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Parity and Hypertension

Relationship between parity and hypertension as shown in data from the Health Examination Survey, 1960-62.

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PARITY AND HYPERTENSION

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INTRODUCTION

Among the many physiological factors which have been hypothesized as associated with elevated blood pressure levels and increased incidence of hypertension, the possible effect of pregnancy in the production of these conditions has proven to be among the more elusive to quantitate and evaluate. At the same time, the possible association is among the more interesting from an epidemiological standpoint, not only because of the importance of the primal question of whether or not pregnancy is a factor in the etiology of hypertension, but also because of the component parts represented by those pregnancies complicated by preeclampsia.

Age is considered by many observers to be an important factor in the production of residual hypertension, and the statistical association of age with increased blood pressure levels is probably the most pronounced and easily demonstrated phenomenon observable in any study population.[4, 5, 7-10, 13] A moderate decline in average diastolic blood pressure among the general population after age 55 is an exception to this, and is less frequently evaluated.[13] Body measurements, race, and several other variables may be cited as also being correlated with blood pressure levels, however, their effect is much less significant than that observable for age.[3-6, 8, 13-15]

Changes in observed blood pressure levels with increased parity are certainly, to some extent, the result of indirect association with age, and attempts to identify any remaining additional effect which might be attributed only to parity are usually compromised in the typical smaller scale clinical study by the very few cases available on which to base mean blood pressures specific for age-parity cross-classifications.

The association between pregnancy, preeclamptic toxemia, and essential hypertension has not been clearly defined despite the results of several studies. It has been noted that 30.2 to 50.9 percent of women who have preeclamptic toxemia are left with a residual hypertension following the pregnancy.[2, 5] A residual hypertension is considered to be the main factor in the causation of recurrent preeclamptic toxemia,[2, 3] which has a reported incidence ranging from 13 to 65 percent in women who had a previous preeclamptic toxemia.[3, 5, 6]

Age and parity are also considered to be causative factors in recurrent preeclamptic toxemia.[2-4] If hypertension present pior to a pregnancy is a precursor to recurrent preeclamptic toxemia, the question still remains as to how much age and parity affect this hypertension. In support of parity being the factor, Quinlivan observed that the incidence of cardiovascular disease in 31,986 women of all parities was 0.8 percent, while in 4,721 women of parity 6 or more, it was 8.4 percent. Isenhour, et. al.'s study of 900 nulliparous and 900 parous hospitalized women however provides opposing evidence.[7] They compared the blood pressures in 10-year age groups as shown in the patient's records and were unable to demonstrate the difference in the incidence of hypertension or average blood pressure levels between nulliparous and parous women. Barnes and Browne obtained similar results in a comparable study.[1]

It is apparent from the above reports that there is a disagreement concerning the part played by parity in the production of hypertension. This may be due to the misinterpretation of data in retrospective studies, differences in the definition of hypertension, and variations in the methodology. The purpose of the present study was to determine whether parity is a factor in the etiology of hypertension.

The following analysis is based on data obtained in the national survey of adults age 18 to 79, conducted between October, 1959 and December, 1962 in the Health Examination Survey Program. The total sample of 6,672 persons who received all or part of a uniform health examination included 3,581 women. Since the examinees are a probability sample of the civilian, noninstitutional population of the United States at the time, they represent (with appropriate application of statistical weighting factors) the characteristics of the national population with respect to parity, blood pressures, prevalence of hypertension, and other factors, with a high degree of accuracy. Thus, in addition to the analytical findings discussed in the following, it is believed that the data of this study provide useful base-line information of the extent to which special population groups in similar studies may differ from a typical national norm with respect to parity and gravidity. Such normative data for blood pressures by sex, race, and selected socioeconomic variables have been previously published.[13-15]

SOURCE OF DATA

The purpose of the National Health Examination Survey of adults was to obtain statistical data on the prevalence of selected chronic diseases (including hypertension), dental health problems, and distributions of certain body measurements and sensory characteristics for the general population. Eighty-seven percent of a representative national sample of 7,710 persons received a standardized examination conducted by medical, dental, and paramedical members of mobile survey teams. Details of the study design, including the methods of obtaining a probability sample representative of the national population, standardization of procedures, quality control, response variation, and training of examiners have been published in previous reports.[11-13] Specific details of the methods used in obtaining blood pressure measurements, data for evaluation of possible diurnal and other special sources of blood pressure variation, as well as blood pressure distributions and prevalence of hypertension for selected characteristics of the national population, have also been published.[13-15]

The total sample of 7,710 included 4,211 females of which 3,581 were examined. A self-administered medical history, directed largely towards cardiovascular disease and arthritis, but also containing questions of diabetes, vision, hearing, and mental health, as well as some miscellaneous questions, was completed by each examinee prior to the examination proper. A receptionist interviewer showed the examinee how to fill in the questionnaire, which was completed in a booth, in privacy, in the clinical setting of the examination unit. On request, the receptionist-interviewer read questions to the examinee but did not provide any assistance in definition of terms or other amplification. Motivation of the respondents in completing the history form was considered to be high. Forms were reviewed for completeness by the receptionist-interviewer and for content by the examining physician.[11]

Information as to whether or not the examinee was pregnant at the time of the examination was obtained from the self-administered medical history form, which asked simply "Are you pregnant now?" and provided three check options: yes, no, and ?. The distribution of answers to this question among the 3,581 examined females was as follows:

Yes	146
No	3,393
?	40
No entry	2
Total	3,581

For this study, the 146 cases with positive response were excluded from the investigation.[a] The study population, therefore, is represented by 3,435 examined women who did not respond affirmatively to the question "Are you pregnant now?" on the self-administered medical history form.

The techniques employed in measurement of blood pressures for these sample people are fully described in references 13 and 14. The following summary of essentials is taken from the former publication.

> "The blood pressure of each examinee was measured three times during the course of the physical examination. The first measurement 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 taken by the nurse and had been allowed a few moments after sitting up for the effects of postural hypotension to disappear. The third measurement was taken at the end of the physical examination.
>
> A venipuncture was usually made during the physical examination, although the specific point at which it was taken varied from one examinee to another.
>
> Blood pressure measurements were taken on the left arm with the examinee sitting on the examining table. The nurse placed the middle cuff over the bulge in the upper left arm. The cuff was left on the arm between the first and second measurements, was removed after the second, and returned for the third.[b] The physician held the arm at the level of the atrium, with the nurse raising the Baumanometer to the physician's eye level. Using the bell of his stethoscope, the physician noted the pressure when the sound was first heard, when it first became muffled, and when it disappeared, recording all three measurements... to the nearest even tenth in mm. Hg. ... ."

The systolic blood pressure for this study is the arithmetic mean of the three systolic measurements taken at the beginning, middle, and end of the physician's examination. The diastolic data are corresponding means recorded for disappearance of the Korotkoff sounds or, if the sounds did not disappear, the point of muffling was substituted.

The basic reference blood pressure distributions for the defined study population are shown in table A; exclusion of the pregnant examinees resulted in a reference distribution for the study population of slightly higher mean blood pressures than for the general U.S. population.[c]

The diagnosis of hypertension was based on mean blood pressure measurements. The criteria used were as follows:

Normotension.—Both below 140 mm. Hg. systolic and below 90 mm. Hg. diastolic

Definite hypertension.—Either (1) 160 mm. Hg. or over systolic, or (2) 95 mm. Hg. or over diastolic

Borderline hypertension.—Below 160 mm. Hg. systolic and below 95 mm. Hg. diastolic, but not simultaneously below both 140 mm. Hg. systolic and 90 mm. Hg. diastolic

[a]The 42 questionnaires representing women for whom a definitive response was not recorded to the "pregnant now" question, were evaluated on a case-by-case basis by examination of data for related variables (age, blood pressure readings, menopausal history, and hypertension diagnosis). The majority were believed to be almost certainly not pregnant at the time of examination and, in any case, the relatively small (statistical) weight of any who might have been, would have no discernible effect on the results obtained.

[b]A 12 cm. cuff was used.

[c]Although tangential with respect to the main study, it is interesting to note that the differences were statistically significant in four out of six cases, the standard normal deviates of the differences between pregnant and nonpregnant means for the first three age groups being, respectively: Systolic — 2.33, .38, 1.16 and Diastolic—4.51, 5.02, and 3.29.

Table A. Mean systolic and diastolic blood pressures in mm. Hg. and standard errors, by age, study population, and comparisions

Age	Female						Male—U.S. population
	U.S. population	Total study population		Pregnant			
		Mean	SE	Number of cases	Mean	SE	
	Systolic pressure in mm. Hg.				Systolic pressure in mm. Hg.		
Ages 18-79 years	...	130.6	.64	146	111.0	.86	...
18-24 years	111.8	112.2	.63	75	109.2	1.12	121.7
25-34 years	115.6	115.9	.68	57	111.4	1.73	124.7
35-44 years	122.8	122.9	.92	14	117.9	4.19	128.6
45-54 years	133.8	133.8	1.43	-	...	...	133.8
55-64 years	146.6	146.6	1.75	-	...	...	140.3
65-74 years	160.2	160.2	1.97	-	...	...	148.0
75-79 years	156.6	156.6	2.59	-	...	...	154.3
	Diastolic pressure in mm. Hg.				Diastolic pressure in mm. Hg.		
Ages 18-79 years	...	78.6	.42	146	65.5	.72	...
18-24 years	69.4	70.2	.48	75	64.0	1.29	71.6
25-34 years	72.9	73.3	.48	57	67.0	1.15	76.4
35-44 years	78.0	78.2	.70	14	66.7	3.43	80.7
45-54 years	82.0	82.0	.69	-	...	...	83.2
55-64 years	84.9	84.9	.86	-	...	...	83.1
65-74 years	83.7	83.7	.75	-	...	...	81.0
75-79 years	79.3	79.3	1.65	-	...	...	79.4

SE = Standard error.

Only the diastolic mean was used (with the cut-off points specified above) in cases for which aortic insufficiency was determined to be present, or the pulse rate was under 60.[18]

The data on prevalance of hypertension in tables B, 8, and 9 of this report refer to definite hypertension plus borderline hypertension. This was done largely for analytical convenience since the estimated prevalence rates based on a larger number of cases in the numerator are relatively more stable than those based only on definite hypertension. Even with the use of this definition, estimation of prevalence is generally of a lesser order of precision than that for mean blood pressures as indicated in the following comparison of mean systolic with the reference distribution of prevalence rates.

The inclusion of persons classified as borderline hypertensive in the numerators of the prevalence rates, as well as the particular criteria used in defining hypertension, are considered to be appropriate for purposes of relating hypertension to parity state, although different prevalence levels would have been obtained for

Table B. Estimated prevalence (in percent) of hypertension, study population, and comparisons

Age	Definite and borderline hypertension			Estimated mean systolic pressure		Number of persons in sample
	Estimated U.S. prevalence, women 18-79	Study population		Study population		
		Estimated prevalence	Rel-variance[1]	Mean in mm. Hg.	Rel-variance[1]	
Ages 18-79 years-	28.6	29.6	.00050	131	.00002	3,435
18-24 years----------	2.6	2.9	.09507	112	.00003	459
25-34 years----------	6.3	6.8	.01165	116	.00003	689
35-44 years----------	17.5	17.6	.00524	123	.00006	770
45-54 years----------	33.5	33.5	.00514	134	.00012	705
55-64 years----------	55.7	55.7	.00268	147	.00014	443
65-74 years----------	72.0	72.0	.00135	160	.00015	299
75-79 years----------	73.4	73.4	.00513	157	.00027	70

[1]Square of ratio of standard error to estimate.

the same subjects, given a different set of examiners or a different clinical setting.[d]

Height and weight measurements were made with examinees stripped to the waist, pockets emptied, wearing paper slippers and a knee-length examining gown. Recording errors were believed to have been virtually eliminated through use of an automatic printing scale for weight, and photographic recording of height. A check of a small series of the clothing worn by representative examinees showed the weights of men's clothing to be slightly over 2 pounds and women's

[d]A methodological study directed by Dr. Jeremiah Stamler carried out by the Medical Research Institute of Michael Reese Hospital prior to the fielding of the survey to investigate comparability between survey diagnoses and those diagnoses which might be obtained for the same people in a full cardiovascular examination, found the overall yields of positive hypertension diagnoses at about the same level, but with significant differences in the extent to which diagnostic categories matched in the two procedures.[20] Information obtained from the personal physicians of a subsample of 448 of the 6,672 examined men and women in the Health Examination Survey showed a similar lack of correspondence of matching of diagnostic categories and in addition, a considerably lower proportion of persons classified as definite or suspect hypertensive by the family physicians (15 percent by the physicians as compared with 34 percent in the survey for these 448 persons).[15,19] A potentially much more significant factor in the context of this study is the fact that the survey diagnosis of hypertension failed to take into account a history of hypertension for persons with blood pressure readings in the normal range who might have been using hypertensive medication at the time of the examination. The possible impact of this in relation to the women in this study is indicated by the following data.

Medical history	Survey diagnosis	
	Hypertension (definite or borderline)	Normotension
Total --------	977	2,458
Doctor confirmed high blood pressure with patient taking medicine for it--------	211	80
Doctor confirmed high blood pressure with patient not taking medicine for it -----	201	110
Other ------------	565	2,268

clothing to be slightly under 2 pounds. In other words, the body weight data of this study may be expected to closely approximate 2 pounds over nude weight.[16]

In this study parity refers to the number of "babies born alive" and gravidity includes both "babies born alive" and the number of "pregnancies that did not result in a live birth."[e] The sources of these data were questions 74g. and 74h. and j. of the self-administered medical history form previously described.

74g. How many babies have you ever had who were born alive?

74h. Have you ever had any pregnancies that did not result in a live birth?[f]

74j. If yes, how many?

Nonresponse to these questions was of no analytical importance. There were only 35 cases for which answers were not recorded for the parity questions, 21 cases for the fetal death question, and two for both questions (table C).

Gravidity data were constructed by adding the responses obtained to the parity and "other pregnancy" questions for each individual. For cases for which both were unknown (two cases only), gravidity was recorded as unknown. If either live births or "other pregnancies" were unknown, but not both, gravidity was recorded as

Table C. Nonresponse by race and age for live birth and "Other pregnancies" questions

Race and age	Women in sample	Nonresponse				
		Frequency			Percent	
		Live births (74g)	"Other pregnancies" (74h/j)	Both	Live births (74g)	"Other pregnancies" (74h/j)
Total[1]	3,435	35	21	2	1.0	.6
Race						
White	2,931	33	18	2	1.1	.6
Negro	448	1	2	-	.2	.4
Age						
18-24 years	459	11	2	-	2.4	.4
25-34 years	689	9	5	1	1.3	.7
35-44 years	770	9	2	1	1.2	.3
45-54 years	705	3	4	-	.4	.6
55-64 years	443	3	5	-	.7	1.1
65-74 years	299	-	3	-	-	1.0
75-79 years	70	-	-	-	-	-

[1]Includes women classified as other than white or Negro.

[e]These operational definitions compromise to some extent, of course, the fully precise standard concepts, such as those recommended by the American College of Obstetricians and Gynecologists, which would have been preferred. In this study, it was not practicable to take into account pregnancies resulting in multiple births in delineating these variables.

[f]Included pregnancies which terminated in abortion or foetal deaths.

equal to the entry for the question for which information was available.[g]

ANALYTICAL METHODS

Complete detail on numbers of sample women available for analysis for specific age-race cross-classifications is shown in tables 2 and 3. Reasonably stable mean blood pressure estimates were obtained for specific parity classes for all age groups among the "all races" and white populations. With the much smaller number of Negroes in the sample (448), estimates for this group are naturally subject to much greater sampling variability and only means in the age range 18-54 were considered appropriate for analysis for this group.

As previously noted, trends of hypertension rates with increasing parity and gravidity have considerably higher relative sampling errors than the corresponding distributions for means. While the sample size is sufficient for the analysis in general, data for certain cells in tables 8 and 9 have been presented as of interest in the context of study as a possible trend, but are underlined to call attention to their larger sampling variability.

In this report, a measure or characteristic for an examinee is weighted by the reciprocal of the probability of her selection in the sample (adjusted by a nonresponse factor), and the percents or means are calculated on the basis of these weighted estimates. The data thus relate to the United States population with the specified characteristics. A standard error, reflecting the variability due to sampling, is shown for most estimates.[h]

In order to evaluate the effect of increased parity on blood pressure levels and hypertension rates, the most direct method, that of studying changes in these measures with different parity levels for specific age groups, is the first approach used in this analysis. In addition, adjustment is frequently made to approximately equalize the effect of age for the various parity classes by calculation of an age-adjusted rate for each of them.[i] Finally, the individual and joint effects of, not only age and parity but also body weight, on mean blood pressure has been evaluated by standard multiple correlation techniques using appropriate independent estimates of the sampling errors of the correlation and regression statistics to reflect the complex statistical de-

[g]Comparison of the parity distribution resulting from the Health Examination Survey data with that of the 1960 Census is of some interest although, in addition to the different reference point in time (the mid- point of HES data collection was October, 1961), there are several other differences in the two populations (see reference 26, table 190).

Parity	1960 Census (ages 18 and over)	Study population (weighted to represent U.S. totals ages 18-79)
	Percent	
0	16.6	22.5
1	18.8	16.6
2	24.1	21.0
3	16.6	15.7
4	9.6	9.8
5-6	8.5	8.1
7 or greater	5.8	6.4

The Bureau of the Census data include Alaska, Hawaii, and the institutional population while the HES figures exclude these. Also, the HES statistics include "never married" women while the Census distribution excludes these.

[h]Because of the complex sample design used for the survey (to maximize precision at minimum cost), standard errors have been calculated by a pseudoreplication technique rather than by using algebraic relationships between the parameters and the sample size. For details see the appendix and references 21, 22, and 23.

[i]The age-adjusted mean or rate simply shows the value that would be expected for the statistic if the age-specific values of the statistics for all parity groups pooled applied to the population for each age group in a specific parity class. Specifically, if there are N_i persons in the i'^{th} age group of women with parity 3, the age-adjusted mean systolic pressure for women of parity 3 is $\frac{1}{N}\sum_i N_i X_i$ where the X_i are the mean systolic blood pressures of women in the i'^{th} age group. (The N_i are, of course, estimated total persons in the United States rather than sample persons).

In order to distinguish this figure from the more commonly calculated "age-adjusted" statistic (which would be obtained by the inverse procedure of applying the age-specific rates or means for a particular group to the age-specific population of all groups), it is sometimes referred to as an "inverse age-adjusted rate" or "expected value."

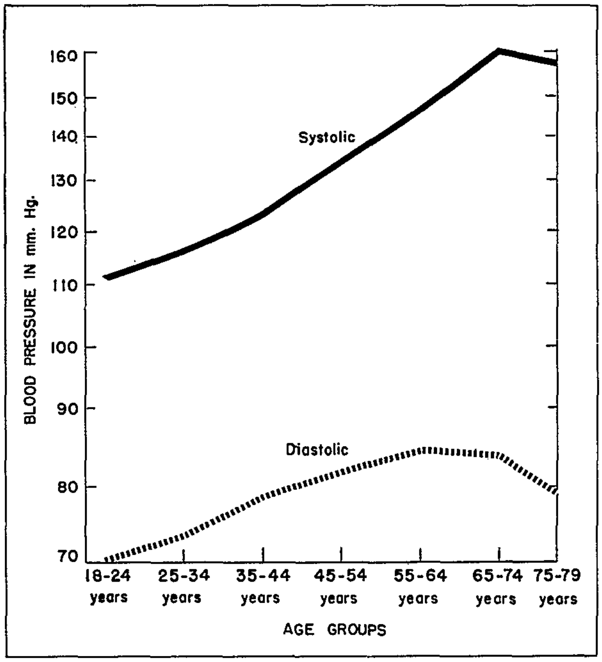

Figure 1. Mean systolic and diastolic blood pressures by age, study population.

sign of the survey to permit imputation of the findings to the United States population.[j]

FINDINGS

Data showing the statistical relationships between age, parity, and gravidity on the one hand and blood pressures on the other are presented in tables 4-7 and figures 1-3.

Diastolic blood pressure increases consistently with increasing age through age group 55-64, and then declines for both white and Negro women. Systolic blood pressure increases with age at a greater rate over all age groups (with the exception of the last group—75-79 years—which is easily explainable by sampling variability among women of both races.

Women of parity 5 or more have higher systolic and diastolic blood pressures. Following

[j]For details of the adaptations to classical theory see the appendix.

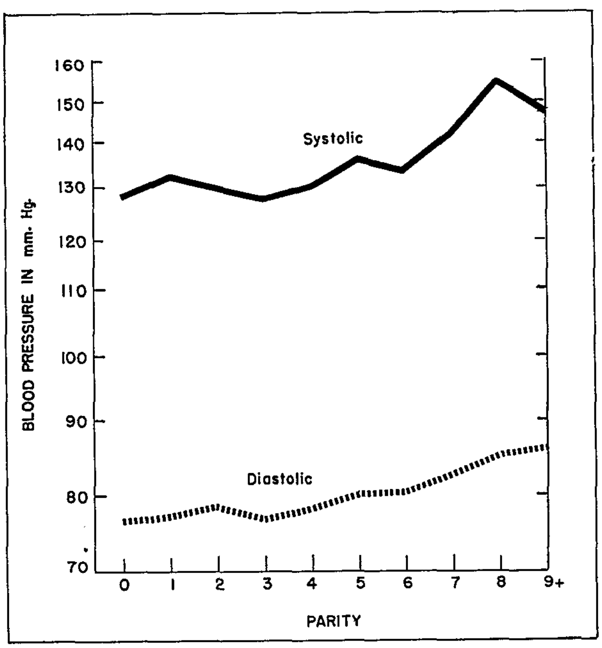

Figure 2. Mean systolic and diastolic blood pressures by parity, study population.

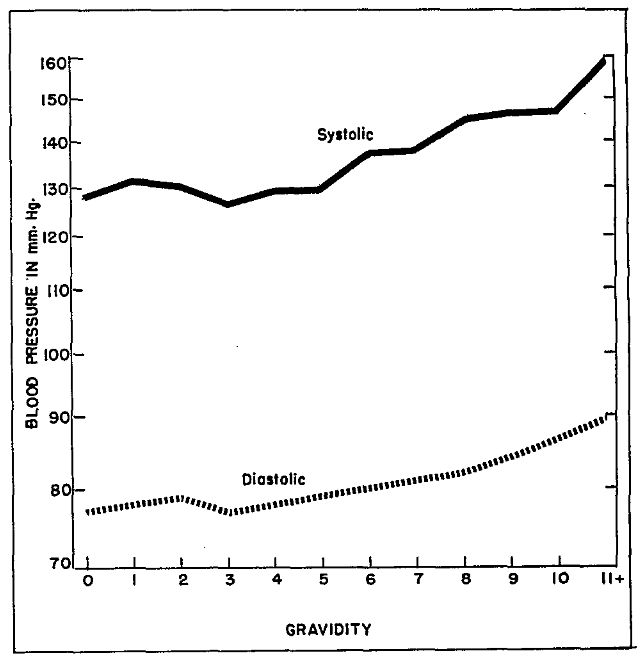

Figure 3. Mean systolic and diastolic blood pressures by gravidity, study population.

parity 3, a consistent increase for diastolic pressure occurs at each succeeding parity level with a similar trend evidenced for systolic blood pressure. At lower parities, mean systolic pressures for Negro women are higher than those for white women, this is somewhat less true at parities 4 and over, although the trend of increased systolic pressure with increasing parity holds for both groups. Mean diastolic blood pressures for Negro women are higher for all parity groups (the one point difference at parity 5 is of no statistical or practical significance) and paralleling the trend for systolic, the differences tend to be greater at parities of less than 4.

The distributions of mean systolic and diastolic blood pressures by gravidity begin to differ from the corresponding distributions by parity beginning at parity and gravidity 3 or 4, after which the gravidity means tend to be lower than the corresponding parity means. Women of gravidity 6 and over have on the average higher systolic and diastolic blood pressures than women with fewer past pregnancies. Mean diastolic blood pressure increases consistently from gravidity 4 and mean systolic pressure, from gravidity 5. Distributions of mean blood pressure levels, specific for each age group, by parity and gravidity are shown in tables 4-7.

For females of all races under age 55, the distributions of systolic blood pressure by parity seem clearly consistent with the hypothesis of no increase in blood pressure with increasing parity. For ages 55-74 the distributions of means may be suggestive of an increase in average systolic pressure after parity 2, but when the sampling variability of the estimates is considered, this cannot be conclusively demonstrated. In examining the systolic and diastolic distributions by gravidity, gravidity 11 and over means may be discounted as being based on too few cases to be meaningful. If this is done the pattern of mean systolic pressures by gravidity is essentially the same as that by parity.

For the distribution of mean systolic pressures by parity, the tests of significance indicate that the mean for women of parity 6 and over is significantly higher than the means for other women on an age-adjusted basis. This is not however considered as being of much, if any, practical significance since (1) the age adjustment inherent in the significance test is not fully sensitive when applied to a pooled group such as parity 6 and over; (2) none of these parity groups considered individually (6, 7, 8, and 9 and over) are significant; and (3) the standard normal deviate is 2.02 (2.13 for white women) which might reasonably be expected to occur among such a very large number of significance tests.

Distributions of systolic pressures by gravidity indicate no appreciable change in the pattern described above. The suggestion of statistically significantly higher systolic pressure among the parity 6 and over group is reinforced by the pattern of the signs of the differences (1-5,- - - - -; 6-11, ++++++), but the qualifications stated for the parity distribution apply.

Diastolic blood pressure distributions seem consistent with the hypothesis of no increase in average pressures with inceasing parity and gravidity. The 55-64 age group, which might appear as a possible exception is also found to be consistent when sampling variability is considered. The borderline significance of the higher mean diastolic pressure for the parity 3 group is not considered to be of practical importance because a standard normal deviate of 2.08 is not unusual when a large number of significance tests is made.

Study of systolic and diastolic distributions specific by race, confirms the preceding impressions relating to all races pooled. The latter are, as expected, dominated by the statistical weighting of white women. The distributions for Negroes, of course, show much more variability because of the smaller numbers of cases on which they are based. However, the parity and gravidity trends seem to parallel those for white women quite well.

Estimated hypertension rates (definite plus borderline) by parity and gravidity are shown for each age and race group in tables 8 and 9. No significant differences in the age-adjusted rates are observable, nor does examination of the changes in mean blood pressures with increasing parity and gravidity suggest a conclusion regarding the possible relationships different than those previously reached in considering systolic and diastolic blood pressures.

It is instructive to further examine the relationships of these variables through study of their multiple correlation constants, which permit more convenient summaries of the degree of possible interassociations.

The (linear) correlation coefficients in table D quantify the extent of the associations between pairs of the variables under study. These coefficients, as well as other correlation and regression statistics presented in this section, have been calculated by weighting the values for each sample person by the reciprocal of the probability of her selection in the sample (adjusted by a small nonresponse factor). The sampling errors have been calculated by the technique described in the appendix. The data thus relate quite accurately to the corresponding population of the United States at the time of the survey.

In a linear correlation context, the regression of systolic blood pressure on age is the strongest association demonstrated, accounting for 37 per-

Table D. Simple and partial correlation coefficients for systolic and diastolic blood pressures, with age, body weight, and gravidity for nonpregnant women, by race: United States, 1960-62

Blood pressure and independent variable (*ab*)	Simple correlation coefficient		Partial correlation coefficient	
	r_{ab}	Replicate standard normal deviate of *z* transform	$r_{ab.cd}$	Replicate standard normal deviate of *z* transform
Total (N=3,435)				
Systolic:				
Age	.609	42.69	.576	29.04
Body weight	.351	14.49	.282	16.72
Gravidity	.152	6.73	-.001	.02
Diastolic:				
Age	.359	20.52	.297	14.04
Body weight	.404	14.35	.355	19.29
Gravidity	.122	4.82	.014	.50
White (N=2,931)				
Systolic:				
Age	.622	35.44	.586	25.95
Body weight	.352	13.51	.268	12.18
Gravidity	.160	6.70	.008	.51
Diastolic:				
Age	.372	18.97	.305	12.35
Body weight	.396	18.11	.338	16.55
Gravidity	.131	4.89	.019	.66
Negro (N=448)				
Systolic:				
Age	.591	13.46	.567	11.22
Body weight	.296	4.87	.241	4.23
Gravidity	.107	2.17	-.034	.66
Diastolic:				
Age	.371	10.04	.331	8.50
Body weight	.368	6.86	.331	6.90
Gravidity	.056	1.16	-.026	.66

cent of the observed variability while the corresponding figure for gravidity is only 2 percent. The latter is, however, statistically significant and confirms the widely-held view that such an association between gravidity and systolic blood pressure is demonstrable.[k] (The slight downward trend of the diastolic pressure curve among the older age groups as shown in table 5 is a somewhat compromising factor causing the lower linear diastolic coefficients. A data transformation or curvilinear technique would have been a better procedure for the diastolic readings but was not done in this analysis.)

The extent to which the positive association between gravidity and blood pressure is not accountable for by the relation of blood pressure with age and body weight, is shown by the corresponding partial correlation coefficients in table D. The modest but significant association of gravidity with systolic blood pressure (r=.152), almost vanishes when the effects of age and body weight which contributed to it are accounted for—the correlation decreases to -.001 and is not, of course, statistically significant. Table D shows that these interrelationships are consistent for both systolic and diastolic blood pressure.

These findings are also confirmed by the values of the regression coefficients in the linear regressions of age, gravidity, and body weight on blood pressure. The coefficients are summarized in table E.

The regression coefficients are, without exception, seen to be statistically significant for age and body weight but not for gravidity.

[k] Statistical significance of correlations in this report refers to a 99-percent confidence level using Fisher's transformation z = aktanh r. The standard error of z is estimated using the relationship $\frac{R\sigma_r^2}{S\sigma_r^2}=\frac{R\sigma_z^2}{S\sigma_z^2}$ where R indicates a replicate estimate of variance as detailed in references 21-23, and refers to the variance under simple random sampling assumptions. This approximation has been found in empirical studies to be generally satisfactory to three significant figures for both simple and partial correlations for this sample design.[21]

SUMMARY

During the first National Health Examination Survey of adults, standardized blood pressure measurements were made on 3,435 women. The data obtained were used to determine whether parity or gravidity were factors in the etiology of cardiovascular hypertension. The results confirm that systolic and diastolic blood pressures were

Table E. Regression coefficients of equation, Blood pressure = $A + b_1$ (age) + b_2 (gravidity + b_3 (body weight) for nonpregnant women, by race: United States, 1960-62

Blood pressure and race	Age		Gravidity		Body weight	
	b_1	SND[1]	b_2	SND[1]	b_3	SND[1]
Systolic						
Total	.908	26.48	-.004	-.018	.200	16.40
White	.897	25.91	.068	.310	.192	11.26
Negro	1.139	10.73	-.288	-.649	.165	4.91
Diastolic						
Total	.227	14.91	.064	.503	.147	17.00
White	.224	13.34	.086	.667	.140	14.92
Negro	.338	9.15	-.125	-.663	.135	7.70

[1](Replicate) standard normal deviate under H_0: $b_i = O$

proportional by age up to age 55, after which a slight drop occurred in the case of diastolic. In comparable age groups there was no evidence to suggest that either parity or gravidity played a part in the etiology of cardiovascular hypertension.

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LIST OF DETAILED TABLES

Table 1. Number of persons, mean blood pressures, mean body weight, and standard errors for adult women, by race and age: United States, 1960-62

Race and age	U.S. population[1] in thousands	Study population[2]							
		Number of examinees	Estimated U.S. population in thousands	Blood pressure in mm. Hg.				Body weight in pounds	
				Systolic		Diastolic			
				Mean	SE	Mean	SE	Mean	SE
Total[3]									
Ages 18-79 years-	58,343	3,435	56,155	...	...	...	...	142	.5
18-24 years----------	8,430	459	7,317	112	.6	70	.5	127	1.2
25-34 years----------	11,291	689	10,450	116	.7	73	.5	135	1.3
35-44 years----------	12,325	770	12,092	123	.9	78	.7	143	1.4
45-54 years----------	10,542	705	10,542	134	1.4	82	.7	147	1.5
55-64 years----------	8,120	443	8,120	147	1.8	85	.9	152	2.0
65-74 years----------	6,192	299	6,191	160	2.0	84	.8	146	1.6
75-79 years----------	1,443	70	1,443	157	2.6	79	1.6	138	4.0
White									
Ages 18-79 years-	51,184	2,931	49,330	...	...	...	...	141	.5
18-24 years----------	7,230	374	6,229	112	.8	70	.6	126	1.1
25-34 years----------	9,656	579	8,994	116	.7	73	.5	134	1.2
35-44 years----------	10,723	659	10,532	122	.7	77	.6	141	1.2
45-54 years----------	9,286	601	9,286	132	1.4	81	.8	146	1.5
55-64 years----------	7,333	392	7,333	146	1.8	84	.9	150	2.3
65-74 years----------	5,685	267	5,685	159	2.0	83	.7	146	1.8
75-79 years----------	1,271	59	1,271	156	3.2	79	1.6	141	3.0
Negro									
Ages 18-79 years-	6,219	448	5,966	...	...	...	...	152	2.6
18-24 years----------	966	70	868	115	1.5	72	1.4	133	4.5
25-34 years----------	1,370	95	1,241	120	2.0	78	1.4	146	3.9
35-44 years----------	1,391	99	1,363	132	2.9	86	1.4	158	5.6
45-54 years----------	1,162	98	1,162	148	4.4	90	1.7	160	3.8

[1] Civilian, noninstitutional population of United States estimated at midpoint of data collection period—October 1, 1961.

[2] Civilian, noninstitutional population excluding women stating that they were pregnant at the time of the health examination.

[3] Includes women classified as other than white or Negro.

Table 2: Sample frequencies for study population by age, race, and parity

Race and age	All examinees	Nulliparous	Parity		
			Total parous	1	2
Total [1]					
Ages 18-79 years	3,435	734	2,666	540	718
18-24 years	459	230	218	97	69
25-34 years	689	110	570	95	159
35-44 years	770	105	656	84	198
45-54 years	705	123	579	122	146
55-64 years	443	100	340	88	82
65-74 years	299	52	247	45	48
75-79 years	70	14	56	9	16
White					
Ages 18-79 years	2,931	615	2,283	445	655
18-24 years	374	199	166	74	56
25-34 years	579	88	482	84	142
35-44 years	659	79	571	65	185
45-54 years	601	97	501	102	133
55-64 years	392	90	299	74	79
65-74 years	267	48	219	41	45
75-79 years	59	14	45	5	15
Negro					
Ages 18-79 years	448	107	340	88	56
18-24 years	70	25	44	19	10
25-34 years	95	19	76	10	13
35-44 years	99	25	74	17	13
45-54 years	98	25	73	20	13

[1] Includes 56 examinees classified as other than white or Negro. This group consists almost entirely of Orientals and American Indians.

Table 2. Sample frequencies for study population by age, race, and parity—Con.

Parity—Continued									
3	4	5	6	7	8	9 or more	4-5	6 or more	Unknown
535	345	172	112	75	51	118	517	356	35
32	13	7	0	0	0	0	20	0	11
142	92	43	23	9	3	4	135	39	9
153	94	44	30	17	11	25	138	83	9
116	71	36	26	20	9	33	107	88	3
56	34	20	14	11	8	27	54	60	3
29	34	20	17	17	18	19	54	71	0
7	7	2	2	1	2	10	9	15	0
492	301	140	88	54	39	69	441	250	33
24	8	4	0	0	0	0	12	0	9
127	75	31	14	5	1	3	106	23	9
143	82	38	24	10	10	14	120	58	9
111	65	30	22	18	4	16	95	60	3
54	31	17	11	7	7	19	48	44	3
27	33	18	15	13	16	11	51	55	0
6	7	2	2	1	1	6	9	10	0
36	41	28	23	17	9	42	69	91	1
7	5	3	0	0	0	0	8	0	1
10	17	11	8	4	2	1	28	15	0
10	10	4	6	5	0	9	14	20	0
4	5	6	4	1	5	15	11	25	0

[1] Includes 56 examinees classified as other than white or Negro. This group consists almost entirely of Orientals and American Indians.

Table 3: Sample frequencies for study population by age, race, and gravidity

Race and age	All examinees	Gravidity 0	Gravidity: Total, 1 or more	Gravidity: 1	Gravidity: 2
Total[1]					
Ages 18-79 years	3,435	682	2,751	476	649
18-24 years	459	233	226	84	77
25-34 years	689	101	587	90	131
35-44 years	770	102	667	71	157
45-54 years	705	95	610	108	132
55-64 years	443	94	349	73	83
65-74 years	299	44	255	43	52
75-79 years	70	13	57	7	17
White					
Ages 18-79 years	2,931	588	2,341	396	570
18-24 years	374	202	172	66	57
25-34 years	579	85	493	76	117
35-44 years	659	80	578	57	142
45-54 years	601	79	522	90	114
55-64 years	392	86	306	65	76
65-74 years	267	43	224	37	49
75-79 years	59	13	46	5	15
Negro					
Ages 18-79 years	448	81	367	74	72
18-24 years	70	24	46	15	16
25-34 years	95	13	82	13	11
35-44 years	99	21	78	12	15
45-54 years	98	15	83	18	18

[1]Includes 56 examinees classified as other than white or Negro. This group consists almost entirely of Orientals and American Indians.

Table 3: Sample frequencies for study population by age, race, and gravidity—Con.

Gravidity—Continued											
3	4	5	6	7	8	9	10	11 or more	4-5	6 or more	Unknown
524	373	234	142	101	76	95	52	29	607	495	2
33	16	11	2	2	1	0	0	0	27	5	0
143	101	57	27	23	8	5	1	1	158	65	1
147	110	68	37	17	17	18	17	8	178	114	1
119	77	50	34	27	15	28	12	8	127	124	0
54	37	27	19	10	10	20	11	5	64	75	0
23	26	18	20	21	21	16	9	6	44	93	0
5	6	3	3	1	4	8	2	1	9	19	0
481	329	194	119	79	59	63	31	20	523	371	2
27	12	6	2	1	1	0	0	0	18	4	0
128	84	44	20	15	3	4	1	1	128	44	1
138	96	60	31	13	13	12	9	7	156	85	1
113	73	40	30	23	12	17	5	5	113	92	0
51	33	23	16	8	10	13	8	3	56	58	0
21	25	18	17	18	17	11	7	4	43	74	0
3	6	3	3	1	3	6	1	0	9	14	0
38	39	37	21	19	14	28	17	8	76	107	0
5	4	5	0	1	0	0	0	0	9	1	0
11	15	13	6	7	5	1	0	0	28	19	0
9	12	7	5	3	2	5	7	1	19	23	0
6	3	9	4	4	3	10	5	3	12	29	0

[1]Includes 56 examinees classified as other than white or Negro. This group consists almost entirely of Orientals and American Indians.

Table 4. Estimated mean systolic blood pressures and standard errors for women[1] ages 18-79, by parity, race, and age: United States, 1960-62

Race and age	Total	0	1	2	3	4	5	6	7	8	9 or more	4-5	6 or more
	Parity												
	Mean systolic blood pressure in mm. Hg.												
Total[2]													
Ages 18-79 years	...	128	131	129	127	130	136	134	143	155	148	132	144
18-24 years	112	113	110	112	111	109	114	...	...	...	...	110	...
25-34 years	116	118	114	114	117	116	115	120	114	*	*	116	118
35-44 years	123	125	123	123	121	122	121	121	120	127	136	122	125
45-54 years	134	134	132	136	129	135	139	129	140	142	140	137	137
55-64 years	147	146	148	139	144	150	150	149	168	145	159	150	157
65-74 years	160	156	161	157	160	153	172	160	160	172	169	161	165
75-79 years	157	156	162	164	151	156	*	*	*	*	139	156	149
Expected value	...	128	131	130	129	131	133	135	139	146	141	132	139
Standard normal deviate[3]	...	.19	-.27	-.71	-1.79	-.49	.91	-.17	1.19	1.04	1.41	.50	2.02
White													
Ages 18-79 years	...	128	131	128	127	131	137	135	146	157	149	133	144
18-24 years	112	113	110	111	110	109	*	...	...	...	...	110	...
25-34 years	115	117	114	113	117	115	115	121	116	*	*	115	118
35-44 years	122	122	120	123	120	121	122	120	118	128	134	121	124
45-54 years	132	133	130	132	129	135	138	123	138	*	145	136	137
55-64 years	146	144	149	138	142	150	150	150	176	143	159	150	158
65-74 years	159	154	161	156	159	152	170	156	160	176	171	160	165
75-79 years	156	156	160	165	*	156	*	*	*	*	134	156	146
Expected value	...	128	131	129	128	131	133	135	139	146	140	132	139
Standard normal deviate[3]	...	-.17	-.33	-.94	-1.15	-.15	1.03	-.20	1.31	1.10	1.83	.75	2.13
Negro													
Ages 18-79 years	...	136	135	143	134	127	133	135	142	148	153	130	146
18-24 years	115	117	112	119	114	*	*	...	...	...	...	111	...
25-34 years	120	123	120	120	123	121	114	117	*	*	*	119	117
35-44 years	132	134	133	133	126	130	*	125	131	...	148	128	136
45-54 years	148	138	147	179	*	133	145	*	*	*	141	140	144
Expected value	...	135	138	135	133	130	135	138	147	148	152	132	147
Standard normal deviate[3]	...	.41	-.67	1.07	.14	-.91	-.38	-.55	-.44	-.03	.14	-.98	-.37
	Standard error of mean												
Total[2]													
Ages 18-79 years	...	1.1	1.4	1.5	1.0	1.2	3.4	3.2	3.7	8.2	4.7	1.3	2.0
18-24 years	.6	.7	1.0	1.9	2.0	2.3	5.9	...	...	...	...	2.0	...
25-34 years	.7	2.4	1.2	.9	1.4	1.5	2.3	4.5	6.2	*	*	1.2	3.2
35-44 years	.9	2.3	3.6	.8	.6	1.1	2.3	2.2	2.5	6.6	5.0	1.1	1.4
45-54 years	1.4	1.9	2.3	3.6	2.1	2.4	4.4	3.6	5.3	11.1	4.4	2.1	2.9
55-64 years	1.8	3.6	2.5	2.3	3.9	4.0	5.4	7.7	15.3	16.0	10.2	3.4	6.9
65-74 years	2.0	3.4	5.0	6.7	7.5	4.1	6.2	7.6	7.6	10.5	4.7	4.3	3.8
75-79 years	2.6	10.5	5.0	4.1	39.0	41.4	*	*	*	*	7.2	12.4	7.7
White													
Ages 18-79 years	...	1.3	1.2	1.4	1.3	1.2	3.8	3.6	5.2	9.7	4.7	1.5	2.4
18-24 years	.8	.8	1.3	1.8	2.8	2.5	*	...	...	...	...	2.1	...
25-34 years	.7	2.6	1.3	.9	1.4	1.2	2.5	6.3	5.2	*	*	.9	5.1
35-44 years	.7	2.0	2.4	.9	.6	1.5	2.3	2.6	3.7	7.0	5.9	1.2	1.6
45-54 years	1.4	2.3	2.0	3.2	2.1	2.7	5.1	4.0	4.5	*	5.2	2.3	2.6
55-64 years	1.8	3.8	2.9	2.2	3.4	3.9	5.6	7.7	24.8	17.1	12.8	3.3	8.1
65-74 years	2.0	3.2	4.9	6.6	7.8	4.2	7.2	8.1	8.5	10.9	3.4	4.6	5.3
75-79 years	3.2	10.5	41.2	5.0	54.2	41.4	*	*	*	*	11.4	12.4	13.4
Negro													
Ages 18-79 years	...	3.2	5.0	7.4	5.0	3.6	4.7	5.9	10.4	12.6	6.9	2.7	4.2
18-24 years	1.5	1.7	3.7	8.9	2.3	*	*	...	...	...	...	28.2	...
25-34 years	2.0	3.8	3.3	4.7	4.4	4.5	4.0	4.4	*	*	*	3.6	5.2
35-44 years	2.9	4.0	11.6	5.0	5.6	3.8	*	4.2	33.7	...	9.5	2.9	3.6
45-54 years	4.4	4.1	9.6	11.7	*	14.1	9.4	*	*	52.5	8.8	8.9	6.0

[1] Civilian, noninstitutional population. Excludes population represented by sample women pregnant at time of health examination.

[2] Includes women classified as other than white or Negro.

[3] Standard normal deviate of difference between (inverse) age-adjusted statistic (expected value) for women classified according to column heading, and women not so classified.

NOTE: Rel-variances of underlined estimates are larger than .0625.

Table 5. Estimated mean diastolic blood pressures and standard errors for women[1] ages 18-79, by parity, race, and age: United States, 1960-62

Race and age	Total	Parity 0	1	2	3	4	5	6	7	8	9 or more	4-5	6 or more
	Mean diastolic blood pressure in mm. Hg.												
Total[2]													
Ages 18-79 years---	...	77	78	79	77	78	80	80	83	85	86	79	83
18-24 years------------	70	71	68	70	70	69	71	...	...	...	...	69	...
25-34 years------------	73	75	74	71	73	74	73	78	69	*	*	74	76
35-44 years------------	78	79	79	78	77	78	77	77	78	80	87	77	80
45-54 years------------	82	83	80	84	80	83	85	79	82	86	86	83	83
55-64 years------------	85	84	85	82	82	85	85	87	98	89	90	85	91
65-74 years------------	84	82	83	87	86	79	87	81	84	85	88	82	84
75-79 years------------	79	78	84	80	75	83	*	*	*	*	75	83	77
Expected value---------	...	77	79	79	79	79	79	80	81	82	82	79	81
Standard normal deviate[3]-------------	...	.58	-.92	-.09	-2.08	-.53	.81	.08	.98	1.53	1.71	.08	2.23
White													
Ages 18-79 years---	...	77	78	78	77	78	81	79	82	85	86	79	83
18-24 years------------	70	71	67	69	70	70	*	...	...	...	...	69	...
25-34 years------------	73	74	73	71	73	73	74	78	71	*	*	73	76
35-44 years------------	77	76	77	78	76	77	77	76	74	80	85	77	78
45-54 years------------	81	82	79	82	80	83	84	79	80	*	87	83	82
55-64 years------------	84	83	86	82	81	85	85	86	101	88	89	85	91
65-74 years------------	83	81	83	87	86	79	86	80	82	85	89	82	83
75-79 years------------	79	78	78	80	80	83	*	*	*	*	73	83	76
Expected value---------	...	77	78	78	78	78	79	80	81	82	81	79	81
Standard normal deviate[3]-------------	...	.14	-1.35	.06	-1.32	-.28	1.20	-.12	.66	1.40	1.83	-1.83	.23
Negro													
Ages 18-79 years---	...	84	83	87	79	80	80	84	85	87	91	80	87
18-24 years------------	72	73	70	76	70	66	*	...	...	...	...	69	...
25-34 years------------	78	82	77	79	73	80	72	79	*	*	*	77	75
35-44 years------------	86	88	86	83	83	82	*	81	87	...	95	82	88
45-54 years------------	90	83	92	105	*	82	91	*	*	86	87	87	88
Expected value---------	...	83	84	83	82	82	83	85	86	87	89	82	87
Standard normal deviate[3]-------------	...	.80	-.66	1.29	-.91	-.95	-1.41	-.24	-.11	.08	.71	-1.83	.23
	Standard error of mean												
Total[2]													
Ages 18-79 years---	...	.6	.5	.7	.6	.8	1.3	1.6	1.7	1.7	2.4	.8	1.0
18-24 years------------	.5	.5	.8	1.6	1.5	2.4	5.4	...	...	...	...	1.6	...
25-34 years------------	.5	1.3	.8	.8	.8	1.0	1.8	2.8	5.5	*	*	.8	2.1
35-44 years------------	.7	1.3	2.0	.5	.8	1.0	2.2	2.2	2.4	4.3	3.3	1.0	1.1
45-54 years------------	.7	1.0	.9	1.6	1.2	1.6	1.6	2.6	2.9	8.9	1.4	1.3	1.5
55-64 years------------	.9	1.4	.9	1.6	2.8	1.8	3.3	3.7	7.4	7.9	6.1	1.6	2.8
65-74 years------------	.8	2.1	2.6	2.4	2.9	1.5	3.0	2.9	3.6	2.2	3.9	1.6	1.8
75-79 years------------	1.6	2.9	4.7	3.9	24.6	21.4	*	*	*	*	3.1	5.4	2.5
White													
Ages 18-79 years---	...	.7	.6	.6	.6	.9	1.4	1.7	2.6	2.2	2.5	.8	1.2
18-24 years------------	.6	.6	1.0	1.6	1.7	2.6	*	...	...	...	...	2.3	...
25-34 years------------	.5	1.3	.9	.7	.8	1.0	2.1	3.5	4.8	*	*	.6	2.7
35-44 years------------	.6	1.0	1.7	.6	.7	1.2	2.2	2.3	2.0	4.5	3.1	1.1	1.4
45-54 years------------	.8	1.2	.8	1.4	1.1	1.8	2.0	2.8	2.5	*	2.0	1.4	1.7
55-64 years------------	.9	1.2	.8	1.5	2.2	1.9	3.9	3.6	13.5	8.7	7.9	1.9	3.7
65-74 years------------	.7	2.1	2.6	2.4	3.1	1.5	3.3	2.7	3.6	2.3	2.1	1.7	1.9
75-79 years------------	1.6	2.9	19.8	3.7	28.5	21.4	*	*	*	*	3.6	5.4	3.1
Negro													
Ages 18-79 years---	...	1.2	1.9	3.0	3.5	1.7	2.2	3.0	6.3	6.2	2.7	1.2	2.2
18-24 years------------	1.4	1.8	3.4	5.0	2.5	16.5	*	...	...	...	...	17.5	...
25-34 years------------	1.4	2.7	2.3	2.4	2.6	3.2	2.1	3.9	*	*	*	2.7	4.4
35-44 years------------	1.4	2.6	3.9	3.0	3.7	3.9	*	5.3	22.5	...	8.2	3.3	3.3
45-54 years------------	1.7	2.4	4.8	6.4	*	6.9	8.2	*	*	32.9	2.0	3.8	2.6

[1]Civilian, noninstitutional population. Excludes population represented by sample women pregnant at time of health examination.
[2]Includes women classified as other than white or Negro.
[3]Standard normal deviate or difference between (inverse) age adjusted statistic (expected value) for women classified according to column heading, and women not so classified.

NOTE: Rel-variances of underlined estimates are larger than .0625.

Table 6. Estimated mean systolic blood pressures and standard errors for women[1] ages 18-79, by gravidity, race, and age: United States, 1960-62

Race and age	Gravidity													
	Total	0	1	2	3	4	5	6	7	8	9	10	11 or more	4-5	6 or more
	Mean systolic blood pressure in mm. Hg.														
Total[2]															
Ages 18-79 years	...	128	131	130	126	129	129	137	137	144	146	146	159	129	142
18-24 years	112	113	110	113	109	114	106	*	*	*	...	...	...	112	113
25-34 years	116	119	114	115	116	115	116	117	113	118	113	*	*	115	116
35-44 years	123	125	123	123	120	123	121	118	127	126	130	134	132	122	126
45-54 years	134	135	132	135	130	134	137	134	133	135	138	138	152	135	136
55-64 years	147	145	150	139	145	145	149	145	158	154	154	151	201	146	155
65-74 years	160	156	162	158	161	162	143	171	157	162	175	171	*	155	166
75-79 years	157	159	153	163	158	*	*	*	*	*	138	*	*	149	154
Expected value	...	127	132	131	128	130	131	135	136	141	141	139	141	130	138
Standard normal deviate[3]	...	.53	-.24	-.50	-1.56	-.32	-.84	.61	.28	1.11	1.21	1.74	1.66	-.69	2.51
White															
Ages 18-79 years	...	128	131	129	125	130	129	137	138	147	146	147	163	129	142
18-24 years	112	113	110	112	108	116	103	*	*	*	...	...	...	112	*
25-34 years	115	118	113	115	116	115	116	116	113	*	*	*	*	115	115
35-44 years	122	124	120	122	120	122	120	118	128	128	125	132	130	121	125
45-54 years	132	134	128	133	129	134	133	134	132	136	140	146	*	133	137
55-64 years	146	144	150	138	143	145	149	146	162	154	155	149	*	147	156
65-74 years	159	155	162	156	160	162	143	167	154	165	175	172	*	154	165
75-79 years	156	159	152	164	*	*	*	*	*	*	*	*	...	149	154
Expected value	...	127	131	131	127	129	131	135	136	142	140	139	138	130	138
Standard normal deviate[3]	...	.30	-.53	-.70	-1.42	.12	-.82	.58	.60	1.62	1.11	1.51	1.98	-.38	2.92
Negro															
Ages 18-79 years	...	134	137	139	137	126	133	139	139	138	152	154	153	129	145
18-24 years	115	117	110	118	114	*	*	...	*	...	...	...	...	109	*
25-34 years	120	123	119	126	123	119	114	122	114	117	*	...	...	117	118
35-44 years	132	132	135	133	128	126	134	121	*	*	157	140	*	129	135
45-54 years	148	140	154	153	147	*	159	*	*	*	140	158	*	157	139
Expected value	...	132	139	136	137	130	132	141	143	144	152	147	155	131	146
Standard normal deviate[3]	...	.68	-.22	.64	.03	-1.10	.08	-.18	-3.3	-1.28	-.09	1.17	-.23	-.44	-.35
	Standard error of mean														
Total[2]															
Ages 18-79 years	...	1.0	1.5	1.5	1.2	1.4	1.6	3.2	2.5	2.7	4.0	4.0	11.0	1.2	1.5
18-24 years	.6	.7	1.2	1.9	1.9	4.1	2.9	*	*	*	...	...	...	2.8	28.7
25-34 years	.7	2.6	1.2	1.0	1.1	1.8	1.9	3.6	2.9	8.1	6.4	*	*	1.2	1.9
35-44 years	.9	1.8	4.5	.8	1.4	1.0	1.5	2.1	9.8	4.3	6.2	4.2	10.4	.8	2.4
45-54 years	1.4	2.3	2.2	3.0	2.2	3.3	3.3	2.9	4.4	7.4	3.4	10.0	39.2	2.4	2.1
55-64 years	1.8	3.6	2.8	2.5	4.0	3.1	3.9	6.2	11.6	39.5	8.2	8.5	27.6	2.2	5.2
65-74 years	2.0	3.5	5.2	5.6	4.8	4.1	9.5	8.6	5.7	5.2	7.3	7.6	60.4	5.9	3.6
75-79 years	2.6	11.6	7.7	3.6	41.1	49.4	*	*	*	*	10.2	*	*	4.6	5.8
White															
Ages 18-79 years	...	1.3	1.3	1.5	1.1	1.5	2.2	3.8	2.4	3.2	4.9	5.1	12.8	1.4	1.6
18-24 years	.8	.8	1.5	2.0	2.2	3.8	4.7	*	*	*	...	...	...	3.8	*
25-34 years	.7	2.7	1.4	1.0	1.3	1.2	2.0	2.6	2.6	*	*	*	*	.9	1.9
35-44 years	.7	1.6	3.1	1.1	1.4	1.2	1.8	2.8	12.4	4.9	6.6	5.0	14.4	1.0	3.0
45-54 years	1.4	2.8	1.7	2.9	2.0	3.3	3.7	3.0	3.7	8.8	4.4	26.1	57.9	2.5	2.3
55-64 years	1.8	3.7	3.1	2.6	2.9	3.5	3.9	7.0	14.0	39.5	9.8	12.4	*	2.2	6.0
65-74 years	2.0	3.3	5.4	5.5	5.2	4.2	9.6	10.1	4.8	6.4	10.8	10.2	*	6.0	4.3
75-79 years	3.2	11.6	39.8	5.4	*	49.4	*	*	*	*	13.4	*	...	4.6	8.2
Negro															
Ages 18-79 years	...	3.0	5.8	4.1	7.1	3.3	6.8	8.3	12.8	5.2	6.7	5.6	10.3	4.0	4.7
18-24 years	1.5	1.4	3.2	6.3	3.2	*	56.4	...	*	...	...	...	...	27.6	*
25-34 years	2.0	5.4	2.4	4.4	4.9	6.4	3.9	8.8	15.2	32.2	*	...	...	3.9	5.4
35-44 years	2.9	4.9	15.1	6.2	4.4	5.2	7.4	5.6	*	*	39.3	12.4	*	5.0	3.4
45-54 years	4.4	5.8	11.3	7.9	39.3	*	18.9	*	*	*	7.0	17.1	*	14.0	5.4

[1]Civilian, noninstitutional population. Excludes population represented by sample pregnant at time of health examination.

[2]Includes women classified as other than white or Negro.

[3]Standard normal deviate of difference between (inverse) age adjusted statistic (expected value) for women classified according to column heading, and women not so classified.

NOTE: Rel-variances of underlined estimates are larger than .0625.

Table 7. Estimated mean diastolic blood pressures and standard errors for women[1] ages 18-79, by gravidity, race, and age: United States, 1960-62

Race and age	Gravidity														
	Total	0	1	2	3	4	5	6	7	8	9	10	11 or more	4-5	6 or more
	Mean diastolic blood pressure in mm. Hg.														
Total[2]															
Ages 18-79 years	...	77	78	79	77	78	79	80	81	82	84	87	89	78	82
18-24 years	70	71	67	70	70	71	68	*	*	*	...	...	...	70	69
25-34 years	73	75	73	73	73	73	73	75	74	75	74	*	*	73	75
35-44 years	78	79	80	78	77	77	78	74	82	80	81	87	83	78	80
45-54 years	82	83	81	82	80	83	85	83	78	81	87	83	89	84	83
55-64 years	85	85	86	83	82	83	82	87	91	93	87	90	*	83	91
65-74 years	84	81	84	86	87	82	78	84	83	85	88	90	*	80	84
75-79 years	79	80	77	82	71	*	*	*	*	*	75	*	*	80	79
Expected value	...	77	79	79	78	79	79	80	80	81	82	81	82	79	81
Standard normal deviate[3]	...	.82	-.79	-.05	-1.45	-.94	-.28	.13	.44	.94	1.54	2.72	.86	-.89	2.44
White															
Ages 18-79 years	...	77	78	78	77	78	78	80	80	83	82	87	93	78	82
18-24 years	70	71	67	69	70	71	66	*	*	*	...	...	...	69	*
25-34 years	73	74	72	73	73	72	73	73	75	*	*	*	*	72	74
35-44 years	77	77	77	77	77	77	77	75	82	79	77	85	82	77	79
45-54 years	81	82	79	81	80	82	83	83	77	80	86	88	*	83	82
55-64 years	84	84	86	82	81	83	82	86	92	93	86	87	*	83	90
65-74 years	83	80	84	86	87	82	78	83	81	86	85	90	*	80	84
75-79 years	79	80	73	80	*	*	*	*	*	*	73	*	...	80	79
Expected value	...	76	78	78	78	78	78	79	80	81	81	81	81	78	80
Standard normal deviate[3]	...	.39	-1.19	-.23	-.89	-.44	-.55	.22	.59	1.36	.68	2.40	1.25	-.68	2.95
Negro															
Ages 18-79 years	...	85	82	86	80	80	84	84	82	81	93	92	84	82	96
18-24 years	72	73	69	75	68	*	*	...	*	...	...	...	...	72	*
25-34 years	78	81	77	83	77	77	73	82	74	69	*	...	...	76	76
35-44 years	86	87	86	86	84	80	90	74	*	*	103	90	*	83	86
45-54 years	90	87	92	90	91	*	97	*	*	*	90	86	*	96	86
Expected value	...	82	84	83	84	82	83	85	84	84	89	89	89	83	86
Standard normal deviate[3]	...	2.12	-.92	1.28	-.79	-1.44	.17	-.50	-.47	-.68	1.59	1.23	-.86	-.47	-.15
	Standard error of mean														
Total[2]															
Ages 18-79 years	...	.6	.6	.6	.8	.7	.7	.9	1.1	1.6	1.7	1.9	8.8	.6	.7
18-24 years	.5	.6	.9	1.7	1.0	2.7	1.7	*	*	*	...	...	...	1.9	17.9
25-34 years	.5	1.6	.8	.9	.6	1.3	1.0	3.1	3.1	7.7	7.4	*	*	.7	1.5
35-44 years	.7	1.2	2.5	.5	1.0	1.1	1.7	1.1	3.6	2.2	4.1	3.6	2.6	.8	1.1
45-54 years	.7	1.2	1.0	1.3	1.1	1.6	1.8	1.6	2.0	3.6	2.0	4.1	23.5	1.4	1.2
55-64 years	.9	1.5	.9	1.8	3.0	1.2	2.9	3.3	4.1	23.8	4.5	4.8	49.5	1.5	2.0
65-74 years	.8	2.5	2.2	1.4	3.1	2.2	4.9	2.2	3.6	2.5	3.2	5.0	28.7	1.2	1.7
75-79 years	1.6	2.6	6.1	3.5	25.1	26.5	*	*	*	*	3.7	*	*	2.9	2.9
White															
Ages 18-79 years	...	.8	.6	.6	.7	.8	.9	1.1	1.3	1.7	2.1	2.4	9.6	.6	.6
18-24 years	.6	.7	1.2	1.8	1.1	3.0	3.9	*	*	*	...	...	...	2.4	*
25-34 years	.5	1.6	.9	1.0	.7	1.1	1.1	2.5	3.6	*	*	*	*	.6	1.4
35-44 years	.6	.8	2.0	.5	1.0	1.2	1.9	1.6	4.9	2.2	3.9	3.7	2.0	1.0	1.5
45-54 years	.8	1.6	.8	1.6	1.0	1.7	1.9	1.9	1.6	4.4	2.4	13.0	33.1	1.4	1.3
55-64 years	.9	1.3	1.0	1.8	2.3	1.2	3.0	3.5	5.0	23.8	6.2	7.6	*	1.6	2.5
65-74 years	.7	2.4	2.2	1.3	3.5	2.3	4.9	2.8	3.0	2.6	3.8	6.6	*	1.2	1.5
75-79 years	1.6	2.6	19.0	3.9	*	26.5	*	*	*	*	3.8	*	...	2.9	4.1
Negro															
Ages 18-79 years	...	1.2	1.8	1.7	4.0	1.7	3.5	2.9	6.1	5.2	2.9	2.9	6.3	2.2	2.3
18-24 years	1.4	2.6	3.2	3.6	1.6	*	36.6	...	*	...	...	...	...	18.2	*
25-34 years	1.4	4.0	2.2	3.4	2.7	4.6	1.6	6.5	9.0	20.1	*	-	-	3.2	4.0
35-44 years	1.4	3.9	5.5	3.2	2.2	4.8	2.0	2.3	*	*	2.58	11.1	*	3.2	3.4
45-54 years	1.7	2.7	4.9	2.7	24.4	*	11.6	*	*	*	4.4	3.6	*	7.4	2.7

[1]Civilian, noninstitutional population represented by sample women pregnant at time of health examination.

[2]Includes women classified as other than white or Negro.

[3]Standard normal deviate of difference between (inverse) age adjusted statistic (expected value) for women classified according to column heading, and women not so classified.

NOTE: Rel-variances of underlined estimates are larger than .0625.

Table 8. Estimated hypertension rates (per 100 women) and standard errors for women[1] ages 18-79, by parity, race, and age: United States, 1960-62

Race and age	Parity												
	Total	0	1	2	3	4	5	6	7	8	9 or more	4-5	6 or more
	Hypertension rate per 100 women												
Total[2]													
Ages 18-79 years	...	27.2	31.4	27.1	22.6	30.5	36.0	32.4	41.4	53.9	57.8	32.3	45.4
18-24 years	2.9	1.9	3.7	3.8	2.4	-	-	...	...	...	...	-	...
25-34 years	6.8	14.4	3.6	5.6	4.3	7.9	1.7	7.8	-	*	*	6.0	6.2
35-44 years	17.6	22.9	18.2	16.0	14.7	16.2	10.8	11.8	18.6	23.7	46.3	14.5	24.2
45-54 years	33.5	40.8	26.9	36.5	24.7	34.8	49.8	22.3	34.9	38.9	45.2	39.9	35.1
55-64 years	55.7	53.1	65.2	43.4	49.9	54.5	61.3	61.3	74.6	45.6	65.7	57.0	64.5
65-74 years	72.0	65.0	74.2	68.1	72.8	78.2	*	*	*	*	92.5	79.4	72.3
75-79 years	73.4	57.4	80.0	92.7	70.8	75.3	100.0	55.7	100.0	100.0	51.9	81.4	60.0
Expected value	...	26.2	30.9	28.5	26.6	29.7	33.0	35.9	41.6	52.2	46.2	30.8	42.6
Standard normal deviate[3]	...	.71	.10	-.49	-.81	-.66	-1.89	.98	-1.52	.38	1.59	1.83	2.06
White													
Ages 18-79 years	...	25.7	30.1	26.0	22.5	30.8	38.6	33.9	40.9	56.0	58.1	33.4	45.5
18-24 years	2.9	2.1	4.0	3.5	3.1	-	*	...	...	...	...	-	...
25-34 years	6.2	12.4	4.0	5.4	3.8	5.5	2.2	11.7	-	*	*	4.6	7.4
35-44 years	14.6	16.9	12.4	14.1	14.6	13.2	7.3	10.3	9.5	26.9	41.0	11.4	19.7
45-54 years	30.9	37.5	22.8	32.4	24.5	35.2	48.8	20.5	32.5	*	49.3	39.7	33.6
55-64 years	55.0	50.8	65.3	42.6	49.1	56.8	67.8	67.2	76.9	38.2	66.7	60.7	65.7
65-74 years	71.4	64.3	73.7	66.7	71.2	77.6	83.2	67.5	54.8	75.1	100.0	79.9	72.1
75-79 years	71.4	57.4	64.1	92.2	67.8	75.3	*	*	*	*	44.1	81.4	55.5
Expected value	...	25.8	30.2	27.4	25.3	29.4	33.3	36.1	41.6	52.9	44.7	30.7	42.2
Standard normal deviate[3]	...	.18	-.24	-.84	-.01	-.17	-1.46	1.36	-.58	.61	1.08	1.08	2.05
Negro													
Ages 18-79 years	...	39.5	39.9	46.7	25.8	25.0	25.7	26.1	54.0	56.6	65.5	25.3	51.5
18-24 years	3.8	-	3.5	8.0	-	-	*	...	...	...	...	-	...
25-34 years	11.2	23.3	-	9.4	7.2	20.6	-	-	*	*	*	12.4	4.2
35-44 years	38.8	44.4	35.4	43.2	17.6	28.7	*	20.0	60.7	...	60.2	34.2	46.9
45-54 years	55.8	53.6	54.8	85.3	*	35.5	55.4	*	*	36.5	48.0	46.1	47.4
Expected value	...	35.8	42.2	37.3	33.7	28.8	35.2	40.3	50.9	57.6	61.9	31.5	53.2
Standard normal deviate[3]	...	1.35	-.08	1.20	-2.39	-1.86	-.08	-1.78	-.56	.06	1.45	1.41	.19
	Standard error												
Total[2]													
Ages 18-79 years	...	1.9	1.9	2.1	2.2	2.0	5.0	5.1	5.0	7.6	4.5	1.6	1.8
18-24 years	.9	.9	1.9	2.2	2.4	-	-	...	...	...	...	-	...
25-34 years	.7	3.3	1.7	2.6	1.9	2.2	1.7	5.5	-	*	*	1.6	3.6
35-44 years	1.3	4.3	4.6	1.7	2.1	3.4	6.6	6.3	8.9	16.2	8.9	3.1	3.7
45-54 years	2.4	4.2	3.4	5.4	4.6	6.6	4.9	9.4	10.8	19.1	8.4	4.5	4.9
55-64 years	2.9	6.0	4.5	6.1	8.5	11.1	10.6	19.4	14.2	20.8	10.1	8.2	7.3
65-74 years	2.6	5.9	6.0	9.5	10.8	8.7	*	*	*	*	7.9	5.2	5.3
75-79 years	5.2	17.6	11.4	5.3	29.9	26.1	70.7	55.7	70.7	50.0	13.1	17.5	10.6
White													
Ages 18-79 years	...	2.6	1.9	2.1	2.5	2.4	5.7	5.5	7.3	8.9	4.4	2.1	2.6
18-24 years	1.0	1.0	2.2	2.6	3.1	-	*	...	...	...	...	-	...
25-34 years	.8	3.7	1.9	2.6	2.0	2.2	2.2	8.9	-	*	*	1.6	5.9
35-44 years	1.1	3.9	4.4	2.0	2.1	3.7	5.2	6.2	9.6	16.9	17.0	3.0	5.0
45-54 years	2.8	5.3	3.1	5.6	4.9	7.1	6.1	10.8	12.9	*	13.8	5.3	5.9
55-64 years	3.0	6.5	5.2	6.2	8.7	10.2	11.5	19.7	17.5	20.0	11.2	8.2	7.0
65-74 years	2.8	6.3	5.9	9.7	11.4	9.2	7.8	15.7	14.8	7.6	-	5.3	6.6
75-79 years	6.9	17.6	30.8	6.0	36.8	26.1	*	*	*	*	22.6	17.5	19.7
Negro													
Ages 18-79 years	...	5.2	8.4	8.7	6.2	8.3	8.6	9.1	14.8	23.7	9.3	5.1	5.8
18-24 years	2.2	-	3.3	11.3	-	-	*	...	...	...	...	-	...
25-34 years	2.6	10.5	-	9.1	6.0	6.8	-	-	*	*	*	4.6	5.7
35-44 years	4.7	11.5	10.8	11.0	14.2	20.3	*	20.9	28.6	...	17.3	16.8	11.3
45-54 years	5.9	9.3	15.0	5.3	*	22.5	24.8	*	*	31.5	10.6	15.2	8.7

[1] Civilian, noninstitutional population. Excludes population represented by sample women pregnant at time of health examination.

[2] Includes women classified as other than white or Negro.

[3] Standard normal deviate of difference between (inverse) age adjusted statistic (expected value) for women classified according to column heading and women not so classified.

NOTE: Rel-variances of underlined estimates are larger than .5.

Table 9. Estimated hypertension rates (per 100 women) and standard errors for women[1] ages 18-79, by gravidity, race, and age: United States, 1960-62

Race and age	Total	Gravidity 0	1	2	3	4	5	6	7	8	9	10	11 or more	4-5	6 or more
								Hypertension rate per 100 women							
Total[2]															
Ages 18-79 years	...	26.5	31.4	29.0	23.5	26.4	24.2	40.7	34.5	47.2	53.2	55.6	60.8	25.6	45.1
18-24 years	2.9	2.7	4.4	3.3	2.3	-	-	*	*	*	...	...	...	-	-
25-34 years	6.8	15.1	4.6	5.5	6.4	4.6	2.0	10.0	6.3	19.4	-	*	*	3.6	8.6
35-44 years	17.6	24.1	18.4	15.8	16.2	16.1	11.8	2.3	23.2	18.2	41.8	36.7	39.9	14.5	20.9
45-54 years	33.5	40.2	24.2	36.2	29.0	32.0	33.8	51.5	24.1	26.4	46.1	30.1	63.1	32.7	40.2
55-64 years	55.7	53.1	68.0	45.9	52.8	49.4	54.2	48.7	71.0	67.0	62.4	63.5	79.6	51.4	62.2
65-74 years	72.0	64.4	74.3	70.8	72.4	84.6	45.1	89.3	56.6	73.4	85.0	100.0	67.8	69.5	77.0
75-79 years	73.4	64.9	50.6	92.9	84.0	48.9	*	*	*	*	38.8	*	*	66.8	71.2
Expected value	...	25.0	31.2	30.0	25.2	27.9	29.4	36.4	37.8	45.3	45.6	42.2	44.7	28.4	40.7
Standard normal deviate[3]	...	.71	.10	-.49	-.81	-.66	-1.89	.98	-1.52	.38	1.59	1.83	2.03	-1.69	2.41
White															
Ages 18-79 years	...	25.2	30.2	27.5	23.5	26.9	23.6	42.8	35.8	49.6	50.7	53.0	61.9	25.7	45.4
18-24 years	2.9	2.6	4.5	3.4	2.7	-	-	*	*	*	...	...	...	-	*
25-34 years	6.2	13.5	5.2	4.1	6.1	3.6	2.4	8.0	6.0	*	*	*	*	3.2	7.4
35-44 years	14.6	19.8	13.8	12.4	16.1	14.2	6.1	2.7	21.9	18.7	31.1	30.7	33.0	11.2	17.5
45-54 years	30.9	35.9	19.7	32.3	28.5	31.0	30.6	50.8	23.2	26.2	47.6	15.8	81.0	30.8	40.4
55-64 years	55.0	50.4	67.5	43.9	54.2	51.7	57.0	51.0	76.1	67.0	61.8	59.3	*	53.8	62.4
65-74 years	71.4	63.8	72.6	69.6	74.1	84.4	45.1	91.8	55.5	74.0	80.5	100.0	*	69.1	77.9
75-79 years	71.4	64.9	38.0	91.9	*	48.9	*	*	*	*	40.3	*	...	66.8	71.1
Expected value	...	24.7	30.6	29.2	23.5	27.4	29.1	35.9	37.7	46.0	44.0	42.0	39.9	28.0	39.9
Standard normal deviate[3]	...	.18	-.24	-.84	-.01	-.17	-1.46	1.36	-.58	.61	1.08	1.03	2.05	-1.07	2.25
Negro															
Ages 18-79 years	...	40.7	40.4	45.8	25.0	19.7	31.4	30.1	33.8	48.8	70.4	65.8	70.6	25.1	49.8
18-24 years	3.8	5.3	5.0	3.6	-	*	-	...	*	...	...	...	...	-	*
25-34 years	11.2	25.1	-	22.9	5.8	11.3	-	18.8	8.1	12.4	*	...	...	6.3	12.9
35-44 years	38.8	43.2	34.0	45.6	18.7	19.4	69.4	-	*	*	100.0	38.6	*	35.8	42.5
45-54 years	55.8	63.0	57.5	64.7	39.6	*	54.4	*	*	*	48.4	77.3	*	59.1	45.6
Expected value	...	32.3	41.1	39.0	39.6	29.2	32.1	43.9	44.5	48.2	61.4	55.1	67.2	30.6	51.6
Standard normal deviate[3]	...	1.35	-.08	-1.20	-2.39	-1.86	-.08	-1.78	-.56	.06	1.15	1.42	.19	-.98	-.27
								Standard error							
Total[2]															
Ages 18-79 years	...	2.1	1.7	2.0	2.1	2.3	2.7	4.4	2.2	5.0	4.8	7.3	7.8	1.7	1.8
18-24 years	.9	1.2	2.2	1.9	2.3	-	-	*	*	*	...	...	...	-	-
25-34 years	.7	3.8	2.0	2.3	2.3	2.4	2.0	4.1	4.2	14.2	-	*	*	1.7	3.3
35-44 years	1.3	4.2	6.1	1.8	3.0	3.2	3.6	2.2	14.9	10.3	15.8	12.9	23.4	2.1	3.5
45-54 years	2.4	4.8	3.1	5.7	4.1	6.8	6.2	8.3	8.5	10.7	8.4	10.5	29.2	5.2	4.0
55-64 years	2.9	5.7	4.1	7.6	9.2	7.0	10.0	15.1	19.6	23.7	11.0	22.1	42.5	6.5	5.4
65-74 years	2.6	7.5	6.1	8.8	9.8	7.8	11.2	6.5	5.8	8.2	11.0	-	29.9	9.2	4.3
75-79 years	5.2	18.7	30.6	4.8	33.9	23.1	*	*	*	*	17.9	*	*	14.3	8.8
White															
Ages 18-79 years	...	2.6	1.7	2.0	2.4	2.5	3.8	5.1	3.3	5.8	6.2	10.1	10.7	2.1	2.5
18-24 years	1.0	1.2	2.5	2.5	2.8	-	-	*	*	*	...	...	...	-	*
25-34 years	.8	3.9	2.3	1.8	2.7	2.0	2.5	5.4	6.0	*	*	*	*	1.6	4.8
35-44 years	1.1	4.7	4.7	2.2	3.2	2.3	2.8	2.8	18.0	9.9	17.4	17.9	25.8	1.7	4.2
45-54 years	2.8	6.1	3.2	6.2	4.2	7.1	6.8	9.8	8.9	13.2	11.5	26.8	33.7	5.8	5.0
55-64 years	3.0	6.3	5.2	8.2	9.0	7.8	10.8	16.2	22.4	23.1	10.7	32.9	*	6.6	5.7
65-74 years	2.8	7.6	6.2	8.9	9.6	8.0	11.2	6.2	9.0	0.0	16.8	-	*	9.4	4.6
75-79 years	6.9	18.7	35.6	6.3	*	23.1	*	*	*	*	21.2	*	-	14.3	13.5
Negro															
Ages 18-79 years	...	6.2	8.7	5.7	6.1	5.1	10.2	7.8	19.2	9.4	7.8	7.6	18.4	5.5	6.7
18-24 years	2.2	5.3	4.3	5.2	-	*	-	...	*	...	...	...	...	-	*
25-34 years	2.6	13.6	-	14.4	5.3	7.1	-	18.5	24.7	25.3	*	...	...	4.2	9.4
35-44 years	4.7	9.8	18.3	11.7	12.7	16.4	20.3	-	*	*	25.0	22.9	*	14.8	11.0
45-54 years	5.9	13.2	14.0	11.9	24.3	*	14.7	*	*	*	24.4	23.0	*	9.4	7.2

[1]Civilian, noninstitutional population, excludes population represented by women pregnant at time of health examination.

[2]Includes women classified as other than white or Negro.

[3]Standard normal deviate of difference between (inverse) by adjusted statistic (expected value) for women classified according to column heading and women not so classified.

NOTE: Rel-variances of underlined estimates are larger than .5.

APPENDIX

The sample design of the Health Examination Survey program in which the data for this study were collected, embodies a number of features to reduce survey costs and sampling variability with optimum balance. Sampling was carried out in four distinct operations. The first three involved clusters of sampling units of successively smaller size—counties or groups of counties (primary sampling units), segments (clusters of households) defined for use in the population census, and households (which may be thought of as clusters of adults). The fourth and final step in sampling consisted of selection of sample persons from the sample households. The primary sampling units were highly stratified, and were selected with probability proportional to size by a controlled selection technique.[30]

In the estimation procedure, a measure (for example, systolic blood pressure) for a sample person is multiplied by a statistical weight which is the reciprocal of the probability of the selection of the person in the sample.

Two weighting adjustments were also made to increase the extent to which the national population is represented by the sample. The first of these is referred to as the "first-stage ratio adjustment." This consisted of adjusting the statistical weight for each sample person in each of the primary sampling units so that the population in the stratum represented by a particular primary sampling unit (PSU) was forced to equal the complete enumeration indicated by the 1960 population census. The second adjustment was a poststratification by age and sex. In this procedure, the statistical weight for each person is adjusted so that the final national estimates from the survey agree exactly with population estimates for the country as a whole for 12 age-sex classes based on the 1960 census and projected to October 1, 1961 (the mid-point of the survey).

Prior to making the poststratification corrections, a small nonresponse adjustment factor was applied to the statistical weight which had the effect of imputing the characteristics of examined sample persons to the 13.5 percent of the selected sample adults who were not examined. (Details of these procedures are given in reference 12.)

It is clear from even the above rather summary and abridged account of the process that the sample design and estimation for this survey were "complex" in an operational as well as a statistical sense. This means that certain algebraic relationships of classical statistical theory among measures which may be derived from the sample cannot be used to evaluate the precision of the estimates. For example, if a simple random selection of persons had been made and a measure of interest (e.g., systolic blood pressure) recorded for each sample person, mean blood pressure for the population would be estimated as $\hat{\bar{x}} = \frac{\Sigma w_i x_i}{\Sigma w_i}$, where w_i is the statistical weight of the ith sample person, and the calculated standard error of this estimate would be:

$$\hat{\sigma}_{\bar{x}} = \left[\frac{\Sigma w_i (x_i - \bar{x})^2}{\Sigma w_i} \right]^{\frac{1}{2}}$$

which in turn would be used to evaluate the extent to which $\hat{\bar{x}}$ might reasonably be expected to vary from the "true" or population mean systolic blood pressure due to the fact that a sample was used.

Similarly, in using a regression model it may be postulated that systolic blood pressure is related to age, parity, and body weight by the relationship

$$\tilde{Y} = \tilde{\beta}_1 \tilde{x}_1 + \tilde{\beta}_2 \tilde{x}_2 + \tilde{\beta}_3 \tilde{x}_3$$

where $\tilde{Y}$ represents systolic blood pressure, and the $\tilde{x}_i$ measures of age, parity, and body weight respectively (measured from their mean values). Again, if a simple random selection of persons had been made, the parameters $\tilde{\beta}_i$ may be estimated by $\hat{\beta} = (XX')^{-1} XY$ where $\hat{\beta}$ is the vector of the three regression coefficients in the immediately preceding equation, Y is the vector of measures of systolic blood pressures for the sample persons, X is the matrix of measures of the other (independent) variables for the sample persons, X' is the transpose of X and $(XX')^{-1}$ is the inverse of the matrix XX'. For a simple random sample of persons, the measures of precision of the estimates $\hat{\beta}$ may easily be computed as $\ddagger_{\hat{\beta}} = \sigma^2 (XX')^{-1}$ where $\ddagger_{\hat{\beta}}$ is the vector of sampling variances of $\hat{\beta}$ (corresponding to $\hat{\sigma}^2_{\bar{x}}$ for the estimate of mean systolic blood pressure discussed previously), and σ^2 is a (scalar) measure of the variance of the variable measures.

For the highly complex design of the survey from which the data in this report were based such straightforward algebraic relationships for estimation of sampling variability as given in the above examples are not appropriate. Although a considerable body of theory is available to permit such estimation for certain situations of clustering of elements, stratification, multiplicity of sampling stages, etc., the extent to which these measures were applied in the Health Examination Survey design (to reduce both sampling variability and survey costs) was such that it has been impossible, or at least impracticable, to develop such direct algebraic expressions for this sample design.

Instead a simulation type technique was used which is equally appropriate mathematically and potentially more effective than direct algebraic calculation in analytical applications. The elements of this procedure, which was used to estimate the sampling variability of the statistics presented in this report, may be enumerated as follows, using estimation of a simple correlation coefficient r_{12} where the subscripts indicate systolic blood pressure and parity, respectively, as an example.

1. The weighting factors described above are included in the estimator. For the parameter of interest, r_{12}, the estimator is:[1]

$$\hat{r}_{12} = \frac{\Sigma x_{1i} \; x_{2i} \; w_i}{\left[(\Sigma x_{1i}^2 \; w_i)\;(\Sigma x_{2i}^2 \; w_i)\right]^{\frac{1}{2}}}$$

2. The model is conceptualized as a random selection of two PSU's from each of 26 strata.
3. *Half-sample replicates* are delineated. Each half-sample replicate consists of data for one PSU from each stratum, e.g., about half of the total sample. The total number of possible different half-sample replicates is 2^{26}.
4. The estimator of interest, $\hat{r}_{12}$ is calculated for each half-sample replicate,[m] with appropriate modification of statistical weights.
5. The value of the correlation between half-samples is such that it can be shown that for a particular half-sample, the expected value $E(\hat{r}^i_{12} - \hat{r}_{12})^2$ is an estimate of the variance of the estimate $\hat{r}_{12}$ from the total sample.[22] Therefore the expected value of the average of the 28 squared differences $S^2_{\hat{r}_{12}} = \frac{1}{28} \sum_{i=1}^{28} (\hat{r}^i_{12} - \hat{r}_{12})^2$ is an unbiased and superior estimate of variance of $\hat{r}_{12}$. Specifically, for the 28 half-samples used for the problems in this report, if $\hat{r}^i_{12}$ is the correlation coefficient as estimated for the ith half-sample replicate and $\hat{r}_{12}$ is the corresponding estimate for the total sample, the statistic

$$S^2_{\hat{r}_{12}} = \frac{1}{28} \sum_{i=1}^{28} (\hat{r}^i_{12} - \hat{r}_{12})^2$$

is used to estimate the sampling variances of the correlation coefficient of interest, $\hat{r}_{12}$

The preceding necessarily rather summary and abridged account is given as illustrative of the methods applied to the data presented in this report. Discussion of detailed theoretical concepts such as a minor bias accruing in the balanced half-sample replication method when a nonlinear estimator, e.g., the correlation coefficient, is used, have been avoided. Also, as pointed out in the text material, a z-transform should be

[1] The actual computations were carried out using transformed data, i.e., with a constant subtracted from the measure. Basic calculations were done in double precision on an IBM 360-40 computer using a generalized program written by Mr. Martin Frankel and Mr. Neal Van Eck of the University of Michigan Institute of Social Research. The program was written under the direction of Professor Leslie Kish under contract with the National Center for Health Statistics. Ancillary calculations (z-transforms, supplementary partial correlation calculations, etc.) were programmed in double precision by the senior author using the more accessible and flexible Univac 1108 installation of the National Bureau of Standards.

[m] In practice, PSU's are selected for inclusion in the half-samples under a set of constraints which permits use of a much smaller number of half-sample replicates. The method was developed by McCarthy, Simmons, and Losee; it is referred to as *balanced half-sample* replication and gives a result numerically equal to that which would be obtained by operating with all possible half-sample replicates. (For these data, 28 half-sample replicates of the possible 2^{26} suffice.) Details of this aspect of the procedure are published in references 21-23. The first large-scale use of the method was made by Simmons and Losee with means and proportions estimated from Health Examination Survey data. An account of the theoretical development and computer program is given in reference 21.

(and was) used to estimate confidence intervals in the case of the correlation coefficient. Readers interested in full mathematical rigor should refer to the references cited. The text and tables of this report contain sufficient data to evaluate the extent to which the theoretical assumptions of the correlation and regression models are met by the data, with the exception of the implied linearity between blood pressure and body weight. This information, which relates to an assumption of the model rather than to an element of primary analytical interest, is shown in the appendix table below.

Table. Estimated mean blood pressure by weight and race for women[1] ages 18-79: United States, 1960-62

Body weight	Systolic			Diastolic		
	Total[2]	White	Negro	Total[2]	White	Negro
	Mean blood pressure in mm. Hg.					
Total	131	130	137	79	78	84
Under 103 pounds	117	117	117	70	70	72
103-125 pounds	121	121	131	73	73	80
126-148 pounds	129	130	132	78	78	81
149-171 pounds	138	138	141	82	82	85
172-194 pounds	142	142	144	85	85	88
195-217 pounds	150	152	144	90	90	87
218-240 pounds	151	148	159	91	88	97
241-263 pounds	152	149	160	95	90	105
264 pounds and over	161	153	177	99	91	114

[1]Civilian, noninstitutional population. Excludes population represented by sample women pregnant at time of health examination.

[2]Includes women classified as other than white or Negro.

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POSTAGE AND FEES PAID
U.S. DEPARTMENT OF HEW
HEW 390

U.S.MAIL

THIRD CLASS
BLK. RT.