypertension had been told by a physician or other health professional that they had high blood pressure; 4.1% had been told on two or more occasions (Table 7). If the definition of hypertension were changed to include those told on two or more occasions, the prevalence of high blood pressure would have been increased to 28.1%, or about 50 million persons in the adult, civilian, noninstitutionalized population of the United States.

A more conservative approach to broadening the definition of hypertension would be to include those who had an average blood pressure <140/90 mm Hg during the survey examination but reported both a history of hypertension and current use of one or more nonpharmacological interventions to lower their blood pressure. As indicated in Table 6, the latter represents 51% of the population who had normal blood pressure at the survey examination but reported a prior diagnosis of hypertension and current use of a nonpharmacological therapy. Inclusion of this group in the estimate of hypertension prevalence would have resulted in the addition of 3.6% of the population, for an overall hypertension prevalence estimate of 27.6%. This equates to a prevalence estimate of 49 685 000 hypertensive people in the adult, civilian, noninstitutionalized population of the United States.

**Discussion**
The NHANES III represents the best available data to estimate the prevalence of hypertension and the extent to which it is being treated and controlled in the general population and in specific subgroups of special interest. Several design features strengthen the NHANES III blood pressure results compared with those from previous NCHS health examination surveys. For example, in previous NCHS surveys, blood pressure was measured on a single occasion. In contrast, in the NHANES III, 80% of the participants had their blood pressure measured on two occasions. Averaging across the measurements obtained on the two occasions provides a more precise estimate of an individual's blood pressure than that obtained by use of either set of readings alone. In addition, considering the extent to which training of blood pressure observers and quality control affect the data, the blood pressure estimates obtained in NHANES III are likely to be more accurate than those provided by previous national surveys. In addition, it is less likely that transient elevations of blood pressure caused by the "white coat" phenomenon played a role in NHANES III because only one of the two sets of measurements was obtained by a physician. For all these reasons, the NHANES III data probably provide the most accurate and precise estimates of hypertension detection, treatment, and control to date in the general population. Because of the extent to which the selection of the sample and the measurement protocol influence prevalence estimation, caution should be observed in comparisons of the findings presented here to corresponding data from previous surveys.

Overall, the NHANES III results suggest that at least 43 million adults in the general population of the United States have hypertension. As in previous surveys, there was evidence of a disproportionate burden of illness in subgroups of the population, with non-Hispanic blacks having an age-adjusted prevalence of hypertension (32.4%) almost 40% higher than that noted in non-Hispanic whites (23.3%) and Mexican Americans (22.6%).

More than 7% of the adults evaluated in the NHANES III were classified as normotensive but reported a history of hypertension. This corresponds to approximately 13 million adults in the general population. About half of this group reported modifying their lifestyles to control their high blood pressure. It is likely that at least some people of this group had hypertension and that they should be included in the prevalence estimate for hypertension. Thus, the true prevalence of hypertension may lie somewhere between the estimate of 24% (43 186 000 adults) using the standard criteria for definition of hypertension and 31.1% (55 930 000 adults). Given the increasing emphasis on lifestyle modification, the role of nonpharmacological therapy in the management of hypertension is likely to become increasingly important. National recommendations for classification of hypertension and the design and implementation of hypertension surveys should reflect this changing emphasis in management.

The Department of Health and Human Services has established a national goal to control high blood pressure in at least 50% of persons with hypertension in the general population by the year 2000. Comparison of findings from the NHANES II and the NHANES III suggests substantial progress toward achievement of this goal.

The percentage of hypertensive adults with controlled hypertension has also increased from 11% of the population 18 to 74 years of age in the NHANES II to 24% of adults 18 years of age and older in the
NHANES III. When the definition of high blood pressure was expanded to include nonpharmacological therapy, the percentage of adults with controlled hypertension in the general population rose to 35% (17.3 of 49.7 million hypertensive individuals). Given the progressive evolution of nonpharmacological therapy as a means to treat hypertension, serious consideration should be given to the impact of this treatment strategy in evaluating the achievement of the Healthy People 2000 Objectives.

The NHANES III data identified variations in awareness, treatment, and control of hypertension in different subgroups of the population. In general, the percentage of persons who were aware of their hypertension was a rough proxy for the corresponding percentages of those who were being treated or treated and controlled.

The percentages of those with hypertension who were aware, treated, or treated and controlled were higher for women than men. The percentages were much lower for Mexican Americans. The success of non-Hispanic blacks and non-Hispanic whites in achieving progressively higher levels of awareness, treatment, and control bodes well for the future and suggests that increasing emphasis should be devoted to education programs targeted to the Mexican American community.

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Footnotes

Reprint requests to Edward Roccella, PhD, National High Blood Pressure Education Program, National Heart, Lung, and Blood Institute, Bldg 31, Room 4A-05, Bethesda, MD 20892.

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