Data from the
NATIONAL HEALTH SURVEY

Series 11
Number 150

# Blood Pressure of Persons 18-74 Years

## United States, 1971-72

Preliminary findings for systolic and diastolic blood pressures of adults by age, sex, and race, from the first Health and Nutrition Examination Survey during 1971-72.

DHEW Publication No. (HRA) 75-1632

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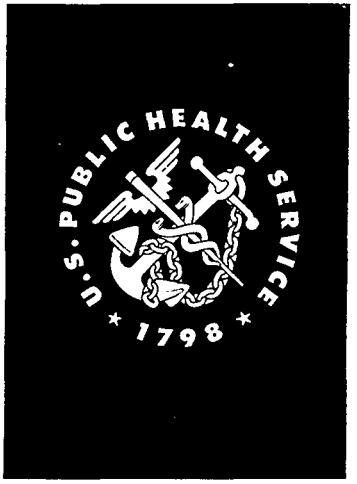


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# NATIONAL CENTER FOR HEALTH STATISTICS



## DIVISION OF HEALTH EXAMINATION STATISTICS



## COOPERATION OF THE BUREAU OF THE CENSUS

In accordance with specifications established by the National Health Survey, the Bureau of the Census, under a contractual agreement, participated in the design and selection of the sample, and carried out the first stage of the field interviewing and certain parts of the statistical processing.

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# CONTENTS


| | Page |
|---|---|
| Introduction | 1 |
| Blood Pressure Measurements | 2 |
| Findings | 4 |
| Systolic Pressure | 4 |
| Diastolic Pressure | 4 |
| Race | 7 |
| Elevated Blood Pressures | 7 |
| Comparison With Previous Studies | 8 |
| Summary | 11 |
| References | 12 |
| List of Detailed Tables | 13 |
| Appendix. Statistical Notes | 20 |
| The Survey Design | 20 |
| Nonresponse | 21 |
| Missing Data | 22 |
| Small Numbers | 22 |
| Sampling and Measurement Error | 22 |

## SYMBOLS

| | |
|---|---|
| Data not available | - - - |
| Category not applicable | . . . |
| Quantity zero | - |
| Quantity more than 0 but less than 0.05 | 0.0 |
| Figure does not meet standards of reliability or precision | * |

# BLOOD PRESSURE OF PERSONS 18-74 YEARS

Jean Roberts, *Division of Health Examination Statistics*

## INTRODUCTION

This report contains preliminary data on blood pressure obtained as part of the examination used in assessing the nutritional and related health status of the U.S. population ages 1 through 74 years. It is one of several preliminary reports of findings on health status obtained in the first Health and Nutrition Examination Survey. The findings here are limited to blood pressures of adults age 18-74 years.

The Health Examination Survey, in which these data were obtained, is one of the major programs of the National Center for Health Statistics authorized under the National Health Survey Act of 1956 by the 84th Congress as a continuing Public Health Service activity to determine the health status of the population.

The programs used to carry out the intent of the National Health Survey[1] include: the Health Examination Survey; the Health Interview Survey which collects health information from samples of people by household interviews focused primarily on the impact of illness and disability within various population groups; the Health Manpower and Facilities surveys which obtain data on hospitals, nursing homes and other resident institutions, and the entire range of personnel in the health occupations; and the Health Resources Utilization surveys.

Only in the Health Examination Survey are health data collected by direct physical examination, tests, and measurements performed on samples of the population. Hence it provides the best of the survey methods for obtaining diagnostic data on the prevalence of medically defined illness. It is the only one of the National Center for Health Statistics' programs to secure information on unrecognized or undiagnosed conditions as well as on a variety of physical, physiological, and psychological measures within the population. Also collected are medical history, demographic, and socioeconomic data on the sample population under study with which the examination findings may be interrelated.

The Health Examination Survey has been conducted as a series of separate programs, called cycles, each of which is limited to some specific segment of the United States population and to specific aspects of health. During the first cycle in 1960-62 the prevalence of certain chronic diseases and the distribution of various physical and physiological measures, including blood pressure, were determined among a defined adult population.[2,3] For that program a national probability sample of 7,710, of which 6,672 (86.5 percent) were examined, was selected to represent the 111 million civilian, noninstitutionalized adults in the U.S. population at that time.

The target populations for the second and third cycles in 1963-65 and 1966-70 were, respectively, the Nation's noninstitutionalized children 6-11 years of age and youths 12-17 years of age.[4,5] In both, the examination focused primarily on health factors related to growth and development. For the second program the size of the probability sample to represent the nearly 24 million U.S. children 6-11 years in the noninstitutionalized population was 7,417, of which 7,119 or 96 percent were examined. In the youths' program the national probability sample size was 7,518, with 6,768 or 90 percent examined, to represent the 22.7 million of that

age in the civilian, noninstitutionalized population.

The Health and Nutrition Examination Survey program (HANES), from which the findings in this report were derived, was designed to measure the nutritional status of the United States population of ages 1 through 74 years and to obtain some limited information on general health status of the entire age group as well as further information on the health status and medical care needs of those from 25 through 74 years in the civilian, noninstitutionalized population. A detailed description of the specific content and plan of operation, including sample design, has been published.[6]

As in previous Health Examination Survey programs, the Bureau of the Census cooperated in the sample design and in the initial visits and interviewing at selected eligible households in the 65 primary sampling units (PSU's) throughout the United States. Additional household visiting, interviewing, history taking, and explaining the examination portion of the program were performed by members of the field teams of the mobile examination center. The selected sample persons for whom an appointment could be made were brought into the specially constructed mobile examination centers which were moved into a central location in each of the primary sampling units. The teams which traveled to the various survey locations throughout the country included professional and paraprofessional medical and dental examiners along with technicians, interviewers, and other staff.

The probability sample design used in the study provided for a higher sampling ratio of the poor, preschool children, women of childbearing ages, and the elderly than of others in the civilian, noninstitutionalized population. It further provided for a nationally representative subset of 35 of the 65 initially planned primary sampling units throughout the United States so that some preliminary national findings could be published before the total survey was completed. More detailed reports will be forthcoming.

The preliminary findings in this report are based on the examination of 6,525 persons aged 18-74 years from the total group of 10,126 examined persons aged 1 through 74 years in a representative subset of 35 of the 65 PSU's which make up the total sample. A sample of 14,147 persons age 1-74 years was selected to be examined at these 35 locations which were visited between April 1971 and October 1972. These 14,147 sample persons are a probability sample of the total U.S. population; if a high proportion of them had been examined, the examined group could also have been regarded as a probability sample of the total population of 192.7 million in the civilian, noninstitutionalized population aged 1-74 years of age at that time. However, despite intensive efforts, the program succeeded in examining only 10,126 of these sample persons. This represents 72.8 percent of the sample persons when adjustments are made for differential sampling rates for the age-, sex-, and income-defined population subgroups. (The unadjusted overall response rate was 71.6 percent.)

Surveys of the National Center for Health Statistics, including all earlier programs of the Health Examination Surveys, have achieved higher levels of response than have been reached for the 35-stand subsample in this first HANES. The 72.8 percent response rate fails to meet fully the requirements of the original probability design. Following a policy of renumeration of participants adopted after the completion of 20 PSU's, there has been a significant increase in participation.

National estimates in this report are based on weighted observations, i.e., the data obtained for each examined person are inflated to the level of the total population. The estimates have been calculated as though the examined persons in each of the age, sex, and income classes are a random subsample of the sample persons in the same class. While there is evidence from earlier examination surveys and medical history data from HANES that this is not an unreasonable approximation, it is clear that some estimates are subject to considerable risk of bias, when more than one-quarter of the sample persons in a particular age-sex-income class were not examined.

## BLOOD PRESSURE MEASUREMENTS

At the beginning of the examination in the nutrition screening evaluation, the physician took

the examinee's blood pressure with the examinee seated on the examining table.

Blood pressure was measured indirectly with standard clinical sphygmomanometers, the instruments usually used in physicians' offices and in most surveys obtaining blood pressure. In 13 of the first 16 examination locations an aneroid instrument was used. In the remaining 22 locations the standard mercury sphygmomanometer, which is the one used in the continuation of HANES, was employed. The following guidelines, based on the American Heart Association's "Recommendations for Human Blood Pressure Determined by Sphygmomanometers," were observed:

- The cuff was at least 20 percent wider than the diameter of the arm or covered approximately two-thirds of the arm. (An adult 13 cm. and a pediatric 9.5 cm. cuff were provided.)
- The manometer was at eye level with the physician.
- The meniscus of the mercury instruments was checked weekly for zero-level calibration.
- While measuring, the rate of fall in pressure was maintained at 2-3 mm. Hg per heartbeat, which was slow enough to detect the first and last sounds but sufficiently rapid to avoid intermittent trapping of blood between systolic and diastolic levels.
- For diastolic pressure, the level was recorded at the point of complete cessation of Korotkoff's sounds or, if there was no cessation, the point of muffling.
- Measurements were recorded to the nearest 2 mm. on the scale.

The middle of the cuff was placed over the bulge in the upper right arm. Using the bell of his stethoscope, the physician noted and recorded the pressure (systolic) when the sound was first heard and the pressure (diastolic) when the sounds disappeared or first became muffled. For convenience the sphygmomanometer was fixed to the wall of the examination room.

While the results will be comparable with clinical findings, the indirect blood pressure measurements as obtained may differ from "true" values, i.e., those obtained by direct (intra-arterial)measurement. The direct and indirect methods of measurement have been found to agree closely for systolic pressure if the cuff size is appropriate to the examinee's height and arm girth. For diastolic pressure, however, the agreement is not as good. Use of the American Heart Association criterion—the point of complete cessation of sound or, if no cessation, the point at which it first became muffled—will tend to underestimate intra-arterial diastolic blood pressure. However, had the point at which the sounds first became muffled been used, there would have been a similar amount of bias introduced in the opposite direction.[7,8]

Blood pressure measurements obtained on more than two-thirds of the examinees in this present survey with mercury sphygmomanometers did not differ significantly from the levels obtained on the remaining one-third with the aneroid instruments. Mean systolic pressures for the two groups differed by less than 1 mm. Hg (0.3) while mean diastolic pressures differed by just slightly more than 1 mm. Hg (1.2), differences that could easily be due to sampling variability alone and are not statistically significant at the 5-percent probability level.

Since blood pressure may vary considerably over a short period of time even under relatively standard conditions, these single measurements can be considered as only a rough estimate of the examinee's "true" blood pressure.

Comparison is made in this report with published national estimates for blood pressure levels of adults from findings of the 1960-62 Health Examination Survey. Several factors may affect the comparability of these test results with the single blood pressure readings from the present survey. Published findings from the earlier survey are shown as the average of the three blood pressure measurements made by the physician during the physical examination. The first of these measurements was taken just after the physician met the examinee. The second was taken midway in the examination, after auscultation of the heart in the sitting

position and before the arthritis examination. The examinee had just had an electrocardiogram given by the nurse and had been allowed a few moments after sitting up for the postural hypotension to disappear. The third measurement was taken at the end of the physical examination. The venipuncture was usually made during the physical examination although the specific point at which it was taken varied from one examinee to another. Mean values for the first measurement obtained on an examinee in this and other studies were higher than those for the two subsequent readings.[9,10,13] In the present survey neither a venipuncture nor an electrocardiogram was taken during the physician's examination. The fact that there were a greater number of examining physicians in the first Health Examination Survey than were employed in the first 35 locations of the Health and Nutrition Examination Survey—39 compared with 23—may also have affected the variability of measurements in the two surveys.

While blood pressure measurements were taken of children and youths in the 1963-65 and 1966-70 Health Examination Surveys, comparison with findings for those of like age in the present survey are not included in this preliminary report because the testing in those earlier 1963-70 surveys was done by the four nurses whose techniques could be more carefully monitored and kept in agreement throughout the survey than was possible with the larger number of physicians.

## FINDINGS

### Systolic Pressure

Mean systolic blood pressure among persons 18 through 74 years in the United States increases substantially with age from 121.3 mm. Hg among young adults 18-44 years to 148.4 mm. Hg among older adults 60-74 years, an increase of 27 percent (table 1). These national estimates are based on preliminary findings from the Health and Nutrition Examination Survey among a probability sample representative of the civilian, noninstitutionalized population in 1971-72, as described earlier. The yearly increment increased slightly from 0.7 mm. Hg per year between younger adults and those 45-59 years, to an average of 0.9 mm. Hg per year between the latter group and older adults 60-74 years. A similar pattern of increment with age is evident with few exceptions across selected percentile points in the distribution of systolic blood pressure shown in table 1 and the percentage distribution in table 2.

The variability in systolic blood pressure as measured by the standard deviation also increases consistently with age from 15.34 mm. Hg among young adults to 24.48 mm. Hg among older adults (60-74 years). It is substantially greater among adults 45-74 years than younger persons. The relative variability in relation to the mean value is also substantially greater among adults 45-74 years (16.4 and 16.5) than younger adults 18-44 years (12.6). Measures of variability based on percentiles in the distribution (semi-interquartile range and its ratio in relation to the median) also show significantly greater variability in systolic pressures among those 45 years and older than persons under 45 years.

For both males and females systolic blood pressure increases substantially with age from 125.2 mm. Hg for young men 18-44 years to 145.3 for men 60-74 years and from 117.7 mm. Hg for young women 18-44 years to 150.9 for women 60-74 years. Mean values for men under 60 years are higher than for women of corresponding age. However, only in the 18-44 year range are the mean differences large enough to be considered statistically significant. Among the oldest age group (60-74 years), there is a reversal in trend with women having, on the average, significantly higher systolic pressures than men.

Comparison of the distribution of systolic blood pressures for men and women in each of the three successive age groups shows a progressive pattern of increased skewing to the right with increasing age (table 2 and figure 1).

### Diastolic Pressure

Among the U.S. population, mean diastolic blood pressure increases substantially with age from 77.8 mm. Hg for young adults 18-44 years to 85.7 in adults 45-59 years, with a leveling off at 85.6 in the older adult group 60-74 years (table 3). This represents an increase of 10

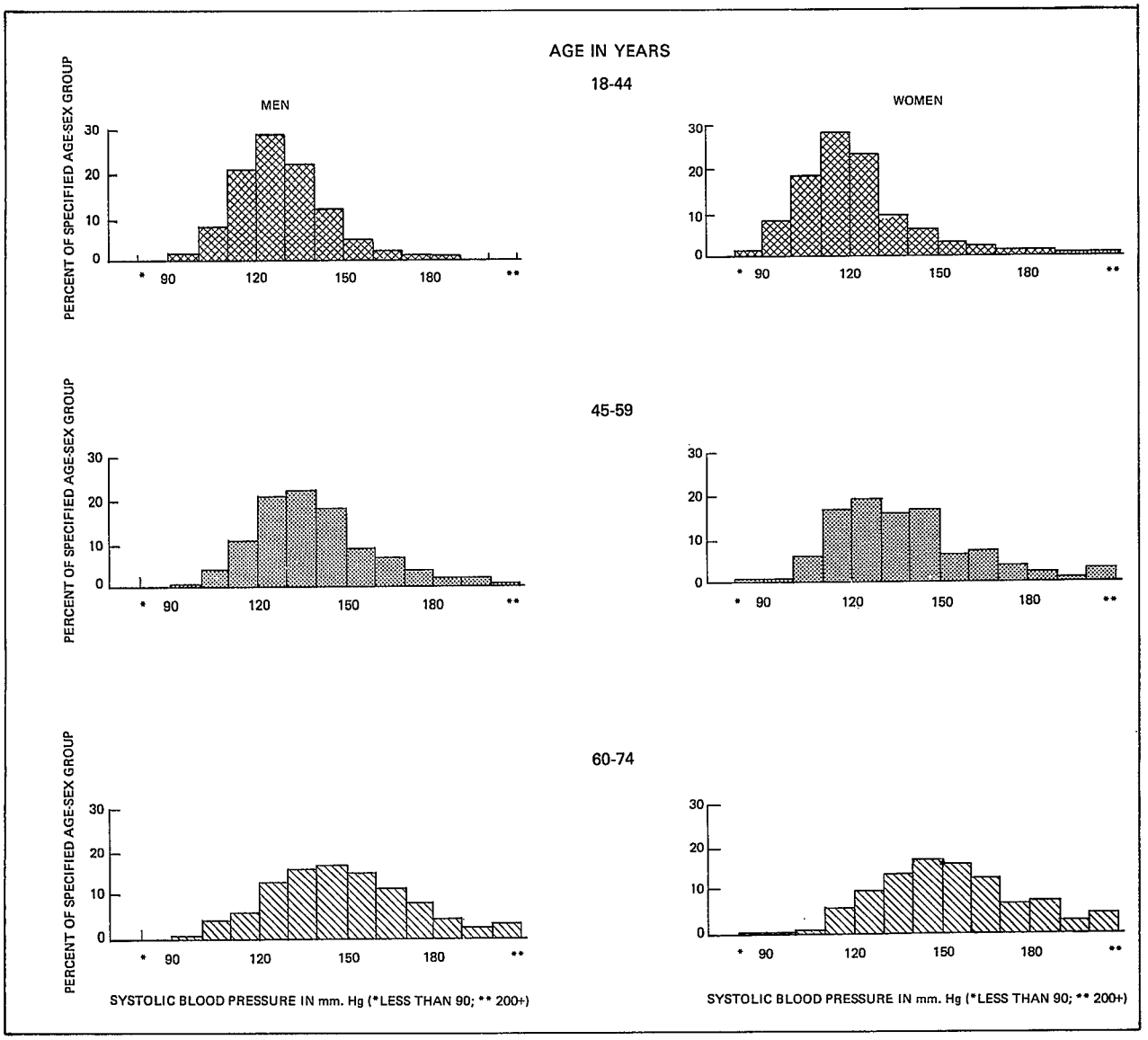


Figure 1. Percent distribution of systolic blood pressure of the population 18-74 years by age and sex: United States, 1971-72

percent in diastolic blood pressure over this 18-74 age range. A similar pattern in yearly increment with age is also evident in the median values and in the percentage distributions (table 4).

As measured by the standard deviation, the variability in diastolic pressure also increases with age up to 60 years—from 11.50 mm. Hg among young adults 18-44 years to 12.80 for ages 45-59 years. The relative variability in relation to the mean values shows no consistent pattern with age but varies between 14.8 and 14.9 over the 18-74 year age span.

Among U.S. men, mean diastolic blood pressure increased substantially from 80.7 mm. Hg for young men 18-44 years to 87.6 for men 45-59 years, then dropped to 85.6 at 60-74 years. For U.S. women, there was a consistent and significant increase in diastolic pressure over the entire age span from 75.1 mm. Hg for young women 18-44 years to 85.7 at ages 60-74 years. Except for the oldest age group (60-74 years) where the sex difference was negligible,

diastolic pressure for men on the average exceeded that for women. Mean differences were large enough to be statistically significant for persons 18-59 years of age.

Variability in diastolic pressure increased slightly and consistently with age for men from a standard deviation of 11.12 at ages 18-44 to 12.90 at 60-74; the pattern was less consistent for females. The greatest variability in these measures among females was found at ages 45-59 years (13.28) and the least variability at 18-44 years (11.88).

As with systolic pressure, the distribution of diastolic blood pressures for each successive age group of men and women tends to become increasingly more skewed to the right with increasing age (table 4 and figure 2).

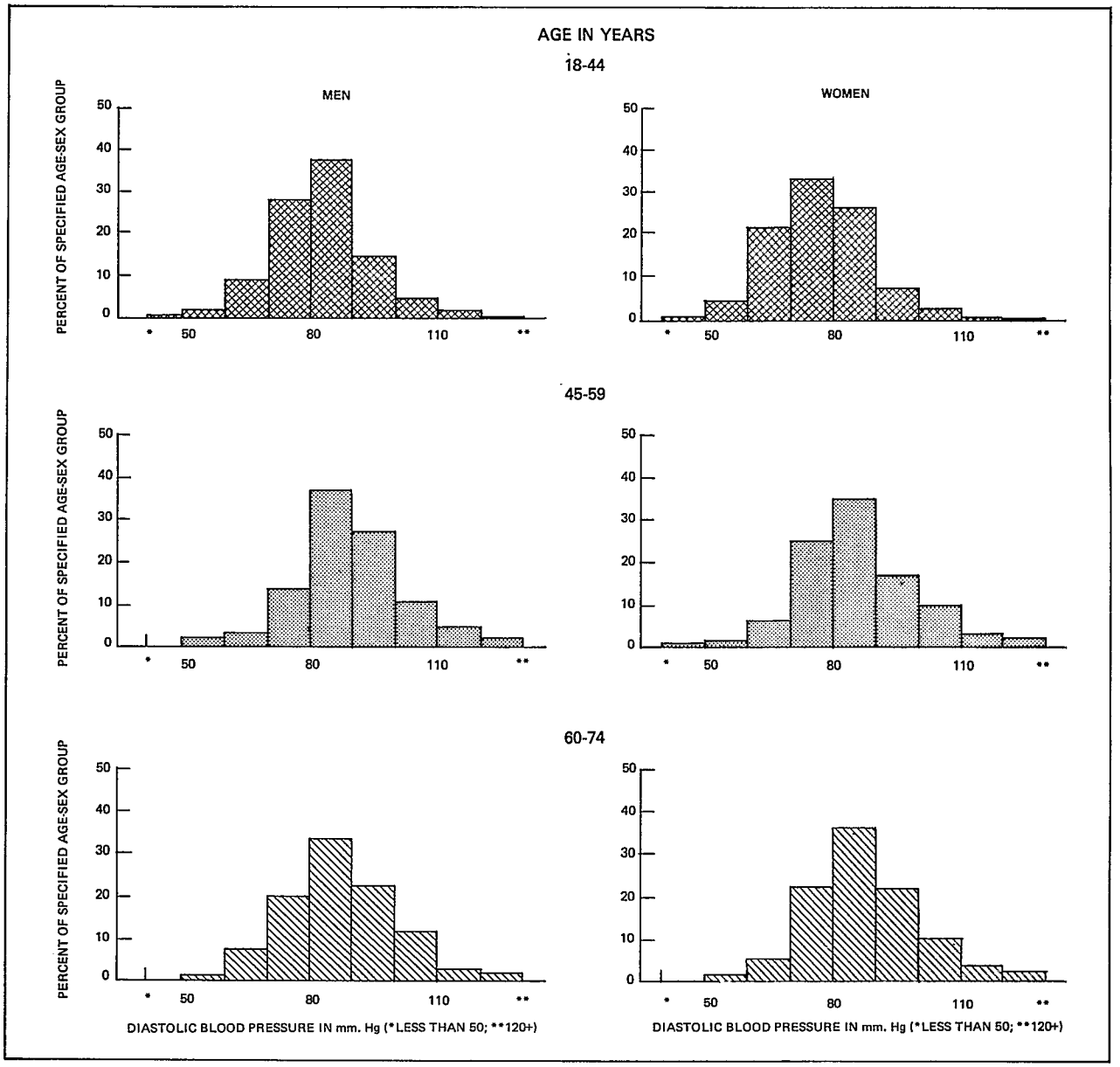


Figure 2. Percent distribution of diastolic blood pressure of the population 18-74 years by age and sex: United States, 1971-72

## Race

Preliminary findings on blood pressure levels in the U.S. adult population from this study are shown by race in table 5. While mean values for the racial groups other than white and Negro are included, the number in that segment of the population and hence in the sample of examinees is too small and heterogeneous to provide reliable national estimates in any detail for them. At the time of the study there were 126 million persons 18-74 years of age in the U.S. civilian, noninstitutionalized population. This included 111 million or 88 percent classed as white, nearly 14 million or 11 percent classed as Negro, and over 1 million or 0.8 percent as all other races including Chinese, Japanese, American Indian, and others. The analysis of the findings will be limited here to those for the white and Negro racial groups.

Mean systolic blood pressure for white adults was consistently less than that for the Negro adults 18-74 years of age and the increase of systolic pressure with age is more rapid for Negro than for white adults. Mean systolic blood pressures for Negro adults exceeded those for white adults by values large enough to be statistically significant and which increased with age from 3.5 mm. Hg among younger adults 18-44 years to 11.0 at 45-59 years and 11.6 at 60-74 years.

Among men, the pattern of racial differences in systolic blood pressure is similar to that for the total population but the increase with age is less marked. Negro men have mean systolic pressures exceeding values for white men of corresponding age by 4.3 mm. Hg at 18-44 years, 4.8 at 45-59 years, and 7.1 at 60-74 years.

Systolic blood pressure of Negro women is also consistently greater, on the average, than for their white counterparts. However, the increase in the racial difference with age for women is substantially greater than that for men. At 18-44 years of age mean systolic pressure for Negro women significantly exceeds that for white women by 3.8 mm. Hg while in the older age groups 45-74 years the values for Negro women are over 15 mm. Hg greater.

Negro-white differences in diastolic blood pressure show a similar but less marked age-related trend than that for systolic pressure. From 18 years on, the mean diastolic pressures for Negro adults are significantly greater than those for white adults by 3.2 mm. Hg at 18-44 years, 7.1 mm. Hg at 45-59 years, and 6.6 mm. Hg at 60-74 years.

Diastolic blood pressures for Negro women consistently exceed those for their white counterparts by values of 3.8, 9.7, and 7.3 mm. Hg across the 18-74 year age range; these differences are large enough to be statistically significant.

As with systolic blood pressure, the differences in mean diastolic blood pressures between middle-aged and older white and Negro men are slightly less than those for women. The mean diastolic pressures for Negro men exceed those for white men by values which are statistically significant and increase with age from 3.3 mm. Hg at 18-44 years to 5.9 mm. Hg at 60-74 years.

## Elevated Blood Pressures

While no attempt was made with these preliminary data to identify or determine the prevalence of hypertension, estimates were made for the prevalence of substantially elevated blood pressures. For this purpose persons with systolic pressure of 140 mm. Hg or greater and/or diastolic pressure of 90 mm. Hg or greater were arbitrarily considered to have elevated blood pressure. On this basis, 25.9 percent or 32.7 million of the U.S. adult population 18-74 years of age would have elevated blood pressure, i.e., somewhat to substantially above what is generally considered "normal" (table 6). The prevalence rate is higher among men than women. It increases sharply with age to about 45 years from 16.7 percent among young adults to 38.0 percent among those 45-59 and 38.5 percent at ages 60-74 years. The increase in the prevalence of this condition with age is continuous across the age range for women but drops off at ages 60-74 for men.

The prevalence of this degree of elevated blood pressure is significantly greater among

Negro than white adults, with differences large enough to be considered statistically significant for the total group and for women but not for men under 60 years of age. However, the increase in this rate with age is substantially more rapid for Negro than for white men and women and the age-specific rates for Negro adults 18-74 years (men and women) are significantly greater than for white adults. By age 60-74 years over one-half of Negro men and women (55 percent for each group) had elevated blood pressures compared with slightly more than one-third of white men and women (39 and 36 percent).

## COMPARISON WITH PREVIOUS STUDIES

Blood pressure is generally considered one of the key indicators of a person's health status. Elevated blood pressure is associated with arteriosclerosis in coronary, cerebral, and peripheral vessels[9-11] and there is increasing evidence that this association may be a causal one.[12] Hence it is of value to determine the distribution of blood pressure in the population as well as in that distribution over time to provide a basis for further study of its relationship to other physical and physiological characteristics, morbidity, the effect of medication, nutritional status, and other factors in the person's background that may be related to or affect it.

Blood pressure levels for adults in the U.S. civilian, noninstitutionlized population 18-79 years have been determined previously through the Health Examination Survey of 1960-62. Several reports from the survey related to these findings have been published.[13-15] Other reports also from this survey have dealt with the association of blood pressure with hypertension, physique, blood glucose, serum cholesterol, and other variables in the U.S. adult population.[16-18]

A brief comparison will be made here between these preliminary findings from HANES and the relevant published findings from the previous Health Examination Survey among adults more to point up the limitations of the data at this stage rather than for any thorough anal-

Table A. Mean blood pressures, population estimates, and number of examinees for persons 18-74 years in 1971-72 and 18-74 years in 1960-62, by age: United States

| Variable | Age in years | | |
|---|---|---|---|
| | 18-44 | 45-59 | 60-74 |
| 1971-72 | | | |
| Systolic (mean blood pressure in mm. Hg) | 121.3 | 135.6 | 148.4 |
| Diastolic (mean blood pressure in mm. Hg) | 77.8 | 85.7 | 85.6 |
| Population in millions | 71.4 | 34.2 | 20.6 |
| Number of examinees | 3,444 | 1,143 | 1,938 |
| 1960-62[1] | | | |
| Systolic (mean blood pressure in mm. Hg) | 121.2 | 136.5 | 150.2 |
| Diastolic (mean blood pressure in mm. Hg) | 75.4 | 83.0 | 83.1 |
| Population in millions | 60.8 | 28.4 | 19.0 |
| Number of examinees | 3,853 | 1,682 | 995 |

[1]Means are average of three readings.

ysis of the differences or similarities. These preliminary HANES findings are based on a national sample size that was slightly less for the age groups 18-59 but nearly twice as large for the age groups 60-74 compared with the Health Examination Survey of 1960-62.

A further limitation in the present HANES data is that they are based on a single blood pressure determination. The published findings from the previous survey of adults were reported as the average of three determinations made during the examination.[13,14] In the earlier survey the initial systolic blood pressure was found to be greater than subsequent determinations for the examinees—on the average 1.8 mm. Hg above the reported mean values. For diastolic blood pressures, there was only a negligible mean difference between the first and the average of the three readings for adults.

Systolic blood pressures of U.S. adults 18-59 years in 1971-72 from the preliminary HANES findings were similar to those for adults of that age range from 10 years ago in the 1960-62 national survey (table A and figures 3-5). Mean values differed by only a negligible amount. However, if compensation were to be made for the fact that the 1971-72 data are from a single determination, these more recent findings would be significantly lower than those estimates from initial readings found among that segment of the population in 1960-62. At ages 60-74 years the mean systolic pressures from the preliminary HANES are significantly lower than for that age group of the population 10 years ago (mean difference of 1.8 mm. Hg) and if compensation were made for the single reading the difference would be even greater. For men, mean systolic pressures are nearly identical to those of 10 years ago (average of three readings) across the entire age range 18-74 years while for women, only the values in the younger age range 18-44 years are similar. At 45-74 years U.S. women in 1971-72 had systolic pressures significantly lower, by mean values of nearly 3 and 4 mm. Hg, than those in the corresponding age range 10 years earlier.

Diastolic blood pressures among U.S. adults in 1971-72 were consistently significantly greater across the age range 18-74 years than those for this age group in 1960-62. Mean differences

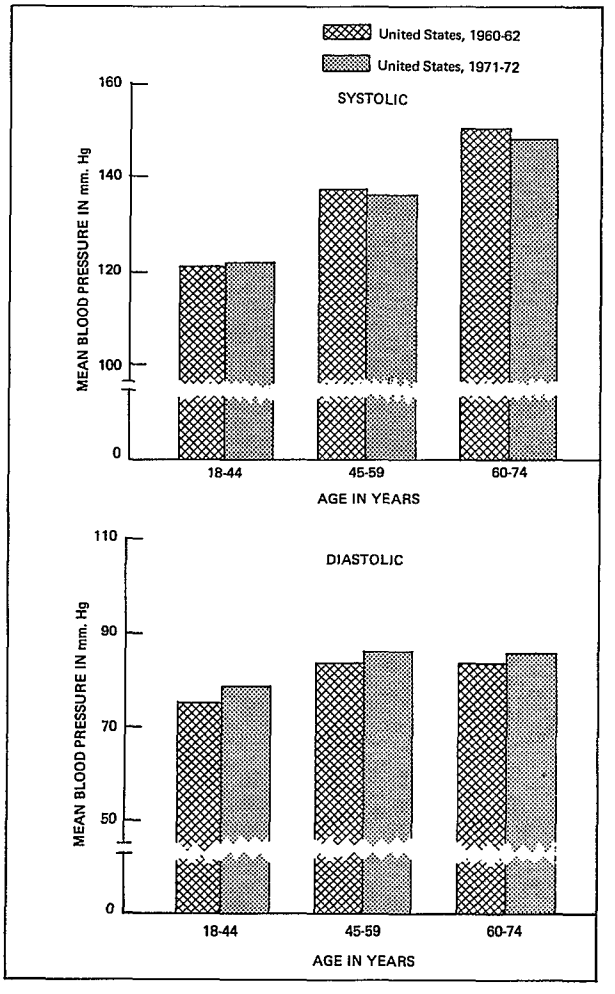


Figure 3. Mean systolic and diastolic blood pressure for adults 18-74 years in 1960-62 and in 1971-72: United States

of 2.2-2.7 mm. Hg were large enough to be statistically significant. The pattern of findings was similar among men 18-74 years of age and among women except at ages 45-59 years where the mean differences between the present findings and those of 10 years ago were negligible. The possibility that the noise level in the examining units may have been somewhat higher because of the additional electrical equipment used and hence may have affected the accuracy of the diastolic readings to a greater extent in the more recent survey, cannot be eliminated.

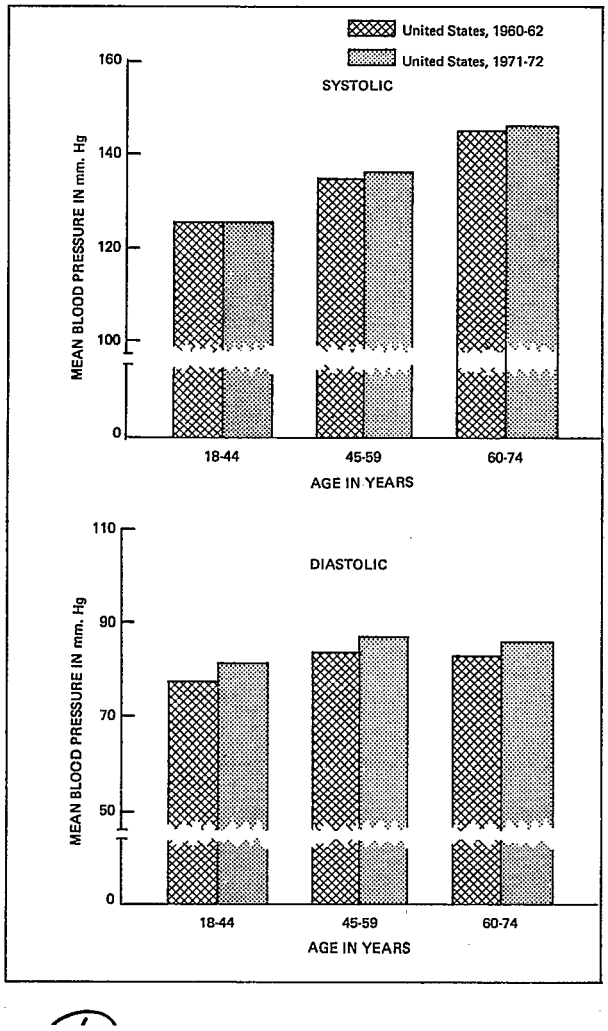


Figure 4. Mean systolic and diastolic blood pressure for men 18-74 years in 1960-62, and in 1971-72: United States

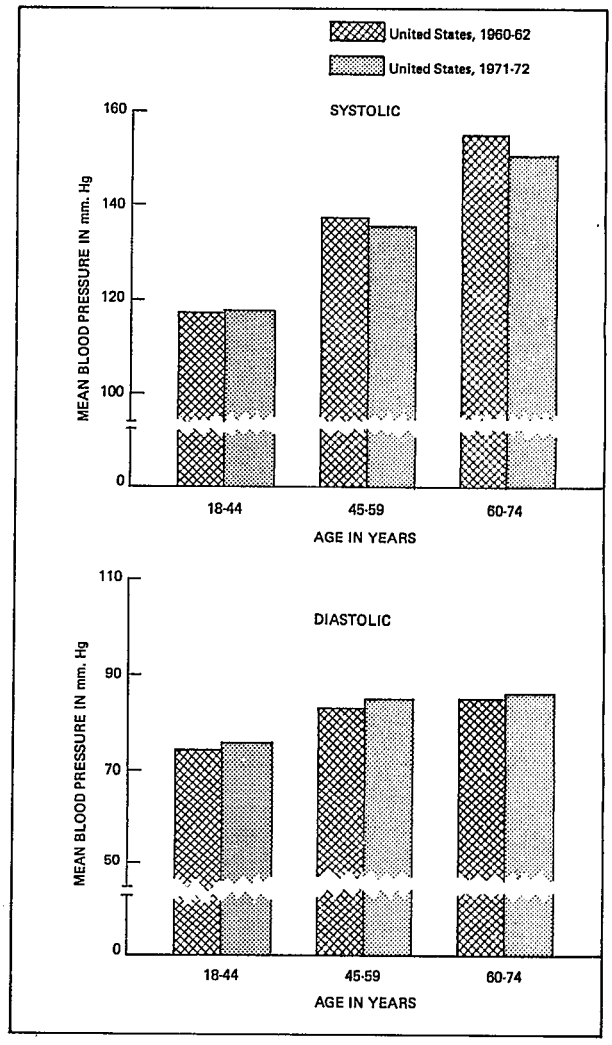


Figure 5. Mean systolic and diastolic blood pressure for women 18-74 years in 1960-62, and in 1971-72: United States

*Race.*—Among adults, systolic pressures from the preliminary HANES in 1971-72 are similar to those from the 1960-62 national study for white and Negro men and Negro women across the entire age range 18-74 years and for white women up to 60 years of age. Mean systolic pressure for white women 60-74 years of age in the present study (preliminary HANES) was significantly lower (4 mm. Hg less) than was found for that age-race group 10 years ago (table B).

Diastolic blood pressure for white and Negro men and women tended to be higher in the 1971-72 national HANES study than for the corresponding age-sex-race groups in the 1960-62 national Health Examination Survey. However, only among white men 18-74 years and Negro men 18-59 years were the mean differences large enough to be considered statistically significant at the 5-percent probability level.

Table B. Mean systolic and diastolic blood pressures for white and Negro adults 18-74 in 1971-72 and in 1960-62, by age and sex: United States

| Blood pressure and age in years | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|
| | White | | Negro | | White | | Negro | |
| | 1971-72 | 1960-62[1] | 1971-72 | 1960-62[1] | 1971-72 | 1960-62[1] | 1971-72 | 1960-62[1] |
| | Mean blood pressure in mm. Hg | | | | | | | |
| Systolic | | | | | | | | |
| 18-44 years | 124.9 | 125.3 | 129.2 | 128.3 | 117.2 | 116.8 | 121.0 | 122.7 |
| 45-59 years | 136.2 | 135.0 | 141.0 | 141.8 | 133.0 | 135.6 | 149.4 | 149.3 |
| 60-74 years | 144.6 | 144.0 | 151.7 | 153.3 | 149.6 | 153.5 | 165.8 | 166.6 |
| Diastolic | | | | | | | | |
| 18-44 years | 80.4 | 76.7 | 83.7 | 79.8 | 74.6 | 73.4 | 78.4 | 78.3 |
| 45-59 years | 87.3 | 82.7 | 91.5 | 87.8 | 82.9 | 81.8 | 92.6 | 90.3 |
| 60-74 years | 85.0 | 81.4 | 90.9 | 88.1 | 85.1 | 83.7 | 92.4 | 90.7 |

[1]Means are average of three readings.

## SUMMARY


This report presents preliminary national estimates of blood pressure levels for the civilian, noninstitutionalized adult population of the United States 18-74 years of age based on findings from the Health and Nutrition Examination Survey of 1971-72.

For this survey, a national probability sample of 14,147 persons was selected to represent the 192.7 million persons in the target population aged 1-74 years. Of these, 10,126 or nearly 73 percent were examined. The findings in this report are limited to those for the 6,525 adult examinees 18-74 years of age.

A single measurement of blood pressure was obtained on each examinee 18-74 years with the use of a sphygmomanometer. A standard set of procedures was followed by the examining physicians responsible for the measurements.

Mean systolic pressures increased substantially with age from 121.3 mm. Hg at 18-44 years to 148.4 mm. Hg at 60-74 years, an increment of 27 percent. Similarly mean diastolic pressures increased substantially but at a somewhat slower rate from 77.8 mm. Hg for young adults to 85.7 mm. Hg for adults age 60-74 years.

Up to 60 years, both systolic and diastolic blood pressures were higher on the average for men than women, but the reverse was found at 60-74 years.

Negro men and women in the U.S. population had higher mean systolic and diastolic pressures than did their white counterparts.

Comparisons with previous national estimates obtained from the Health Examination Survey of 1960-62 among adults are included. Similarity and differences in methods and sample sizes that may account for agreement or the absence of it between the present and earlier findings are noted. In general, without compensating for survey differences, these preliminary HANES findings show higher mean diastolic pressures among adults 18-74 years and roughly comparable mean systolic pressures for adults 18-59 years, but lower systolic means at 60-74 years than in the previous national survey.

The final reports on blood pressure findings for the entire 65 stands of examinations in the first HANES program will investigate the effects of these differences more thoroughly.


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# LIST OF DETAILED TABLES


| | | Page |
|---|---|---|
| Table 1. | Means, selected percentiles, and measures of variability in the distributions of systolic blood pressure among adults 18-74 years by age and sex: United States, 1971-72 | 14 |
| 2. | Percentage distributions of men and women 18-74 years by age, according to systolic blood pressure: United States, 1971-72 | 15 |
| 3. | Means, selected percentiles, and measures of variability in the distributions of diastolic blood pressure among adults 18-74 years by age and sex: United States, 1971-72 | 16 |
| 4. | Percentage distributions of men and women 18-74 years by age, according to diastolic blood pressure: United States, 1971-72 | 17 |
| 5. | Mean systolic and diastolic blood pressures among adults 18-74 years by age, race, and sex, with standard errors for totals: United States, 1971-72 | 18 |
| 6. | Prevalence rates for significantly elevated blood pressure among adults 18-74 years by age, race, and sex, with standard errors: United States, 1971-72 | 19 |

Table 1. Means, selected percentiles, and measures of variability in the distributions of systolic blood pressure among adults 18-74 years by age and sex: United States, 1971-72

| Age and sex | Mean | $s_x$ | $s_{\bar{x}}$ | Percentiles | | | | | Coefficient of variability $100\, s_x/\bar{x}$ | Semi-interquartile range (SIR) $\frac{1}{2}(P_{75}-P_{25})$ | $\frac{100 \text{ SIR}}{P_{50}}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $P_5$ | $P_{25}$ | $P_{50}$ | $P_{75}$ | $P_{95}$ | | | |
| Both sexes | Blood pressures in mm. Hg | | | | | | | | | | |
| 18-44 years | 121.3 | 15.34 | 0.72 | 100.0 | 112.5 | 120.6 | 129.6 | 150.4 | 12.6 | 8.6 | 7.1 |
| 45-59 years | 135.6 | 22.21 | 1.19 | 105.6 | 120.6 | 132.4 | 147.4 | 180.5 | 16.4 | 13.4 | 10.1 |
| 60-74 years | 148.4 | 24.48 | 1.09 | 112.4 | 132.3 | 145.6 | 162.4 | 193.4 | 16.5 | 15.0 | 10.3 |
| Men | | | | | | | | | | | |
| 18-44 years | 125.2 | 14.21 | 0.75 | 104.2 | 116.6 | 124.4 | 133.0 | 150.7 | 11.3 | 8.2 | 6.6 |
| 45-59 years | 136.6 | 19.98 | 1.49 | 110.2 | 122.3 | 134.1 | 148.5 | 175.9 | 14.6 | 13.1 | 9.8 |
| 60-74 years | 145.3 | 23.74 | 1.09 | 110.2 | 130.2 | 140.9 | 160.4 | 188.4 | 16.3 | 15.1 | 10.7 |
| Women | | | | | | | | | | | |
| 18-44 years | 117.7 | 16.46 | 0.80 | 95.9 | 108.4 | 116.8 | 126.1 | 150.1 | 14.0 | 8.8 | 7.5 |
| 45-59 years | 134.7 | 24.44 | 1.27 | 100.9 | 118.8 | 130.6 | 146.3 | 185.1 | 18.1 | 13.8 | 10.6 |
| 60-74 years | 150.9 | 25.22 | 1.63 | 114.6 | 134.4 | 150.2 | 164.5 | 198.3 | 16.7 | 15.0 | 10.0 |

NOTE: $s_x$ = standard deviation; $s_{\bar{x}}$ = standard error of mean.

Table 2. Percentage distributions of men and women 18-74 years by age, according to systolic blood pressure: United States, 1971-72

| Systolic blood pressure in mm. Hg | Men | | | Women | | |
|---|---|---|---|---|---|---|
| | 18-44 years | 45-59 years | 60-74 years | 18-44 years | 45-59 years | 60-74 years |
| | Percent distribution | | | | | |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Under 70 | - | - | - | - | - | - |
| 70-79 | - | - | - | - | - | - |
| 80-89 | 0.0 | - | - | 1.1 | 0.8 | 0.1 |
| 90-99 | 1.7 | 0.4 | 0.5 | 7.8 | 1.1 | 0.2 |
| 100-109 | 7.6 | 3.7 | 3.8 | 18.3 | 6.3 | 1.3 |
| 110-119 | 21.4 | 10.5 | 6.2 | 28.6 | 17.4 | 5.7 |
| 120-129 | 29.0 | 21.4 | 13.3 | 23.7 | 19.1 | 9.7 |
| 130-139 | 22.0 | 22.0 | 16.1 | 9.7 | 15.9 | 14.2 |
| 140-149 | 11.7 | 18.0 | 17.3 | 5.8 | 16.4 | 17.3 |
| 150-159 | 4.5 | 9.4 | 15.3 | 2.6 | 6.3 | 16.6 |
| 160-169 | 1.6 | 6.5 | 11.0 | 1.4 | 7.3 | 13.1 |
| 170-179 | 0.3 | 3.5 | 7.5 | 0.4 | 3.5 | 6.9 |
| 180-189 | 0.2 | 2.3 | 4.1 | 0.4 | 1.8 | 7.3 |
| 190-199 | 0.0 | 2.0 | 1.9 | 0.1 | 0.9 | 3.1 |
| 200-209 | 0.0 | 0.1 | 1.6 | 0.1 | 1.8 | 1.6 |
| 210-219 | - | 0.2 | 0.6 | 0.0 | 0.9 | 1.2 |
| 220-229 | - | - | 0.4 | - | 0.5 | 0.7 |
| 230-239 | - | - | 0.2 | 0.0 | - | 0.7 |
| 240-249 | - | - | 0.2 | - | - | 0.1 |
| 250-259 | - | - | - | - | - | 0.1 |
| 260-269 | - | 0.0 | - | - | - | 0.1 |
| 270-279 | - | - | - | - | - | 0.0 |
| 280-289 | - | - | - | - | - | - |
| 290 and over | - | - | - | - | - | - |

Table 3. Means, selected percentiles, and measures of variability in the distributions of diastolic blood pressure among adults 18-74 years by age and sex: United States, 1971-72

| Age and sex | Mean | $s_x$ | $s_{\bar{x}}$ | Percentiles | | | | | Coefficient of variability $100\, s_x/\bar{x}$ | Semi-interquartile range (SIR) $\frac{1}{2}(P_{75}-P_{25})$ | $\frac{100 \text{ SIR}}{P_{50}}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $P_5$ | $P_{25}$ | $P_{50}$ | $P_{75}$ | $P_{90}$ | | | |
| | Blood pressures in mm. Hg | | | | | | | | | | |
| Both sexes | | | | | | | | | | | |
| 18-44 years | 77.8 | 11.50 | 0.40 | 60.5 | 71.4 | 78.0 | 84.6 | 98.3 | 14.8 | 6.6 | 8.5 |
| 45-59 years | 85.7 | 12.80 | 0.65 | 67.6 | 78.4 | 85.3 | 93.5 | 109.6 | 14.9 | 7.6 | 8.9 |
| 60-74 years | 85.6 | 12.64 | 0.62 | 67.6 | 78.6 | 84.9 | 93.7 | 108.9 | 14.8 | 7.6 | 9.0 |
| Men | | | | | | | | | | | |
| 18-44 years | 80.7 | 11.12 | 0.55 | 62.3 | 74.1 | 80.6 | 88.4 | 100.6 | 13.8 | 7.2 | 8.9 |
| 45-59 years | 87.6 | 12.33 | 0.88 | 70.3 | 80.4 | 88.3 | 96.1 | 110.5 | 14.1 | 7.8 | 8.8 |
| 60-74 years | 85.6 | 12.90 | 0.70 | 66.2 | 78.5 | 85.2 | 92.9 | 108.9 | 15.1 | 7.2 | 8.5 |
| Women | | | | | | | | | | | |
| 18-44 years | 75.1 | 11.88 | 0.38 | 58.1 | 68.6 | 75.5 | 80.9 | 96.0 | 15.8 | 6.2 | 8.2 |
| 45-59 years | 84.0 | 13.28 | 0.61 | 64.9 | 76.4 | 82.3 | 90.9 | 108.6 | 15.8 | 7.2 | 8.7 |
| 60-74 years | 85.7 | 12.37 | 0.72 | 68.9 | 78.6 | 84.6 | 94.5 | 108.9 | 14.4 | 8.0 | 9.5 |

NOTE: $s_x$ = standard deviation; $s_{\bar{x}}$ = standard error of mean.

Table 4. Percentage distributions of men and women 18-74 years by age, according to diastolic blood pressure: United States, 1971-72

| Diastolic blood pressure in mm. Hg | Men | | | Women | | |
|---|---|---|---|---|---|---|
| | 18-44 years | 45-59 years | 60-74 years | 18-44 years | 45-59 years | 60-74 years |
| | Percent distribution | | | | | |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Under 40 | - | - | - | 0.3 | - | - |
| 40-49 | 0.1 | - | - | 0.6 | 0.4 | 0.0 |
| 50-59 | 1.8 | 1.5 | 0.7 | 4.7 | 1.2 | 0.7 |
| 60-69 | 9.2 | 2.6 | 6.5 | 21.6 | 6.4 | 4.5 |
| 70-79 | 28.3 | 14.3 | 20.1 | 34.1 | 25.1 | 22.0 |
| 80-89 | 38.7 | 36.7 | 32.7 | 26.8 | 35.4 | 35.6 |
| 90-99 | 14.9 | 26.8 | 23.2 | 8.4 | 17.4 | 22.1 |
| 100-109 | 5.2 | 11.1 | 12.0 | 2.5 | 9.6 | 10.2 |
| 110-119 | 1.7 | 5.4 | 3.0 | 0.6 | 2.9 | 3.4 |
| 120-129 | 0.1 | 1.4 | 1.8 | 0.3 | 0.9 | 1.1 |
| 130-139 | 0.0 | 0.2 | 0.0 | 0.1 | 0.4 | 0.2 |
| 140-149 | 0.0 | - | - | - | 0.3 | 0.2 |
| 150 and over | - | 0.0 | - | - | 0.0 | - |

Table 5. Mean systolic and diastolic blood pressures among adults 18-74 years by age, race, and sex, with standard errors for totals: United States, 1971-72

| Age and sex | Systolic | | | Diastolic | | |
|---|---|---|---|---|---|---|
| | White | Negro | Other | White | Negro | Other |
| | Mean blood pressure in mm. Hg | | | | | |
| Both sexes | | | | | | |
| 18-44 years | 121.0 | 124.5 | 118.1 | 77.5 | 80.7 | 77.0 |
| 45-59 years | 134.6 | 145.6 | 131.8 | 85.0 | 92.1 | 87.5 |
| 60-74 years | 147.4 | 159.0 | 144.0 | 85.1 | 91.7 | 79.9 |
| Men | | | | | | |
| 18-44 years | 124.9 | 129.2 | 118.7 | 80.4 | 83.7 | 78.1 |
| 45-59 years | 136.2 | 141.0 | 111.3 | 87.3 | 91.5 | 79.1 |
| 60-74 years | 144.6 | 151.7 | 140.1 | 85.0 | 90.9 | 76.3 |
| Women | | | | | | |
| 18-44 years | 117.2 | 121.0 | 117.2 | 74.6 | 78.4 | 75.2 |
| 45-59 years | 133.0 | 149.4 | 139.4 | 82.9 | 92.6 | 90.6 |
| 60-74 years | 149.6 | 165.8 | 150.5 | 85.1 | 92.4 | 86.0 |

Table 6. Prevalence rates for significantly elevated blood pressure among adults 18-74 years by age, race, and sex, with standard errors: United States, 1971-72

| Age and sex | Significantly high blood pressures[1] | | Standard error of rate | Prevalence rate for significantly high blood pressures[1] | | | Standard error of prevalence rates for significantly high blood pressures[1] | | |
|---|---|---|---|---|---|---|---|---|---|
| | Rate per 100 persons | Population in thousands | | White | Negro | Other | White | Negro | Other |
| | | | | Rate per 100 persons | | | | | |
| Both sexes | | | | | | | | | |
| 18-44 years | 16.7 | 11,869 | 1.28 | 15.7 | 24.8 | 13.1 | 1.44 | 2.52 | 9.28 |
| 45-59 years | 38.0 | 12,972 | 2.29 | 36.7 | 51.4 | 26.1 | 2.17 | 5.91 | 37.42 |
| 60-74 years | 38.5 | 7,898 | 2.52 | 37.0 | 54.9 | 24.1 | 2.64 | 4.15 | 20.29 |
| Men | | | | | | | | | |
| 18-44 years | 21.9 | 7,500 | 2.18 | 21.1 | 30.6 | 11.1 | 2.38 | 4.46 | 12.90 |
| 45-59 years | 45.0 | 7,391 | 3.11 | 45.0 | 46.2 | 6.0 | 2.72 | 12.35 | 30.60 |
| 60-74 years | 40.1 | 3,607 | 2.79 | 38.6 | 54.9 | 18.8 | 3.04 | 5.39 | 18.58 |
| Women | | | | | | | | | |
| 18-44 years | 11.8 | 4,367 | 0.86 | 10.6 | 20.5 | 16.6 | 0.92 | 3.87 | 8.86 |
| 45-59 years | 31.5 | 5,581 | 2.13 | 28.8 | 55.8 | 33.6 | 2.26 | 4.98 | 40.28 |
| 60-74 years | 37.3 | 4,291 | 2.91 | 35.7 | 55.0 | 33.0 | 3.04 | 4.97 | 37.47 |

[1]Systolic pressure of 140 mm. Hg or greater and/or diastolic pressure of 90 mm. Hg or greater.

# APPENDIX

# STATISTICAL NOTES

## The Survey Design

The sampling plan for the first 65 stands of the Health and Nutrition Examination Survey (HANES) followed a stratified, multistage probability design in which a sample of the civilian, noninstitutionalized population, 1-74 years of age, of the conterminous United States was selected. Excluded from the selection were persons residing in Alaska and Hawaii and those within the conterminous United States who were confined to institutions or residing on reservation lands of American Indians. Successive elements dealt with in the process of sampling were the primary sampling unit (PSU), census enumeration district (ED), segment (a cluster of households), household, eligible persons, and, finally, sample persons.

The starting points in the first stage of this design were the 1960 decennial census lists of addresses and the nearly 1,900 primary sampling units (PSU's) into which the entire United States was divided. Each PSU is either a standard metropolitan statistical area (SMSA), a single county, or two or three contiguous counties. The PSU's were grouped into 357 strata for use in the Health Interview Survey and subsequently collapsed into 40 superstrata for use in Cycles II and III of the Health Examination Survey and HANES.

Fifteen of the 40 superstrata contained a single large metropolitan area of more than 2,000,000 population. These 15 large metropolitan areas were selected for the sample with certainty. The 25 noncertainty strata were classified into four broad geographic regions of approximately equal population and cross-classified into four broad population density groups in each region. Then a modified Goodman-Kish controlled selection technique was used to select two PSU's from each of the 25 noncertainty superstrata with the probability of selection of a PSU proportionate to its 1960 population so that proportionate representation of specified State groups and rate of population change classes was maintained in the sample. In this matter a total first-stage sample of 65 PSU's was selected. These 65 sample PSU's or stands are the areas within which samples of persons would be selected for examination over a 3-year survey period.

In order to produce national estimates of the nutritional status of the U.S. population at an earlier date, a probability subsample of 35 stands of the 65 stands was selected. This 35-stand subsample also made it possible to produce national estimates of certain other aspects of health status in the population that were critically needed at an earlier date and examination components that for logistic reasons could not be continued for the remainder of the 65 stands. Included among the 35 stands were 10 of the 15 large certainty metropolitan areas and one stand from each of the 25 noncertainty superstrata. The reduction from 15 to 10 large metropolitan areas was accomplished by randomly selecting one stand from multiple-stand Standard Metropolitan Statistical Areas, e.g., selecting the southern half of the Chicago SMSA to represent the entire SMSA. (This selection procedure was based on operational considerations, and although unbiased, is recognized as not being statistically optimal). It is this subsample of 35 stands upon which the findings contained in this report are based.

Although the 1970 Census data were used as the frame for selecting the sample within PSU's when they became available, the calendar of operations required that 1960 Census data be used for the 35-stand sample of HANES. Census enumeration districts (ED's) in each PSU were divided into segments of an expected six housing units each. In urban ED's the segments were clusters of six addresses from the 1960 Census Listing Books. For ED's not having usable addresses, area sampling was employed and consequently some variation in the segment size occurred. To make the sample representative of the current population of the United States, the address or list segments were supplemented by a sample of housing units which had been constructed since 1960.

Within each PSU a systematic sample of segments was selected. The enumeration districts which fell into the sample were coded into one of two economic classes. The first class, identified as the "poverty stratum," was composed of "Current Poverty Areas" that had been identified by the Bureau of the Census in 1970 (pre-1970 census), plus other ED's in the PSU with a mean income of less than $3,000 in 1959 (based on the 1960 census). The second economic class, the "nonpoverty stratum," includes all ED's not designated as belonging to the "poverty stratum."

All sample segments classified as being in the "poverty stratum" were retained in the sample. For those sample segments in "nonpoverty stratum" ED's, the selected segments were divided into eight random subgroups and one of the subgroups was chosen to remain in the HANES sample. This procedure permits a separate analysis with adequate reliability of those classified as being below the poverty level and those classified as being above the poverty level.

After identification of the sample segments, a list of all current addresses within the segment boundaries was made, and the households were interviewed to determine the age and sex of each household member, as well as other demographic and socioeconomic information required for the survey.

To select the persons in sample segments to be examined in HANES, all household members aged 1-74 in each segment were listed on a sample selection worksheet with each household in the segment listed serially. The number of household members in each of the six age-sex groups shown below was listed on the worksheet under the appropriate age-sex group column. The sample selection worksheets were then put in segment number order and a systematic random sample of persons in each age-sex group was selected to be examined using the following sampling rates:

| *Age in years* | *Rate* |
|---|---|
| 1-5 | ½ |
| 6-19 | ¼ |
| 20-44, male | ¼ |
| 20-44, female | ½ |
| 45-64 | ¼ |
| 65-74 | 1 |

The persons selected in the 35-stand sample of HANES comprised a representative sample of the target population and included 14,147 sample persons 1-74 years of age of whom 10,126 or 71.6 percent were examined. When adjustments are made for differential sampling for high risk groups, the response rate becomes 72.8 percent.

All data presented in this report are based on "weighted" observations, that is, data recorded for each sample person are inflated to characterize the subuniverse from which that sample person was drawn. The weight for each examined person is a product of the reciprocal of the probability of selecting the person, an adjustment for nonresponse cases (i.e., persons not examined), and a poststratified ratio adjustment which increases precision by bringing survey results into closer alignment with known U.S. population figures.

A more detailed description of the survey design and selection technique can be found in the Plan and Operation of a Health and Nutrition Examination Survey, United States, 1971-73, *Vital and Health Statistics*, Series 1. No. 10a.

## Nonresponse

In any health examination survey, after the sample is identified and the sample persons are requested to participate in the examination, the survey meets one of its more severe problems. Usually a sizable number of sample persons will not participate in the examination. Whether or not an individual participates is determined by many factors, some of them are uncontrollable and therefore may be reasonably treated as an outcome of a random event with a particular probability of occurrence. If these probabilities of participation were known and greater than zero for all persons, then the examined persons would constitute a probability sample from which unbiased estimates of the target population could be derived. In this situation, the effect of nonparticipation would only be to reduce the sample size, thereby increasing the sampling errors of examination findings. However, in practice a potential for bias due to nonresponse exists since the exact probabilities are never known. A further potential for bias exists if a sizable proportion of sample persons have a zero probability of participation, that is, they would never agree to participate in an examination survey of the same procedures and inducements, and if these persons differ from other sample persons with respect to characteristics under examination. It is for these reasons that intensive efforts are made in HANES to develop and implement procedures and inducements that would reduce the number of nonrespondents and thereby reduce the potential of bias due to nonresponse. These procedures and inducements are discussed in the Plan and Operation of the Health and Nutrition Examination Survey, Series 1, No. 10a.

Despite these intensive efforts 27.2 percent of the sample persons from the first 35 stands were not examined. Consequently, the potential for a sizable bias does exist in the estimates in this publication. From what is known about the nonrespondents and the nature of nonresponse it is believed that the likelihood of sizable bias is small. For instance, only a small proportion of persons gave reasons for nonparticipation which would lead to the belief that they would never agree to participate in examination surveys and that they may differ from examined persons with respect to the characteristics under examination. Only 15 percent of the nonrespondents gave as their reasons for nonparticipation personal illness, physically unable, pregnant, antidoctor, or fear of finding something wrong. Typical among the reasons given by the other nonrespondents were the following: unable because of work, school, or household duties; suspicious or skeptical of the program;

just not interested in participating; and private medical care sufficient or just visited doctor.

An analysis of medical history data obtained for most nonexaminees as well as examinees also supports the belief that the likelihood of sizable bias due to nonresponse is small. No large differences were found between the examined group and the nonexamined group for the statistics compared. For example, 11 percent of persons examined reported having an illness or condition which interfered with their eating as compared to 9 percent of persons who were not examined but who had completed a medical history. The percent of persons examined who reported ever being told by a doctor that they had arthritis was 20 percent, the percent for high blood pressure was 18 percent, and for diabetes was 4 percent. The corresponding percents for nonexamined persons were 17 percent for arthritis, 21 percent for high blood pressure, and 4 percent for diabetes.

As mentioned earlier, the data in this report are based on weighted observations, and one of the components of the weight assigned to an examined person was an adjustment for nonresponse. Since the probabilities of participation are not known for sample persons in HANES, a procedure was adopted which multiplies the reciprocal of the probability of selection of sample persons by a factor which brings estimates based only on examined persons up to a level which would have been achieved if all sample persons had been examined. This nonresponse adjustment factor is the ratio of the sum of sampling weights for all sample persons within a relatively homogeneous class defined by age, sex, and poverty status, to the sum of sampling weights for all responding sample persons within the same homogeneous class. To the degree that homogeneous groups can be defined which are also homogeneous with respect to the characteristics under study, the procedure can be effective in reducing the potential bias from nonresponse.

For the 35-stand sample of HANES, persons were grouped into 20 age-sex-poverty status groups within each stand, yielding 700 separate cells with an average membership of about 20 sample persons each. These adjustment factors are distributed among examined persons as shown in table I.

Table I. Percent distribution of nonresponse adjustment factors, Health and Nutrition Examination Survey, Stands 01-35, 1971-72

| Size of factor | Percent distribution |
|---|---|
| Total | 100.0 |
| 1.00-1.24 | 38.4 |
| 1.25-1.49 | 31.6 |
| 1.50-1.74 | 12.9 |
| 1.75-1.99 | 8.4 |
| 2.00-2.49 | 6.1 |
| 2.50-2.99 | 1.2 |
| 3.00-3.03 | 1.4 |

## Missing Data

Examination surveys are subject to the loss of information not only through the failure to examine all sample persons, but also from the failure to obtain and record all items of information for examined persons. The extent of missing data was generally very low—only about 1 percent for the 6-74 year age range—but ranged from 6 percent among children 6-11 years to less than 1 percent across the remainder of the age groups.

No estimates were made for missing data in this preliminary report on blood pressures. Rather it has been assumed that the distribution of these values by age, sex, and race would be similar to that for those who were measured.

## Small Numbers

In some tables magnitudes are shown for cells for which the sample size is so small that the sampling error may be several times as great as the statistic itself. Obviously in such instances the numbers, if shown, have been included to convey an impression of the overall story of the table.

## Sampling and Measurement Error

In the present report, reference has been made to efforts to minimize bias and variability of measurement techniques. The potential of residual bias due to the high nonresponse rate has also been discussed.

The probability design of the survey makes possible the calculation of sampling errors. Traditionally the role of the sampling error has been the determination of how imprecise the survey results may be because they come from a sample rather than from the measurement of all elements in the universe.

The estimation of sampling errors for a study of the type of the Health and Nutrition Examination Survey is difficult for at least three reasons: (1) measurement error and "pure" sampling error are confounded in the data—it is not easy to find a procedure which will either completely include both or treat one or the other separately, (2) the survey design and estimation procedure are complex, and, accordingly, require computationally involved techniques for the calculation of variances, and (3) hundreds of statistics are presented in the tables in this report,

many for subclasses of the population for which there are a small number of sample cases. Estimates of sampling error are obtained from the sample data and are themselves subject to sampling error when the number of cases in a cell is small or, even occasionally, when the number of cases is substantial.

Estimates of the standard errors for selected statistics used in this report are presented in tables 1, 3, 5, and 6. These estimates have been prepared by a replication technique which yields overall variability through observation of variability among random subsamples of the total sample. Again, readers are reminded that these estimated sampling errors do not reflect any residual bias which might still be present after the attempted correction for nonresponse. The standard error is primarily a measure of sampling variability, that is, the variations that might occur by chance because only a sample of the population is surveyed. As calculated for this report, the standard error also reflects part of the variation which arises in the measurement process. It does not include estimates of any biases which might lie in the data. The chances are about 68 out of 100 that an estimate from the sample would differ from a complete census by less than the standard error. The chances are about 95 out of 100 that the difference would be less than twice the standard error and about 99 out of 100 that it would be less than 2½ times as large.

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