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VITAL and HEALTH STATISTICS

DATA FROM THE NATIONAL HEALTH SURVEY

Blood Pressure of Adults by Race and Area

United States - 1960 - 1962

Mean blood pressure by race and area.

DHEW Publication No. (HRA) 74-1273

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BLOOD PRESSURE OF ADULTS

BY RACE AND AREA

Tavia Gordon, *Division of Health Examination Statistics*

INTRODUCTION

The National Health Survey uses three methods for obtaining information about the health of the U.S. population. The first is a household interview in which persons are asked to give information relating to their health or to the health of other household members. The second is the collection of data from available health records. The third is direct examination. The Health Examination Survey (HES) was organized to use the third procedure, drawing samples of the population of the United States and, by medical examination and with various tests and measurements, undertaking to characterize the population under study.

The initial enterprise of the Health Examination Survey was the examination of a sample of adults. Its purpose was to obtain information on the prevalence of certain chronic diseases, on dental health, and on the distribution of a number of anthropometric and sensory characteristics. A nationwide probability sample of 7,710 persons aged 18-79 years was drawn. Altogether, 6,672 persons were examined during the course of the Survey which was begun in October 1959 and completed in December 1962. Sample persons received a standard examination, lasting about 2 hours, performed by medical and other staff members of the Survey in specially designed mobile clinics.

This is one of a series of reports describing and evaluating the plan, conduct, and findings of the first cycle of the Health Examination Survey. The general plan has already been described;[1] a description of the sample population and response has been published.[2]

This report continues the presentation of data on blood pressure. The first report on this subject described the context in which these data were collected and the techniques used in measurement.[3] "Casual" blood pressure readings were taken. It was shown that these were comparable in level with readings obtained in ordinary clinical practice. Possible artifacts arising from the conduct of the Survey or the examination procedures were examined and it was concluded that none of these constituted complicating factors. Estimates for the United States were given of the distribution of blood pressure and of mean levels by age and sex. In the present report the relationship of blood pressure to area and race is considered. Comparison of racial differences is limited to findings for white and Negro persons since the sample was too small to permit adequate representation of other nonwhite races.

AREA

The sample design of the Health Examination Survey resulted in the selection of 42 primary sampling units or "stands." The selection procedure was stratified by region and size of place. As a consequence, relatively efficient estimates by region and by size of place can be made, although the sample size will necessarily result in estimates with relatively sizable variances. This section presents estimates of mean blood pressure by region and by size of place. In addition, individuals were assigned to demographic areas

within the stand, with these areas designated as urban or rural, and mean blood pressures are presented for these more specific areas.

In making comparisons between areas, allowance must be made for the fact that there are differences from place to place in the distribution of the population by age and sex and that mean blood pressure varies by age and sex. Because the sampling variability of age-sex-specific values for individual areas is very large, a summary comparison was thought preferable to the presentation of mean values specific by age and sex. For this reason, the actual mean systolic blood pressure for an area is compared with an expected mean value. The expected value is obtained by weighting age-sex-specific means for the total United States by the age-sex distribution for the area. Presented in tables A, B, and C are the actual and expected mean systolic pressures and the differences between them. The obvious meaning can be attached to these differences, with the understanding that small differences may arise by chance. A positive difference, for example, indicates that the mean blood pressure for the area is higher than expected. In general, where there is no statistically significant difference between the actual and expected values for an area, differences for individual age-sex groups exhibit only random fluctuations.

Table A. Actual and expected mean systolic blood pressures of adults, by region: United States, 1960-62

Region	Actual	Expected	Difference
	Mean blood pressure in mm. hg.		
Northeast	132.6	131.0	1.6
South	129.7	130.1	-0.4
West	130.2	131.5	-1.3

Table B. Actual and expected mean systolic blood pressures of adults, by population-size group: United States, 1960-62

Population-size group	Actual	Expected	Difference
	Mean blood pressure in mm. hg.		
Giant metropolitan areas	132.5	131.4	1.1
Other very large metropolitan areas	129.1	130.7	-1.6
Other standard metropolitan statistical areas	130.2	130.4	-0.2
Other urban areas	129.9	130.1	-0.2
Rural areas	132.1	131.8	0.3

Table C. Actual and expected mean systolic blood pressures of adults, by place of residence: United States, 1960-62

Residence	Actual	Expected	Difference
	Mean blood pressure in mm. hg.		
Urban	130.7	130.7	0.0
SMSA[1]—in central city	131.1	131.6	-0.5
SMSA[1]—outside central city	130.7	130.2	0.5
Not in SMSA[1]	129.7	130.1	-0.4
Rural	131.9	131.7	0.2
Farm	133.2	132.5	0.7
Nonfarm	131.4	131.4	0.0

[1] Standard metropolitan statistical area.

The systolic pressure was chosen for this comparison rather than the diastolic for two reasons: (1) a smaller proportion of its variability arises from measurement error than is the case with diastolic pressure; and (2) systolic pressure has a distinct gradient with age, so that differences in age distribution are more clearly reflected in the expected values than would have been the case if diastolic pressures were used. A higher expected mean systolic pressure indicates an older population group.

The findings in tables A, B, and C can be briefly summarized. There are only slight differences between regions with respect to mean systolic pressure. These differences are statistically significant. Mean pressures are essentially the same for persons living in giant metropolitan areas, other large metropolitan areas, or any other areas specified by population size. Blood pressures are the same for residents of standard metropolitan statistical areas in the central city as for residents outside the central city, are the same in urban as in rural areas, and are the same in rural-farm areas as in rural-nonfarm areas. It cannot be said that no area differences exist, but those that do exist are probably small.

RACE

Blood pressure was higher for Negro adults than for white adults—5.6 mm. hg. higher for systolic pressure and 5.0 mm. hg. higher for diastolic (table D). This relationship appeared in almost every age group (table 1, figs. 1 and 2). The difference was small in the age group 18-24 years, and for men in this age group the pressure was higher in the white population than in the Negro. The racial contrast became greater in the age groups 25-34 and 35-44 years and remained at this higher level at older ages. It was less for men than for women. These differences in mean levels were reflected in similar differences in the number of persons with elevated blood pressures (tables 3-5).

Table D. Mean blood pressure for white and Negro adults, by sex: United States, 1960-62

Sex	Systolic		Diastolic	
	White	Negro	White	Negro
	Mean blood pressure in mm. hg.			
Both sexes-	130.6	136.2	78.3	83.3
Men----------	131.8	136.2	79.0	83.4
Women--------	129.4	136.3	77.5	83.2

RACE AND REGION

Slightly more than half of the Negro population of the United States is concentrated in the South. Therefore, it may be useful to consider the

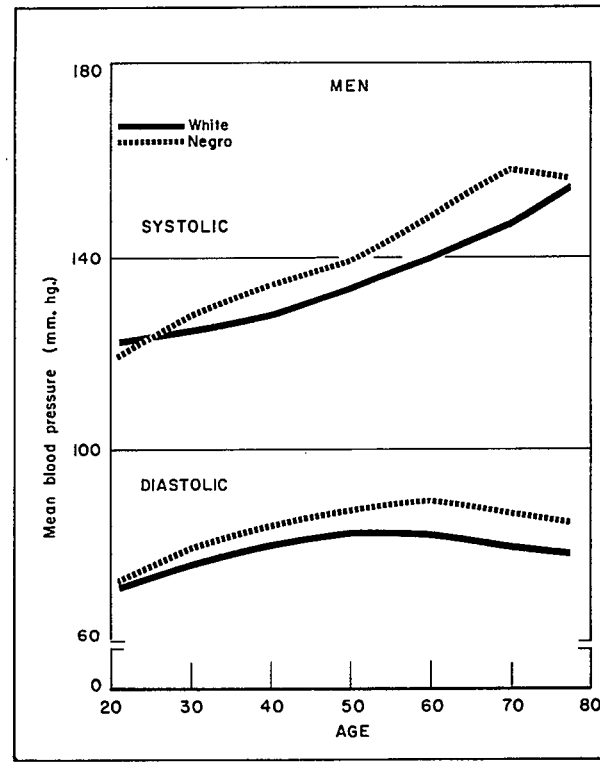

Figure 1. Mean blood pressure for white and Negro men, by age.

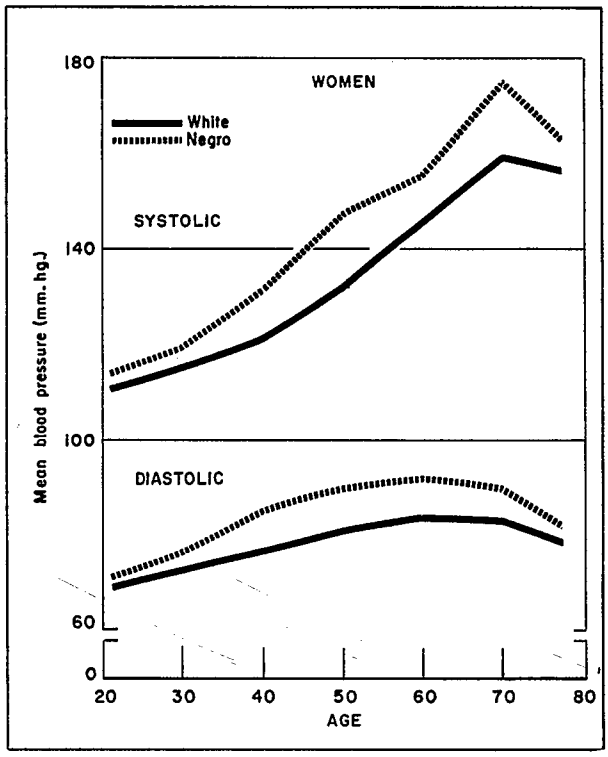

Figure 2. Mean blood pressure for white and Negro women, by age.

racial contrast separately for the South. Similarly, the percentage of Negroes is higher in the South than in the rest of the United States. Hence it is desirable to consider the regional contrast separately for the white population.

The racial difference in mean blood pressure, although small, is associated with a large difference in the percentage of persons with elevated blood pressures. Thus, 18.8 percent of all Negro adults had systolic pressures in excess of 160 mm. hg. and 22.0 percent had diastolic pressures in excess of 95 mm. hg., while the corresponding percentages for white adults were 10.5 and 8.7. The implication of these facts, which are closely connected with a consideration of hypertension and its pathological concomitants, will not be discussed here. In terms merely of the distributions given in tables 4 and 5, the effect of adding to each blood pressure measurement of white adults the mean difference between the races might be considered. This would move the distribution curve of the white population without any change in shape but with a change of the mean value to equal that for the Negro population. The curve for systolic pressures at levels about 160 mm. hg. would then overlay the curve for the Negro population and what differences there were could be attributed to sampling variability. Diastolic blood pressures above 95 mm. hg., however, would present a somewhat different picture, since there would still remain a clear excess of high diastolic pressures in the Negro population, especially at levels above 110 mm. hg. In short, the differences noted between the races are not fully described by the differences in mean values.

Unfortunately, the relatively small number of Negro examinees makes it difficult to proceed with a detailed analysis of the differences in blood pressure findings for white and Negro adults. One observation might be made, however, respecting the relation of systolic and diastolic blood pressures. For both races the mean pulse pressure (the difference between systolic and diastolic pressures) rises with age, with an especially sharp rise after 55 years of age. In this respect there was very little difference between the pressures of white and Negro persons, and while the pulse pressure was slightly greater for Negro than for white women, it was practically the same for Negro and white men, except for what appears to be sampling variation.

Table E. Mean blood pressure for white and Negro adults in the southern region, by sex: United States, 1960-62

Sex	Systolic		Diastolic	
	White	Negro	White	Negro
	Mean blood pressure in mm. hg.			
Both sexes-	127.6	138.1	78.2	84.3
Men----------	129.1	137.7	79.1	84.6
Women--------	126.4	138.4	77.5	84.0

Table E presents mean blood pressures for the South by race and sex. (Table 2 gives these data by age.) Although there are differences in detail for the United States as a whole, most of these can be explained by the large sampling variability of regional statistics. Overall, the racial differences in blood pressure level seem about the same in the South as in the remainder of the country.

In table F, regional comparisons are presented for the white population only. When the values in this table are compared with those in table A, it is obvious that the mean systolic blood pressure is definitely, if only slightly, lower in the South than in the rest of the country. The expected mean values for table F would be practically the same as those used in table A.

DISCUSSION

The failure to find any but minor difference in blood pressure level associated with area in the United States is one of the more striking findings of the Health Examination Survey. Small differences no doubt do exist, although these may be presumed of little meaning from an epidemiological or public health point of view. Whether the Health Examination Survey provided a sufficiently precise instrument for measuring such small differences may be questioned. The itinerary for the Survey was designed to avoid the South in summer and the North in winter, so that if there are (as there may well be) slight fluctuations in mean blood pressure with the seasons, slight regional differences might be either lost or accentuated as a consequence.

Table F. Mean systolic blood pressure of white adults, by region: United States, 1960-62

Region	Mean blood pressure in mm. hg.
Northeast	132.6
South	127.6
West	130.5

The difference found between white and Negro blood pressures was, of course, expected. There is evidence from a large number of surveys that blood pressure is higher among the Negro race than among the white, both in this country and in the West Indies. Figures 3 and 4 compare the findings from the Health Examination Survey with those from three other surveys—two in this country and one in Nassau.[4, 5, 6] While all these surveys (as well as at least one unpublished survey [7]) show higher levels for the Negro population than for the white, the Health Examination Survey in general shows a smaller differential than the others and also contrasts with these surveys in showing little or no racial difference in pulse pressure.

One difference between the surveys cited for the United States and the Health Examination Survey is that the Health Examination Survey examined a random sample of the population whereas the others examined generally rural populations. It is conceivable that the racial contrast is greater in rural areas than in the country as a whole and that this accounts for the difference between the findings of the Health Examination Survey and other surveys in the United States. However, the data from the Health Examination Survey are too sparse to permit firm conclusions on such details, but so far as can be judged from these data, there is no evidence that this is so. The racial contrast appears to be about the same for the rural South as for the remainder of the country.

The mean difference between the races found by the Health Examination Survey was approximately 5 mm. hg., both in systolic and diastolic pressures. This is not a very large difference, and if the levels for the different races had been obtained by different surveys it would be impossible to assert that the races differ in mean blood pressure. Since the data are from one survey, however, the difference is clearly significant statistically. It is not equally definite that this statistically significant difference could not have resulted (at least in part) from an artifact in the examination process. It is conceivable that the examination situation generally represents greater stress for Negro examinees than for white, either because of differences in social status between these groups or because of the fact

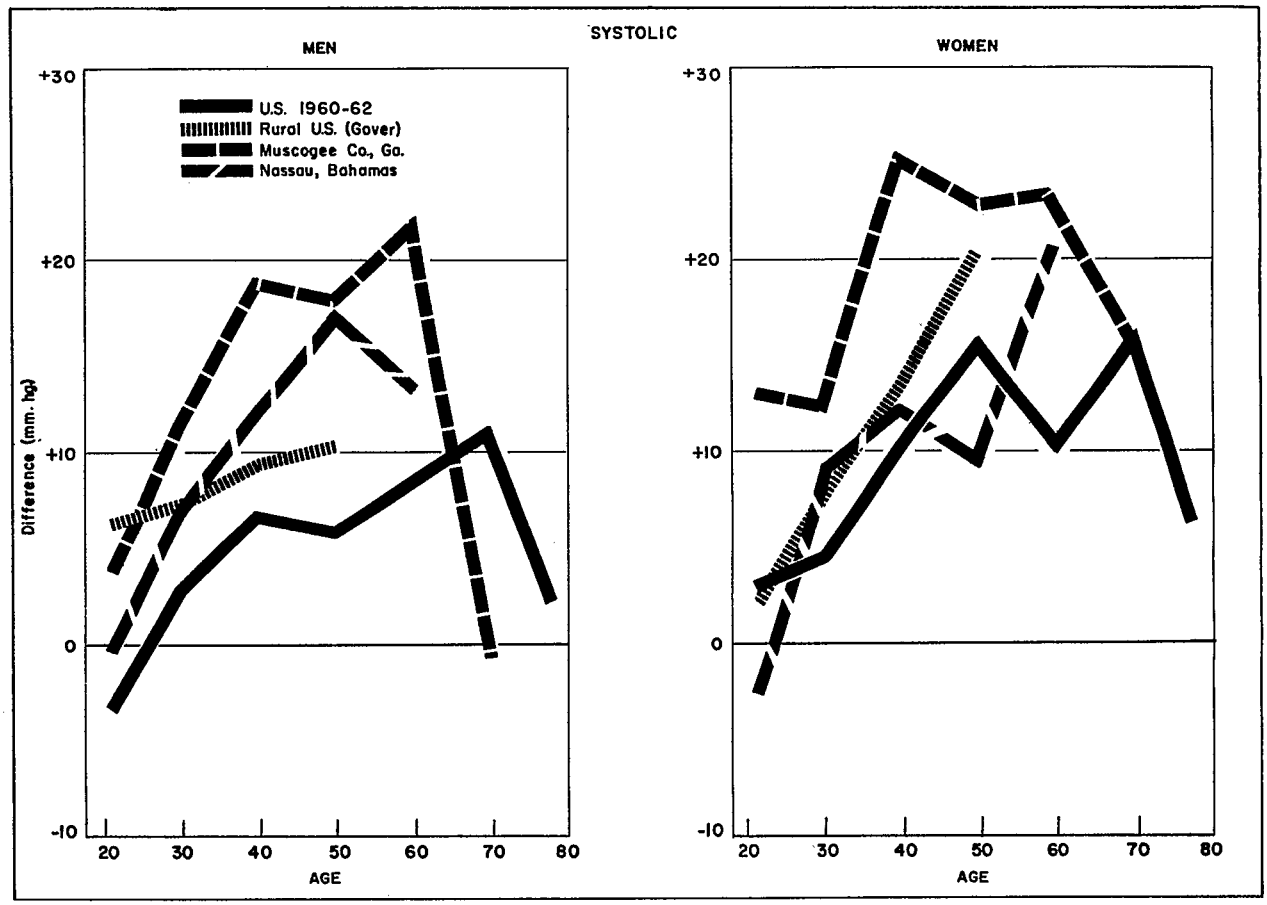

Figure 3. Mean difference between systolic blood pressures for white and for Negro persons, by age and sex: four surveys.

NOTE: Mean systolic blood pressure for Negro persons minus mean systolic blood pressure for white persons.

that medical procedures and a medical setting are less familiar to the average Negro examinee. It is, of course, well known that differences in attitude toward an examination can affect the blood pressure level by an amount as great as that found between the Negro and white races in this Survey.

This factor of tension would be difficult to investigate and the Survey did not undertake to do so. However, there is some indirect evidence in the data collected. If the blood pressure is measured repeatedly while the examinee is otherwise undistracted, it tends to fall to a "near basal" level.[8] The blood pressure of each examinee was measured three times, once at the beginning of the physical examination, once near the middle, and once at the end. While the physical examination did not provide an undistracted setting, the examinee was probably less tense at the end of the examination than at the beginning. This was reflected in the blood pressure. On the average, systolic blood pressure was lower on the third measurement than on the first (diastolic pressure remained unchanged). If there was a greater drop during the physical examination in the blood pressure for Negro than for white examinees, this would indicate a greater initial tension on their part; if the drop was the same it would argue that there is no racial difference in tension.

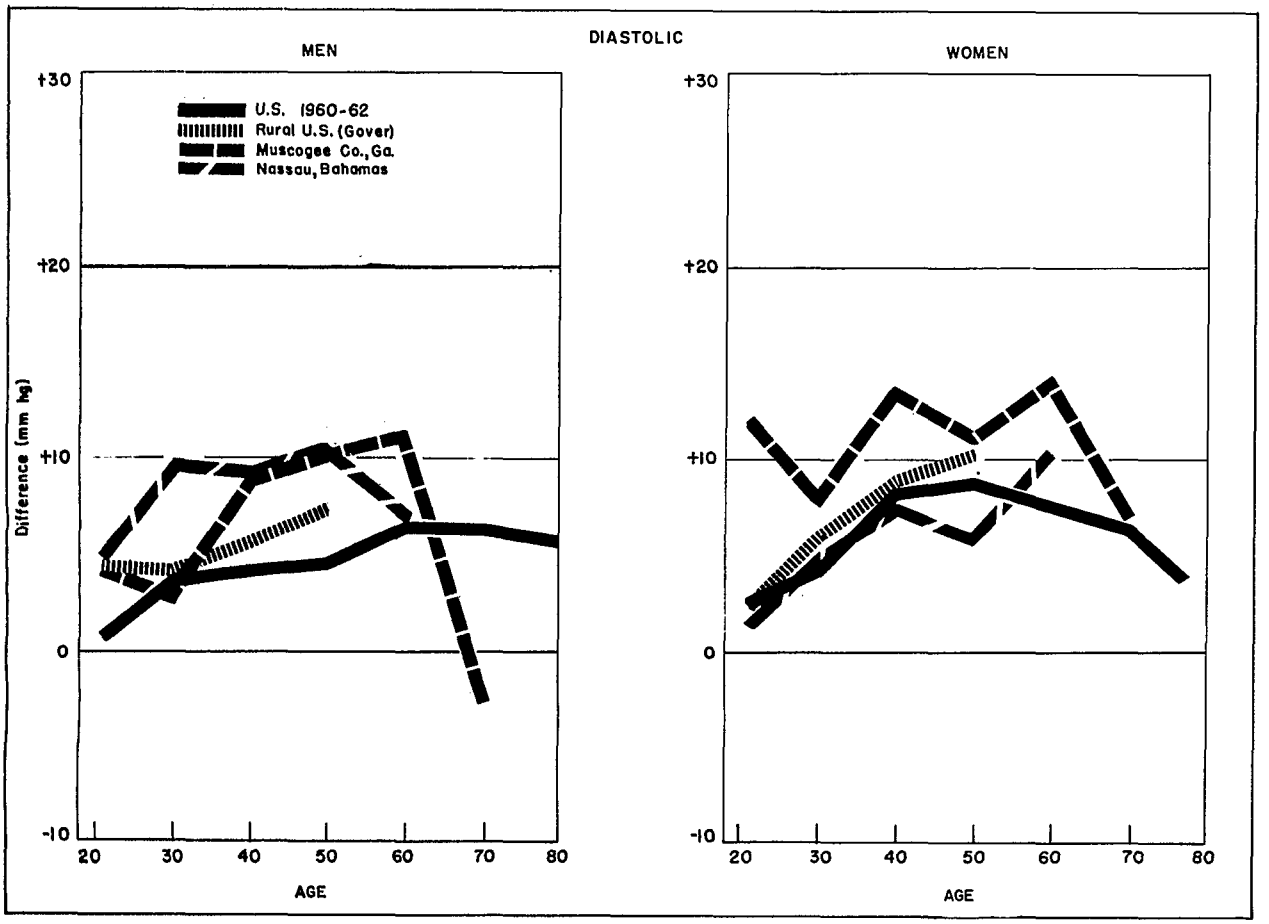

Figure 4. Mean difference between diastolic blood pressures for white and for Negro persons, by age and sex: four surveys.

NOTE: Mean diastolic blood pressure for Negro persons minus mean diastolic blood pressure for white persons.

On the first blood pressure measurement the average blood pressures by race were as follows:

	Negro	White	Difference
Systolic	138.56	132.68	5.88
Diastolic	83.44	77.35	6.09

On the third measurement the mean pressures were:

	Negro	White	Difference
Systolic	133.94	129.07	4.87
Diastolic	82.72	77.50	5.22

In short, the decrease was greater for the Negro examinee than for the white. It is therefore reasonable to suggest that some of the difference in mean blood pressure between Negro and white examinees found by the Health Examination Survey reflects a greater tension by Negro examinees at the time of the examination.

SUMMARY

1. There were only slight differences between regions of the United States in mean blood pressure level, but these differences were statistically significant.
2. No differences in blood pressure level were demonstrable between places (PSU's) of different population size or between urban and rural areas or between subdivisions of such areas.

3. The blood pressure of Negro adults was greater than the blood pressure of white adults, by 5.6 mm. hg. systolic and 5.0 mm. hg. diastolic. The comparison was about the same if the South is considered separately.

4. The HES data suggest that part of the recorded racial difference in blood pressure readings may arise from greater tension on the part of Negro examinees at the time of examination.

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DETAILED TABLES

Table 1. Mean blood pressures for white and Negro populations, by sex and age: United States, 1960-62

Sex and age	Systolic		Diastolic	
	White	Negro	White	Negro
	Mean blood pressure in mm. hg.			
Both sexes-18-79 years	130.6	136.2	78.3	83.3
Men				
Total-18-79 years	131.8	136.2	79.0	83.4
18-24 years	122.3	119.0	71.6	72.5
25-34 years	124.5	127.4	76.0	79.8
35-44 years	127.9	134.7	80.2	84.4
45-54 years	133.2	139.0	82.7	87.1
55-64 years	139.7	148.3	82.6	89.3
65-74 years	147.1	158.3	80.5	86.9
75-79 years	154.1	156.5	78.9	84.9
Women				
Total-18-79 years	129.4	136.3	77.5	83.2
18-24 years	111.6	114.6	69.1	71.5
25-34 years	115.2	119.7	72.5	76.6
35-44 years	121.6	132.1	77.0	85.3
45-54 years	132.2	147.8	81.1	89.9
55-64 years	145.8	155.7	84.2	91.9
65-74 years	159.2	175.2	83.3	89.7
75-79 years	156.5	162.8	79.1	82.9

Table 2. Mean blood pressures for white and Negro populations in the southern region, by sex and age: United States, 1960-62

Age and sex	Systolic		Diastolic	
	White	Negro	White	Negro
	Mean blood pressure in mm. hg.			
Both sexes-18-79 years	127.6	138.1	78.2	84.3
Men				
Total-18-79 years	129.1	137.7	79.1	84.6
18-24 years	120.3	121.1	71.9	73.9
25-34 years	123.6	126.2	76.1	80.3
35-44 years	123.6	141.1	79.6	88.1
45-54 years	131.6	143.5	83.1	90.4
55-64 years	138.5	143.0	83.3	87.0
65-74 years	146.9	157.7	81.5	88.2
75-79 years	149.7	142.7	79.4	80.2
Women				
Total-18-79 years	126.4	138.4	77.5	84.0
18-24 years	110.3	115.4	70.7	72.0
25-34 years	113.6	119.9	72.8	78.6
35-44 years	120.1	133.4	76.7	86.1
45-54 years	129.3	152.5	81.2	91.4
55-64 years	143.3	148.6	84.0	88.0
65-74 years	159.1	177.3	84.4	93.0
75-79 years	157.2	162.3	78.5	79.6

Table 3. Percent of white and Negro adults with blood pressures of at least 160 systolic or 95 diastolic, by sex and age: United States, 1960-62

Sex and age	Systolic at least 160 mm. hg.		Diastolic at least 95 mm. hg.		Systolic at least 160 mm. hg. or diastolic 95 mm. hg.	
	White	Negro	White	Negro	White	Negro
	Percent					
Both sexes-18-79 years	10.5	18.8	8.7	22.0	14.7	27.6
Men						
Total-18-79 years	8.6	16.8	9.1	22.6	13.6	27.6
18-24 years	0.2	-	1.7	1.9	1.7	1.9
25-34 years	0.7	4.6	3.4	11.5	3.7	12.5
35-44 years	3.9	16.2	10.9	25.9	11.8	26.5
45-54 years	8.7	10.8	13.8	29.5	17.3	30.8
55-64 years	15.9	29.4	11.9	31.6	21.4	44.6
65-74 years	26.1	63.2	12.3	40.5	27.3	66.0
75-79 years	39.1	59.8	13.3	21.2	40.2	59.8
Women						
Total-18-79 years	12.3	20.4	8.3	21.5	15.6	27.6
18-24 years	-	0.7	0.8	3.4	0.8	3.4
25-34 years	0.7	3.4	2.1	8.5	2.3	8.5
35-44 years	2.3	14.3	5.3	24.1	6.2	25.6
45-54 years	10.7	30.8	10.9	34.3	15.5	41.9
55-64 years	25.3	33.8	16.4	36.7	31.0	41.0
65-74 years	45.4	68.5	17.9	32.1	48.6	71.0
75-79 years	42.7	69.4	12.0	26.3	44.9	69.4

Table 4. Number and percent distribution of systolic blood pressures for white and Negro adults, by sex: United States, 1960-62

Pressure in mm. hg.	Men		Women		Men		Women	
	White	Negro	White	Negro	White	Negro	White	Negro
	Number of persons in thousands				Percent distribution			
Total	46,561	5,195	51,184	6,219	100.0	100.0	100.0	100.0
Under 90	43	-	167	18	0.1	-	0.3	0.3
90-99	584	99	2,258	196	1.3	1.9	4.4	3.1
100-109	3,517	434	7,566	825	7.6	8.4	14.8	13.3
110-119	8,866	955	11,655	1,333	19.0	18.4	22.8	21.4
120-129	11,287	920	9,432	919	24.2	17.7	18.4	14.8
130-139	9,290	814	6,813	698	20.0	15.7	13.3	11.2
140-149	5,558	571	4,296	536	11.9	11.0	8.4	8.6
150-159	3,382	522	2,676	420	7.3	10.1	5.2	6.8
160-169	1,734	319	2,047	370	3.7	6.1	4.0	6.0
170-179	1,060	249	1,467	246	2.3	4.8	2.9	3.9
180-189	447	157	1,085	236	1.0	3.0	2.1	3.8
190-199	416	86	843	127	0.9	1.6	1.6	2.0
200-209	214	34	465	61	0.5	0.7	0.9	1.0
210-219	74	-	172	152	0.2	-	0.3	2.4
220-229	53	25	91	25	0.1	0.5	0.2	0.4
230-239	27	-	88	19	0.1	-	0.2	0.3
240-249	-	-	11	-	-	-	0.0	-
250-259	9	9	13	-	0.0	0.2	0.0	-
260+	-	-	36	36	-	-	0.1	0.6

Table 5. Number and percent distribution of diastolic blood pressures for white and Negro adults, by sex: United States, 1960-62

Pressure in mm. hg.	Men		Women		Men		Women	
	White	Negro	White	Negro	White	Negro	White	Negro
	Number of persons in thousands				Percent distribution			
Total	46,561	5,195	51,184	6,219	100.0	100.0	100.0	100.0
Under 50	490	43	314	25	1.1	0.8	0.6	0.4
50-54	367	42	552	93	0.8	0.8	1.1	1.5
55-59	846	108	1,573	74	1.8	2.1	3.1	1.2
60-64	2,362	167	3,619	279	5.1	3.2	7.1	4.5
65-69	5,094	461	6,698	714	10.9	8.9	13.1	11.5
70-74	6,689	686	8,636	680	14.4	13.2	16.9	10.9
75-79	9,807	722	9,364	976	21.1	13.9	18.3	15.7
80-84	7,191	686	7,923	891	15.4	13.2	15.5	14.3
85-89	5,936	598	4,999	706	12.7	11.5	9.8	11.4
90-94	3,520	507	3,250	441	7.6	9.8	6.3	7.1
95-99	2,023	638	1,819	457	4.3	12.3	3.6	7.4
100-104	990	182	1,132	243	2.1	3.5	2.2	3.9
105-109	663	108	616	221	1.4	2.1	1.2	3.6
110-114	243	132	191	99	0.5	2.5	0.4	1.6
115-119	162	55	234	145	0.3	1.1	0.5	2.3
120-124	80	27	109	52	0.2	0.5	0.2	0.8
125-129	-	25	64	83	-	0.5	0.1	1.3
130-134	49	-	18	14	0.1	-	0.0	0.2
135+	48	9	72	24	0.1	0.2	0.1	0.4

APPENDIX I

STATISTICAL NOTES

The Survey Design

The Health Examination Survey is designed as a highly stratified multistage sampling of the civilian, noninstitutional population, aged 18-79 years, of the conterminous United States. The first stage of the plan is a sample of the 42 primary sampling units (PSU's) from 1,900 geographic units into which the United States has been divided. A PSU is a county, two or three contiguous counties, or a standard metropolitan statistical area. Later stages result in the random selection of clusters of about four persons from a small neighborhood within the PSU. The total sample included 7,710 persons in the 42 PSU's in 29 different States. The detailed structure of the design and the conduct of the Survey have been described in previous reports.[1,2]

Reliability in Probability Surveys

The methodological strength of the Survey derives especially from its use of scientific probability sampling techniques and of highly standardized and closely controlled measurement processes. This does not imply that statistics from the Survey are exact or without error. Data presented are imperfect for three important reasons: (1) results are subject to sampling error, (2) the actual conduct of a survey never agrees perfectly with the design, and (3) the measurement process itself is inexact, even when standardized and controlled. The faithfulness with which the study design was carried out has been analyzed in a previous report.[2]

Of the total of 7,710 sample persons, 86 percent or 6,672 were examined. Analysis indicates that the examined persons are a highly representative sample of the adult civilian, noninstitutional population of the United States. Imputation for the nonrespondents was accomplished by attributing to nonexamined persons the characteristics of comparable examined persons. The specific procedure used [2] consisted of inflating the sampling weight for each examined person to compensate for nonexamined sample persons at the same stand and of the same age-sex group.

While it is impossible to be certain that the blood pressures are the same in the examined and the nonexamined groups, the available evidence indicates that they are. One source of information on this question is a special inquiry sent to the physicians of nonexamined persons and to the physicians of a matching set of examined persons. The mean blood pressure reported for the examined and for the nonexamined groups was in exact agreement. For further details on this subject see *Vital and Health Statistics*, Series 11, No. 4.

Sampling and Measurement Error

In this report and its appendices, several references have been made to efforts to evaluate both bias and variability of the measurement techniques. 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 measurement of all elements in the universe.

The task of presenting sampling errors for a study of the type of the Health Examination Survey is complicated by at least three factors. (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 calculation of variances. (3) Thousands of statistics come from the survey, many for subclasses of the population for which there are small numbers of sample cases. Estimates of sampling error are obtained from the sample data and are themselves subject to sampling error, which may be large when the number of cases in a cell is small, or even occasionally when the number of cases is substantial.

In the present report, estimates of approximate sampling variability for selected statistics are presented in tables I and II. These estimates have been prepared by a replication technique which yields overall variability through observation of variability among random subsamples of the total sample. The method

Table I. Relative standard errors for estimated actual mean systolic blood pressure of adults, by region, population size, and place of residence

Item	Relative standard error
Region	
Northeast	0.020
South	0.020
West	0.020
Population size	
Giant metropolitan areas	0.010
Other very large metropolitan areas	0.010
Other standard metropolitan statistical areas	0.010
Other urban areas	0.025
Rural areas	0.010
Residence	
Urban	0.005
SMSA—in central city	0.010
SMSA—outside central city	0.010
Not in SMSA	0.015
Rural	0.010
Farm	0.015
Nonfarm	0.010

reflects both "pure" sampling variance and a part of measurement variance.

In accordance with usual practice, a 68 percent confidence interval may be considered the range within one standard error of the tabulated statistic and a 95 percent confidence interval the range within two standard errors.

An overestimate of the standard error of a difference $d=x-y$ of two statistics x and y is given by the formula $s_d=\left[x^2V_x^2+y^2V_y^2\right]^{\frac{1}{2}}$, where V_x^2 and V_y^2 are relvariances respectively of x and y, or the squares of the relative errors shown in table I. For example, table D shows systolic $x=130.6$ for white adults and $y=136.2$ for Negro, while from table II relvariances are found to be: $V_x^2 = 0.000025$ and $V_y^2 = 0.000225$. The formula yields the estimate of standard error of the difference ($d = 5.6$ and $s_d = 2.14$ mm. hg.). Thus, as the observed difference is more than two times its sampling error, it can be concluded that systolic blood pressure is higher among Negro adults than among white.

Table II. Relative standard errors of mean blood pressure for the United States and for the South, by race, sex, and age

Area, sex, and age	Systolic		Diastolic	
	White	Negro	White	Negro
United States				
Both sexes-18-79 years	0.005	0.015	0.005	0.010
Men-18-79 years	0.005	0.015	0.005	0.015
Women-18-79 years	0.005	0.020	0.005	0.010
Men-55-64 years	0.010	0.025	0.010	0.020
Women-35-44 years	0.005	0.020	0.010	0.015
South				
Both sexes-18-79 years	0.010	0.020	0.010	0.020
Men-18-79 years	0.010	0.020	0.010	0.025
Women-18-79 years	0.015	0.025	0.010	0.025
Men-55-64 years	0.025	0.040	0.020	0.040
Women-35-44 years	0.020	0.035	0.020	0.030

Small Numbers

In some tables magnitudes are shown for cells for which sample size is so small that the sampling error may be several times as great as the statistic itself. Obviously in such instances the statistic has no meaning in itself except to indicate that the true quantity is small. Such numbers, if shown, have been included to convey an impression of the overall story of the table.

Tests of Significance

As shown above, the difference in mean blood pressure between Negro and white adults was submitted to a formal test of significance and found to be significantly different from zero. This difference could have been examined in other ways. It might have been more meaningful, for instance, to ask whether the blood pressure for Negro adults was higher than (rather than "different from") the blood pressure for white adults. There is much evidence indicating this, and the test for a one-sided hypothesis is more powerful than the test for a two-sided hypothesis. Alternatively, the question might have been, "Is the blood pressure higher for Negro adults than for white adults if age is held constant?" Conceivably, the age-sex-specific means could be identical for the two groups but a larger proportion of older people in one group could lead to an overall higher blood pressure for that group.

This last version of the hypothesis can be tested directly from table 1, with the use of a table for the binomial variable. Mean diastolic pressure is higher for Negro adults in every age-sex group and mean systolic in all but one age-sex group. The chances of 14 heads out of 14 tosses of a true coin are 0.00006 and this corresponds to the case for diastolic pressure. The chances of 13 or more heads out of 14 tosses are 0.00098 and this corresponds to the case for systolic pressure. A more powerful statistical procedure could be suggested but is obviously unnecessary.

Differences among areas are of course confounded by age-sex differential composition. Accordingly a review was made for regions of age-specific means (not published). These show that in 12 of the 14 age-sex groups, the mean systolic pressure was higher in the Northeast than in the South. On the null hypothesis of no difference, the probability of such a contrasting result is about 0.01. In 13 age-sex groups it was higher in the Northeast than in the West. If the data for white adults are considered, the regional differentials are even stronger. On the other hand, a comparison of South and West shows 7 age-sex groups for which systolic pressure is higher in one region than in the other and 7 in which the comparison is reversed. It can therefore be concluded that when these two latter regions are compared the mean systolic pressure is not consistently higher in either. Ranking the mean systolic pressure for the three regions in each age-sex group leads to the same average rank for South and West, corroborating the supposition of no difference between these two regions.

Expected Values

In tables A-D, expected mean systolic blood pressures are computed and the actual blood pressures for the area are compared with the expected. The computation of expected values was done as follows:

Suppose that in an area (say the Northeast) the Health Examination Survey estimates that there are N_i persons in the ith age-sex group ($i = 1, 2, \ldots, 14$; sum of $N_i = N$).

Table III. Excess of actual over expected blood pressure, by stand: Health Examination Survey, 1960-62

Stand number	Blood pressure	
	Systolic	Diastolic
	Mean deviation (mm. hg.)	
1	0.6	2.8
2	-0.5	0.6
3	-1.8	-5.8
4	-0.5	-4.4
5	2.3	-1.6
6	-1.3	-5.3
7	-5.7	-3.4
8	-2.1	-3.5
9	-4.0	-5.8
10	-2.8	0.6
11	0.3	-1.7
12	2.3	2.5
13	-4.2	-0.3
14	2.5	-2.4
15	3.4	-0.6
16	-4.6	-2.5
17	1.2	1.1
18	5.3	1.4
19	2.4	-2.2
[1]20	-1.6	-0.5
23	-1.2	2.5
24	-4.2	-2.2
25	1.6	4.2
26	4.7	4.0
27	4.4	3.0
28	7.7	4.3
29	-0.2	1.5
30	-0.9	1.0
31	0.8	-0.5
32	-6.7	-1.9
33	-1.2	-0.3
34	11.5	6.9
35	8.0	5.7
36	0.2	1.6
37	2.4	2.3
38	-3.7	-1.2
39	-8.1	-0.5
40	1.8	3.6
41	0.9	-1.1
42	-6.0	-0.1

[1] Three stands combined.

Suppose the Health Examination Survey estimates that the systolic pressure for the United States in the ith age-sex group is $X_{i.}$

Then the expected mean systolic pressure for the area is

$$\frac{1}{N} \sum_i N_i \bar{X}_i$$

If the N_i are considered to be a set of constants, the variance of the expected value for an area will ordinarily be negligible when compared with the variance of the estimated actual value. This means that as a first approximation the variance for the difference between the actual and the expected value can be taken as equal to the variance for the actual value. This should be considered as indicative, only, since the actual and expected values are not independent.

Stand Variation

The discussion of area differences may be supplemented by a consideration of differences among PSU's. To do this, the following computation is performed:

Suppose that N_i persons are examined at a stand from the ith age-sex group, $i = 1, 2, \ldots, 14$ (sum of $N_i = N$).

Let $\bar{x}_i$ be the mean blood pressure obtained at this stand for age-sex group i.

Let $\bar{\bar{x}}_i$ be the mean blood pressure for the ith age-sex group as measured at all stands combined. Then

$$D = \frac{1}{N} \Sigma N_i (\bar{X}_i - \bar{\bar{X}}_i)$$

D is a summary measure of the deviation of this stand from the average stand and it is the statistic tabulated in table III.

There were 42 stands at which examinations were conducted. At most stands there were two physicians who took examinees alternately. It was shown in the first report on blood pressure [3] that blood pressure measurements vary significantly from one examiner to another. Since physicians were ordinarily engaged for only one or two stands, differences between physicians will be confounded with differences between stands. The separation of these two components of variance is a difficult undertaking in view of the complexity of the sampling design and estimation procedures used in the Health Examination Survey and is not attempted in this report. However, preliminary analysis indicates that there is a measurable component of variation attributable to stand variation. The differences presented in table III, however, considerably overstate the amount (because they include interexaminer variation).

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APPENDIX II

DEMOGRAPHIC TERMS

Age.—The age recorded for each person is the age at last birthday. Age is recorded in single years.

Race.—Race is recorded as "White," "Negro," or "Other." "Other" includes American Indian, Chinese, Japanese, and so forth. Mexican persons are included with "White" unless definitely known to be Indian or other nonwhite race.

Population density.—The five classes comprising this characteristic were derived from the design of the sample which accomplished a stratification of the primary sampling units by population density in each of three broad geographic locations. Because the Survey was started in 1960, the primary sampling units within each of the five population density classes were necessarily based on populations and definitions of the 1950 census. The name of each selected primary sampling unit within each population density class and geographic location, along with selected sample data are presented in an earlier report.[2]

The definitions for each of the five population density classes are as follows:

Giant metropolitan areas.—This class includes nine primary sampling units, defined in the 1950 census as a standard metropolitan statistical area (SMSA) and having a population of 3,000,000 persons or more.

Other very large metropolitan areas.—Included in this class are six standard metropolitan statistical areas with a population of 500,000 to 3,000,000 as defined by the 1950 census.

Other standard metropolitan statistical areas.—This class includes nine other SMSA's selected as primary sampling units. With one exception—Providence, R.I.—all had less than 500,000 population.

Other urban.—This includes eight primary sampling units which were highly urban in composition but were not defined in 1950 as standard metropolitan areas.

Rural.—This includes 10 primary sampling units which were primarily rural in composition according to 1950 census definitions.

Region.—For the purpose of classifying the population by geographic area, the United States was divided into three major regions. This division was especially made for the design of the HES sample. The regions and the States included are as follows:

Region	States Included
Northeast	Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, New York, Pennsylvania, Ohio, and Michigan.
South	Delaware, Maryland, District of Columbia, West Virginia, Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, and Texas.
West	Washington, Oregon, California, Idaho, Nevada, Montana, Utah, Arizona, Wyoming, Colorado, New Mexico, North Dakota, South Dakota, Nebraska, Kansas, Minnesota, Iowa, Missouri, Wisconsin, Illinois, and Indiana.

Location of residence terms.—This term refers to urban or rural place of residence of the sample persons. For the first six primary sampling units at which examinations were conducted, the definition of urban and rural was the same as that used in the 1950 census. These locations were Philadelphia, Pa., Valdosta, Ga., Akron, Ohio, Muskegon, Mich., Chicago, Ill., and Butler, Mo. For the remainder of the sampling units, the 1960 census definitions were used.

The change from 1950 to 1960 definitions is of small consequence in the Survey since only six locations were affected and the major difference is the designation in 1960 of urban towns in New England and of urban townships in New Jersey and Pennsylvania.

According to the 1960 definition, the urban population comprises all persons living in (a) places of 2,500 inhabitants or more incorporated as cities,

boroughs, villages, and towns (except towns in New England, New York, and Wisconsin); (b) the densely settled urban fringe, whether incorporated or unincorporated, of urbanized areas; (c) towns in New England and townships in New Jersey and Pennsylvania which contain no incorporated municipalities as subdivisions and have either 25,000 inhabitants or more, or a population of 2,500-25,000 and a density of 1,500 persons or more per square mile; (d) counties in States other than the New England States, New Jersey, and Pennsylvania that have no incorporated municipalities within their boundaries and have a density of 1,500 persons or more per square mile; and (e) unincorporated places of 2,500 inhabitants or more not included in any urban fringe. The remaining population is classified as rural.

Size of place.—In this Survey the urban population is classified as living "in the central city" or "outside the central city" of an SMSA. The remaining urban population is classified as "not in SMSA."

The definitions and titles of standard metropolitan statistical areas are established by the U.S. Bureau of the Budget with the advice of the Federal Committee on Standard Metropolitan Statistical Areas.

The definition of an individual standard metropolitan statistical area involves two considerations: first, a city or cities of specified population to constitute the central city and to identify the county in which it is located as the central county; and, second, economic and social relationships with contiguous counties which are metropolitan in character, so that the periphery of the specific metropolitan area may be determined.

Persons "in the central city" of an SMSA are therefore defined as those whose residency is in the city appearing in the stand and metropolitan statistical area title. Persons residing in a SMSA but not in the city appearing in the SMSA title are considered to reside "outside the central city."

Rural farm - nonfarm residence.—The rural population may be subdivided into the rural-farm population, which comprises all rural residents living on farms, and the rural-nonfarm population, which comprises the remaining rural population. The farm population includes all persons living in rural territory on places of 10 or more acres from which sales of farm products amounted to $50 or more during the previous 12 months or on places of less than 10 acres from which sales of farm products amounted to $250 or more during the preceding 12 months. Other persons living in rural territory were classified as nonfarm. Persons were also classified as nonfarm if their household paid rent for the house but their rent did not include any land used for farming.

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