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A SAMPLING SURVEY STUDY OF ARTERIAL BLOOD PRESSURE LEVELS IN NASSAU, NEW PROVIDENCE, BAHAMAS, 1958 FOR DESCRIPTION OF LEVELS OF BLOOD PRESSURE IN A POPULATION IN RELATIONSHIP TO AGE, SEX, RACE AND OTHER FACTORS

Benjamin Charles Johnson

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Department of Epidemiology
School of Public Health
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CHAPTER I

INTRODUCTION

Much has been written regarding the normal and abnormal blood pressure of man. In the more severe forms of hypertension there is no question that it constitutes a true disease state. Yet, many questions remain unanswered. First of these is the uncertainty of distinguishing the normal from the abnormal, except at the extremes. Considering the blood pressure reading alone, there is no point at which one can say that a specific person has hypertension or hypertensive disease. This reading, or preferably a series of readings over time, must be considered in relation to the patient's medical history, symptoms, and examination to determine the presence of hypertensive disease. Also to be considered are his race, age, sex, degree of obesity or type of body build, as well as emotional factors. The same applies to hypotension, if such a state can be considered a pathological entity.

Numerous studies have been done which describe blood pressure in various groups and subdivisions of populations. Some have applied arbitrary division points delineating "normal" from "abnormal", others have expressed the blood pressures observed in terms of the arithmetic mean and variation about it. Many attempts at a definition of blood pressure values in a population have been made (Morsell[14] lists 51), but almost invariably studies are directed toward specific, easily obtainable segments of a population. There has been considerable disagreement, particularly in regard to the relative importance of the various factors mentioned, such as race, age and obesity. Since essential hypertension is still a disease of unknown etiology, such disagreement is inevitable.

Much research activity has been directed toward the individua patient with the disease. From study directed toward the biochemical and physiological aspects of the condition, many important discoveries have been made. A few specific and sometimes remediable causes have been found, such as pheochromocytoma, primary aldosteronism and, of course, chronic renal disease. From this approach have come hypotheses which form the basis for much current research. These include investigation into the broad categories of the neural, humoral and renal mechanisms in disease.

There is yet another approach to the study of chronic disease and one which has provoked much thought in recent years. This is the study of disease in the mass, or the relationship of persons with the disease in question to their environment, community, racial origin, sex and age, as well as past experience with disease. This is the epidemiological approach, as old as the affair of the Broad Street Pump, yet new as long as its principles are intelligently applied.

In relation to hypertension, several studies in recent years have attempted to describe blood pressure levels in specific populations[1, 3, 13]. These have varied in scope from a relatively small community in Wales[13] to the entire city of Bergen, Norway.[1] A goal of this method may be to establish more definitely the distribution of blood pressure levels in a population in reference to such variables as age, sex, race, pregnancy, socioeconomic status, occupation, environmental conditions, etc. Information may also be gained as to the possible role of genetic factors. Hopefully, the aggregate of such information may provide clues for more specific investigations.

One aspect of such investigations deserves special mention. In any situation where conclusions are to be drawn beyond the individual case, special care must be taken that such results may withstand statistical scrutiny. The science of statistics has given us many invaluable tools. Since statistical techniques are an essential part of epidemiologic method, population studies of disease must be designed with full appreciation of the statistical basis of the analysis to be employed.

The study to be described was undertaken because of two separate stimuli. The first was the findings of Moser, Hoobler, Remington and Dodge (unpublished) in the Bahamas of what appeared to be a population with an inordinately high proportion of people with elevated blood pressure levels. Since the majority (three-fourths) of the population is Negro, this impression agreed with Comstock's findings in Georgia.[3] Since people of the Bahamas represent a geographic isolate, and perhaps a genetic isolate, these islands might be a useful location for the study of the effect of race on blood pressure.

The second stimulus was the knowledge that the water supply in the Bahamas has a relatively high salt content. If, in truth, excess sodium has a hypertensive effect, it should theoretically affect both races equally and cause noticeable differences in both races from their counterparts in the United States and elsewhere.

An additional incentive was the concern of the resident medical profession and the Colonial Medical Service over hypertension as a major public health problem.

The specific aims of this study were then formulated. It was desired to study a representative sample of the Bahamian people with a sufficient degree of precision to ensure statistical validity and reproducibility of the results. The primary information desired was a knowledge of the distribution of blood pressure levels in relation to race, sex and age. Secondarily, information regarding height, weight, build, arm girth, socioeconomic status, length of residence in the Bahamas and in Nassau, family history and parity would also be elicited. If possible, information on relative intake of salt (in water supply) would be obtained for units within the sample.

In addition to these specific goals, it was felt that such a project could provide useful information in regard to the methodology itself. The two principal methodological problems were choosing a proper sample for a population study and standardization of procedure. This latter included the type and method of examination as well as an attempt to assess differences in results due to instrument error, error due to the observer and error due to variability within the person observed.

CHAPTER II

CHOICE OF SITE

Since it had been decided to study the people of the Bahamas, it was necessary to know something of the geography and history, as well as the population distribution of the Islands. The Bahama Islands constitute a British Colony separate from the federated British West Indies. The island chain contains hundreds of small islands and cays which extend almost 900 miles in a southeasterly direction from the northern tip of the chain which lies less than 100 miles off the southeastern Florida coast.

Because of its separate political status, immigration is greatly restricted from islands outside the Bahamas and to a lesser degree from other parts of the world. This has enabled the Bahamians to maintain a considerable degree of racial purity.

The original Indian inhabitants were either exterminated or sent off to other islands by the Spaniards. When the English took possession, all Spaniards were evacuated. The forebears of many of the population today descended from the white Tories of the American Revolution and their Negro slaves. Over the next fifty years more Negroes entered, being left on the islands as free men from slave ships intercepted by the British. These Negroes, then, are all of the same basic geographic origin as Negroes in the United States. This origin cannot be specifically identified other than West Africa.

The population of the islands remained relatively stable until the twentieth century when the universal population explosion had its effect. From available data(19) it is seen that the relative proportions of Negro to white has been approximately unchanged since 1800. This suggests that most of the population increase is natural and not by immigration. In the 1953 census only 8.3% of the people were born outside of the Bahamas. Since 1953 the population has increased greatly, but good data is unavailable as to source of increase. Undoubtedly, the rate of immigration was increased somewhat. The total population in 1953 was listed at 84,000, and in 1956 it was grossly estimated at 118,000. If this rate of increase continued into 1958, total population would approach 150,000. No valid estimate of immigration or emigration is available.

It is felt that the best estimate of stability of the population, under the circumstances, is the evaluation of the birthplace of the people in the sample finally chosen. It was found in the sample that 8.7% of the people were born outside of the Bahamas. This is remarkably close to the total of 8.3% born outside of the colony in the 1953 census. Without further examination, these figures indicate that our sample primarily represents native Bahamians without undue dilution by recent immigration. However, since it is known that the population of Nassau has increased significantly since 1953 beyond increase accountable for by births, one must postulate that most of the increase has resulted from movement of people to Nassau from the other islands of the colony. In making this statement it is necessary to state that the sample was drawn from essentially the "old city" and newer developed areas of the island may show greater proportions of immigrants.

Since this total population is scattered over a great many widely separated islands, sampling of the total population was not considered feasible. A central population concentration was needed for study.

The island of New Providence has become not only the geographic cent of the colony, but also the cultural and population center. It is small (58 square miles) and quite densely populated (790 persons/square mile in 1953). The majority of the people are clustered on the north-east shore in the city of Nassau. The population of the city is unknown since the island is governed as a unit and no definite city boundaries exist. It is likely that about 60,000 people live on the island. It was decided to perform a population study of New Providence, not only because it was more convenient geographically and contained a large enough population for sampling procedures, but also that this population probably represented a "melting pot" of the people of the entire colony.

In short, Nassau was selected as the site of the study because of its central location in the colony, its population concentration, and its "melting pot" quality. Because of the latter one feels that a sample studied here may represent not only the people of Nassau, but generally speaking, a cross-section of Bahamians.

CHAPTER III

CHOICE OF SAMPLE DESIGN AND SAMPLE VALIDATION

In order to describe a characteristic of a group of people, one of two alternatives may be used: 1) to measure this characteristic in the entire group, or 2) measure a sample of the people in such a way that results may be extended to the parent population with a calculable degree of sampling error. The sample size is chosen depending upon the expected variation of the results and the importance of precise accuracy. Various methods of sampling may be used. The choice depends upon local conditions and problems of selection, the cost of obtaining the information in various sampling plans, the degree of accuracy desired, the number of variables to be studied and the varying complexity and cost of analysis. All of these factors must be weighed separately and in relation to one another before the most practical design may be selected.

In recent years the applications of sample survey techniques have been extensively studied. The potential usefulness of these techniques in epidemiology is becoming increasingly apparent. In regard to studies on blood pressure, Comstock[3] and Miall[13] have used types of sample surveys. Many others have selected people for study on a haphazard basis or have chosen special, restricted groups. The results of such studies cannot be extended beyond these restricted groups. Boe, on the other hand, did not sample, but undertook the Herculean task of measuring blood pressure of the population of an entire city.

Since we wish better to understand the natural level of the human blood pressure and how it varies within the population, we must sample from a defined population. One reason for the disparity between the findings of some blood pressure studies may be that the population was not truly represented in the sample. Another reason is that of the variability which can be accounted for by the process of sampling.

The first cardinal rule is that the sample should be a probability sample. This implies that the sampled units have a known chance of being included in the sample. Calculation of sampling error is dependent upon this known probability. If one wishes to oversample in a particular segment, he may do so, with proper weighting procedures in subsequent analysis.

Quota sampling is the only feasible alternative. This also is a population sample, but in this case a specified number in each age, sex, or race group is interviewed, often on the basis of convenience. It is impossible in this case to assign sampling error to results, but this is not to say that results are necessarily inaccurate. In the study at hand, more precision was desired so that probability sampling was chosen.

Within the realm of probability sampling lies a variety of sample designs. Primary types are simple random sampling, systematic sampling, cluster sampling, stratified sampling and various combinations of these. All have their place in specific situations and choice is made according to the factors mentioned. After the sample is drawn, the population may be post-stratified, e.g., by age, sex or race group for analysis. All of these possible designs will not be covered but the discussion of specific problems in sampling in this area will describe why the design used was selected.

Goals of the study were:

1) To study distribution of blood pressure in a representative sample of Bahamians. This implies inclusion of all race groups, all age and sex groups and all socioeconomic groups.

2) To study these variables as accurately as possible, meanwhile keeping cost at a minimum. Accuracy implies careful work in all phases, cognizance of potential sources of error, with effort exerted to minimize or eliminate these errors. Cost also involves all phases from planning to data collection to analysis.

In the planning phase, several facts were immediately apparent:

1) Budgetary restrictions were such that actual field work must be accomplished in about five weeks. This meant that sample selection and operational planning facilitate rapid observations.

2) In order to include all types of persons in the population, the primary scheme for classification must be according to race and socioeconomic status. Information regarding specific age-sex-race groups must be obtained by means of post-stratification.

3) Information about geographical location of people on the island was lacking. The following difficulties arose:

   a) People were too scattered to attempt a sampling study of the entire island.

b) City limits of Nassau were not demarcated.

c) In the thickly populated areas of the city, streets were reasonably marked, but house numbers were not used. Houses were often scattered haphazardly in regard to street location, sometimes in clusters in the center of blocks.

d) Races and socioeconomic classes were sometimes mixed on the same blocks, making such classification by block occasionally difficult.

The perimeter of the area for sampling was then arbitrarily established at major arterial streets which enclosed the majority of the thickly populated area. Total population enclosed was estimated at 30-35 thousand, by a rough extension of 1953 census data. Excluded were the mansion district of the white "winter resident" and the fringes of the colored areas. This did not appear to prejudice our goals. Also excluded with the sampling area were tourist hotels, hospital and institutions.

Any selection scheme for sampling individuals was made impossible because of lack of any listing by person. Therefore, the household itself must be the selection unit. Simple random selection of households was not feasible because of cost of mapping all household locations within the area. Systematic sampling, though possible, was not desirable because of potential bias, but primarily because of time and cost of travel in reaching households in this manner.

In order to keep cost at a minimum, the primary sampling unit was designed as a cluster of households. "Sampling unit" by definition is that which is chosen to represent the whole of like units. Therefore, the first step of outlining these clusters was to drive around every block within the area chosen, counting the number of dwelling units in each block. At the same time a racial composition estimate was made and a socioeconomic score assigned for each block. This yielded 261 blocks of greatly varying size.

Before further subdivision, it is necessary to consider how large a sample is needed. According to the initial goals, blood pressure readings are to be compared in three separate racial classes (white, Negro, mixed), the two sexes and twelve separate five-year age groups. This means an ultimate separation of the data into seventy-two mutually exclusive groups, each of which is specified as to its race, sex and age composition. Variability within these groups was one of the aspects to be studied and about which there was little foreknowledge. Therefore, it was estimated that an average of 40 persons per group would produce a reasonably reliable mean and standard error for the blood pressure distribution. These requirements suggested a working goal of about 3000 persons.

It was then necessary to estimate the number of persons per household in order to select an adequate number of households in the sample. From 1953 census figures the average household contained 3.8 persons. Since children under six years were to be excluded, this average would be reduced to about three persons per household. Thus a yield of at least 3000 persons required that 1000 households be included in the sample.

Since it was known that the white and mixed races were minority groups, steps to ensure adequate numbers of these groups were necessary. Since all blocks had been assigned racial and socioeconomic scores, they were used as the basis for stratification. Since the blocks were of varying size, the concept of "measure of size" was used. It was found that 40 houses per block was a very rough estimate of average size. All of the blocks were then segregated by race and socioeconomic status and reapportioned into measures of size of approximately 40 houses (actually 35-45). This involved combining two or more blocks of like race and socioeconomic score where houses were sparse and dividing large blocks into two or more measures. By this sytem 13 measures of size were of predominantly white race, 16 measures were mixed white and Negro races and 174 were predominantly Negro.

In sampling one must consider the ultimate cost of analysis as a feature of planning. Keyfitz'[10] simplified computational scheme for means and standard errors stipulates the use of a stratified design such that strata are constructed approximately equal in size and from these strata, two primary sampling units are chosen at random. The primary sampling unit is the measure of size, or 40 houses. This design proved the most convenient for the purpose.

Since the goal was 3000 persons, this was equivalent to 26 measures of size at 40 houses each in the final sample. This would make the overall sampling ratio one house in eight of the sampled area. Size of stratum was dictated by these facts: 26 measures were needed; oversampling in the white areas was needed to guarantee sufficient numbers. (Oversampling is permissible in this scheme if weighting procedures are used.) If the entire white group (13 measures) is considered as a stratum, four of these would constitute a doubled sampling ratio. The mixed stratum (16 measures) would be sampled with two units. This leaves 20 units left to be drawn from 174 colored measures. If these are divided into strata of approximately 17 measures from which two are sampled, our requirement of 26 measures or 1000 households would be met. These stratum sizes were felt to approximate equality sufficiently for this computation. The colored measures were grouped into strata on the basis of the socioeconomic score insofar as possible.

The alternative method of allocation of portions of the sample to strata was that of optimum allocation. Such a method gives a greater precision of the estimate in relation to cost if sampling within a stratum is performed in a manner directly proportional to estimated variance and inversely proportional to cost per element of data collection. In this case we had no reason to believe that either variance or cost per element was significantly different over the strata. Therefore, this method offered no advantage.

The value of stratification may be viewed as two-fold. It tends to ensure a uniform coverage of all segments of the population and provides a measure of differences between these strata, while minimizing variance within strata. A further generalization is that efficacy of stratification is directly proportional to degree of homogeneity within strata, heterogeneity between strata and the extent to which the quality compared for homogeneity affects the variables under study.

In the present study it becomes apparent that the principal value of stratification would be that of more complete coverage of the population. Since the measurements of blood pressure on people are to be the ultimate comparison items, the people must be grouped within strata by age and sex (since these are variables known to be associated with variation in blood pressure). Even if race were completely homogeneous within strata, grouping by age and sex of 240 persons (average yield per stratum) makes such minute comparisons of doubtful validity. Overall stratum means and variances would probably be meaningless.

It is important in any study to be aware of the potential sources of error. These should be known in the planning phase so that steps may be taken to minimize or eliminate them.

Kish[11] categorizes two main types of error, those of sampling and those classed as nonsampling. The nonsampling error includes "variable response error" and "biases." "Variable response" includes errors in data collection, punching, coding, as well as nonresponse. Errors of this type tend to cancel one another to some extent. "Bias" implies discrepancies between observations and the true values of the measurements taken. These may be of a systematic and noncanceling nature. Because of variable response errors, repeated observations of the same sample would yield a theoretical distribution of population values. The mean of this distribution is the "expected value." The difference between this and the "true value" is the bias. The size of the bias is unknown in practice.

The second category, sampling error, is the standard error of the sampling distribution over all possible samples. The total error is not the sum of these two types (nonsampling error and sampling error) since the former is of a partially self-canceling or compensating type. This total error is, of course, larger than either of its two constituents.

The errors in the mechanics of data collection and processing are minimized by a foreknowledge of these sources and the use of proper care. "Bias" in the sense of the true value as opposed to measured value of blood pressure is impossible to study in this setting. However, the aim here is to study distributions of blood pressure using the measurement tools available and in general use. Potential differences in the use of this measuring instrument is discussed in the chapter on observer variation (Chapter V). The ability to calculate sampling error is inherent in the sample design and is one of the principal justifications for the sampling procedure.

The material to follow in this chapter is properly considered to be a part of the result of the study but will be given out of context for convenience in considering the adequacy of the planning of the sampling method.

At the conclusion, estimates of validity of the sample must be made. This is accomplished in four ways: a) a count of the total households in sample and the yield in persons examined; b) an estimate of response rate; c) a comparison of racial proportions in the sample with census data; and d) a comparison of age and sex proportions within these races with census data.

The total number of households in the sample was 1008. The total number of persons with complete data for study was 3057. The average number of persons over age 5 per household was 3.3.

The response rate was 91.5%. Approximately 2-3% of the sample were male migrant workers in the United States or seamen at home infrequently.

If these were to be excluded, the proportion studied of those selected would approach 94-95%. The refusal rate was 0.8%. These were a mixed group of a few wealthy white persons, uncooperative children and persons with an insurmountable language or intelligence barrier. The remainder (7.7%) were not at home after at least three call-backs. Adequacy of coverage must be considered sufficient in view of the results to be expected from sample surveys. There is no convenient means by which to quantitate adequacy in this sense. However, the potential bias of the nonrespondents is felt to be minimal in this study because of the high proportion of completeness of the sample chosen.

The age-sex proportions for nonrespondents does show that more males than females were lost to the sample at about a 2 to 1 ratio. The majority of both sexes followed approximately the same relative age proportions of the population except that very few children under 10 were not located.

Comparing racial proportions in the sample with census information, some discrepancies are seen:

	1953 Census	Sample
White	14.62%	18.46%
Negro	69.69%	77.73%
Mixed	14.71%	3.91%
Other	0.99%	

The major difference is that "mixed" racial stocks were noticeably fewer in the sample. Census enumerators in 1953 did not ask specifically about race, but estimated subjectively. These enumerators were local people, much more accustomed to detecting racial mixtures. It was also possible that they were hypersensitive to such differences. The examiners in the present study were not familiar with making such subjective judgments in regard to race and listed as "mixed" only those with obvious racial mixing.

Whichever was the case, the figures would indicate that if approximately 10% of the total in 1953 were subtracted from the 14% allotted to "mixed" and divided equally (5%) among the Negro and white totals, the percentages would be remarkably alike. One might speculate that of this 14% called "mixed" in 1953, 5% were principally white, 5% principally Negro, and 4% truly mixed. If this were accepted, it would tend to strengthen the probability that the sample is valid.

For the purposes of the study here reported, it would seem wiser not to be overly sensitive to minimal degrees of racial mixture. It seems logical to suppose that a person predominantly Negro or predominantly white would tend to be more like his primary racial stock in regard to his blood pressure.

Sample validation was also attempted by comparing age and sex proportions of the sample with the census data. Comparison was made with extracted data showing proportions by sex for similar five-year age groupings. The census did not provide an age distribution by race. In Table 3.1 this comparison shows that there is a reasonably good agreement throughout. Most of the differences do not exceed 1%. A Chi square test for significance of differences between these age-sex proportions was done showing $X^2 = 0.68$ (df = 23). This would indicate with a high degree of probability that no significant difference exists between the sample proportions and the census proportions. Further substantiation is given by the approximate identity of total sex proportions in the sample as compared to census. The close approximation here must be considered in great measure fortuitous, since one would expect greater deviations by chance alone. However, these facts further support the claim to sample validity.

In summary, the problems in choice of sample design and its implementation have been presented. The analysis necessary for validation of the sample has been reviewed, with the conclusion that the sample drawn has a strong claim to validity.

Table 3.1

COMPARISON OF AGE-SEX PROPORTIONS (PERCENT) OF THE POPULATION
AS SHOWN BY 1953 CENSUS AND THE SAMPLE STUDIED AS TO BLOOD PRESSURE
NASSAU, 1958

Age Group in Years (Inclusive)	Numbers				Proportion (Percent) of Total			
	Males		Females		Males		Females	
	1953 Census	1958 Sample	1953 Census	1958 Sample	1953 Census	1958 Sample	1953 Census	1958 Sample
5-9	2524	188*	2506	203*	6.53	6.83*	6.48	7.37*
10-14	2194	164	2191	169	5.68	5.96	5.67	6.13
15-19	2104	168	2362	177	5.44	6.10	6.11	6.43
20-24	1941	148	2401	201	5.00	5.38	6.21	7.30
25-29	1746	119	2148	154	4.52	4.32	5.56	5.59
30-34	1458	85	1914	111	3.77	3.09	4.95	4.03
35-39	1579	71	1811	128	4.09	2.58	4.69	4.65
40-44	1261	84	1583	105	3.26	3.05	5.00	3.81
45-49	935	80	1135	89	2.42	2.91	2.94	3.23
50-54	625	48	876	59	1.62	1.74	2.27	2.14
55-59	427	25	574	43	1.10	0.91	1.49	1.56
60+	904	52	1462	82	2.34	1.89	3.78	2.98
Total	17688	1232	20963	1521	45.77	44.76	55.15	55.22

* Actually represents ages 6 through 9 years inclusive.
Sample proportions corrected for oversampling of white stratum. "Mixed" omitted from sample calculations because of difficulty of this type of correction on small numbers.

CHAPTER IV

THE INTERVIEW AND EXAMINATION PROCEDURE

One of the principal difficulties in comparing studies on blood pressure is that procedures vary between studies and often vary within individual studies. There was no single, previously reported, study which was felt to be appropriate as a model in all essential respects.

Blood pressure is known to vary under many circumstances; the magnitude and consistency of these variations are largely unknown. In addition to age, sex, body build and arm girth, all of which can be measured or classified with a fair degree of accuracy, there are other factors such as emotion and state of rest, which cannot be classified with any hope of accuracy. Also, posture in which blood pressure is measured, e.g., sitting, standing or recumbent, is known to affect blood pressure. This effect was not studied here, but was rather held constant by using the same posture throughout.

This study was designed for examinations to be done in the home. Home examinations gave promise to more complete coverage of families. It was also felt that a casual blood pressure taken at home would provide a more nearly accurate measure of the blood pressure the person "lives with" when not subjected to stress. This was undoubtedly counterbalanced to some degree by the presence of a strange person in the home.

Examinations were, of necessity, performed when the individual subject could be found at home. This frequently involved several call-backs before an entire family could be completed. For this reason, variation in blood pressure due to time of day, elapsed time since last meal, fatigue, etc., could not be compensated for by standardization. Most of the people were seen between 2-9 P.M., although many were seen in the morning.

Examinations were done in almost equal numbers by one physician (study director) and four senior medical students from the University of Michigan.

The interview itself was standardized so that information was gathered in a systematic manner. This helped to ensure completeness of information in addition to a standard order to the entire examination. See Page 1, Appendix (Data Collection Sheet). All identifying information was obtained in the following manner: 1) arm girth measurement; 2) first casual blood pressure reading; 3) first pulse rate; 4) height measurement; 5) weight measurement; 6) second blood pressure; 7) second pulse rate.

Blood pressures were taken from the left arm with the subject in the sitting position. Recorded were systolic, fourth phase diastolic (muffling) and fifth phase diastolic (disappearance). Studies have been done in all positions (sitting, standing, recumbent), but sitting appears to be more commonly used and was much more convenient in home examinations. Four of the five examiners were fourth year medical students and relatively unaccustomed to recording fourth phase diastolic pressures. However, standardization tests demonstrated that all were recording similar readings (see Chapter V). Pulse rates were taken immediately after blood pressure readings, using a 15 second timing procedure.

Routinely, height and weight measurements were recorded after the first blood pressure and pulse. The cuff was left on the arm since it would speed up the procedure and more accurate weights were not necessary for the purpose. Scales used were of the simple bathroom type, portable in a briefcase. Since they were spring scales, careful adjusting of zero point was necessary. All five scales agreed within 2 or 3 pounds when checked. It was found, also, that considerable variability resulted from placement of the scale on a rug or an uneven surface. In some homes a level surface was difficult to find.

Height was measured to the nearest half inch with a firm cloth tape after marking height on a wall from the subject standing without shoes. Arm girth was measured to the nearest quarter inch at the point of maximum circumference of the upper left arm. This firm cloth tape was felt to be sufficiently comparable in accuracy to a metal flexible tape.

After these measurements, the second blood pressure and pulse were recorded. Total elapsed time between measurements was 1-2 minutes.

Sphygmomanometers used were of the aneroid type, compared daily for accuracy using a mercury-type instrument as a standard (see Chapter V).

After thorough familiarization with the methods and procedures of examination, all examiners engaged in a field test in order to ensure uniformity of information elicited and the routine of examination. An area of the city not included in the sample was used in the pre-test.

The examiners worked in pairs, observing each other's techniques until it was felt that all were comparable.

The progress of the work was facilitated greatly by the almost universal cooperation and interest of the people. Many were quite concerned about "high blood" in themselves and their families. Not a small problem were those people in the neighborhood (not included in the sample) who requested examination.

Persons were told either that their blood pressure was normal, that it was borderline high, or high. The criterion used for the most part was diastolic pressure. All those over 110 were referred to their physician or to the Colonial Medical Service. Diastolic pressures 100-110 were called borderline and advised to consult their physician at a later date. Others were called "normal". Some exceptions were made in young people, some older persons with extremely wide pulse pressures, and other with suggestive symptoms. These also were referred to their physician.

In summary, the location, content and method of the interview and examination have been discussed, as well as the referral system of persons with elevated blood pressures.

CHAPTER V

ANALYSIS OF POTENTIAL OBSERVER ERROR

Prior to actual observations, it was necessary to obtain assurance that the five observers, using similar techniques and similar instruments, did not introduce significant systematic differences into their readings of arterial blood pressure.

Aneroid sphygmomanometers were used because of their greater practicality for examinations in the home. All of the instruments used were standardized daily against a mercury type instrument. None of the instruments varied by more than 2 mm. at any level. At the time of the experiment on observer error, one aneroid instrument was defective and the standard instrument was used by one observer. Subsequently, a new aneroid was used in the actual field work.

The experiment to test observer error was done prior to any collection of data. Five different persons were to be observed by the five field examiners. The examinations were arranged so that the effects of the three potential variables could be measured. These were: 1) variation due to the subject himself; 2) variation due to the examiner; and 3) variation due to the order in which the persons were examined.

These variations may be measured by a Latin Square analysis of variance design. Each subject and each observer were assigned a number. A Latin Square involving these numbers was then randomly selected to determine order of observation. Each observer examined a different subject at the same time. When all had finished, each moved to the next subject in the prearranged order. The examination of each subject by each observer included three successive blood pressures and pulses. Both fourth and fifth phase diastolic pressures were recorded. Pulses were taken with fifteen second readings.

In the analysis of the above, three components of variances were compared. It was found that:

1) Variation between subjects was great. This also included a component of variability within the subject himself.
2) Variation due to order of observation was slight or minimally significant.
3) Variation due to observers was insignificant for all blood pressure readings. However, significant observer variation was present in pulse readings. This variation in regard to pulse was probably due to taking of fifteen second pulses where an error in counting one or two beats could produce such an error as seen here. This finding would not appear to be of such magnitude that its use for general comparisons is lost.

The level of significance was taken at the 5% level, utilizing the "F" test. It must be remembered that this determines a range of "F" ratios which enable one to accept or reject a null hypothesis. If these "F" ratios fall outside this acceptable zone, the null hypothesis is rejected. For example, the first hypothesis was that of no difference between subjects. The "F" ratio fell outside the acceptable zone and, therefore, we state that there is a significant difference between subjects.

However, "F" ratios as such cannot be treated in a strictly quantitative fashion in order to compare accuracy of observing different variables. These ratios tell us how strongly a belief should be held that no difference exists. For example, (Table 5.1) the "F" ratio for systolic mean observer variation is .193. This is equivalent to saying that if no difference between observers exists, an "F" ratio would be obtained as large as this between 90-95 times in a hundred. (.95 > p > .90)

Table 5.1

LATIN SQUARE COMPONENTS OF VARIANCE TEST FOR VARIATION DUE TO OBSERVER

Reading	Effect	"F" Ratio	"p" Value
Systolic (Mean)	Subject Variation	85.215	p < .0005
	Order Variation	4.147	.025 > p > .010
	Observer Variation	.193	.95 > p > .90
Systolic (First Reading)	Subject Variation	39.133	p < .0005
	Order Variation	2.989	.10 > p > .05
	Observer Variation	0.143	.975 > p > .950
Diastolic (Fourth phase) Mean	Subject Variation	52.908	p < .0005
	Order Variation	3.38	.050 > p > .025
	Observer Variation	3.15	.10 > p > .05
Diastolic (Fourth phase) First Reading	Subject Variation	37.594	p < .0005
	Order Variation	2.331	.25 > p > .10
	Observer Variation	2.597	.10 > p > .05
Diastolic (Fifth phase) Mean	Subject Variation	38.85	p < .0005
	Order Variation	0.278	.90 > p > .75
	Observer Variation	1.08	.50 > p > .25
Diastolic (Fifth phase) First Reading	Subject Variation	29.68	p < .0005
	Order Variation	0.440	.90 > p > .75
	Observer Variation	.962	.50 > p > .25
Pulse (Mean)	Subject Variation	39.856	p < .0005
	Order Variation	0.763	.75 > p > .50
	Observer Variation	7.792	.005 > p > .001

At 5% level (two-tailed test) an "F" value of greater than 4.12 indicates significant difference.

Further study of potential observer variation is possible through analysis of the frequency of terminal digits in blood pressure readings. All examiners were instructed to read to the nearest 2mm. marking, i.e., 0,2,4,6,8. Theoretically, the distributions will be equal on these five numbers. It is unfortunately true that habit formation usually tends to cause a lumping at the usual 5 mm. breaks, e.g., 0 and 5. This is probably more true at the very high and very low levels of the measurement scale, since in these ranges one is usually not concerned clinically with precise readings.

Table 5.2 shows the varying proportions of readings of terminal digit by the various examiners. The principal deviation from an even distribution is the excess proportion at the 0, at the expense of the 2 and 8. There were also some inadvertent readings at the 5 mark, at the expense of 4 and 6. However, considering 4, 5 and 6 together, there is no lumping apparent in this area.

One might expect a degree of random deviation from an expected 20% in each of the five read points. One examiner, No. 5, however, was remarkably close to this distribution. All of the others shared the lumping at 0. This disproportion at 0 does not cause great concern, although it was higher than hoped. Many investigators have found this true to an even greater extent. In this case it means, in effect, an error of plus or minus 2 mm. in reading which is within the scope of expected reading error. Nor does it invalidate the attempt at greater accuracy by reading to the nearest 2 mm. rather than to the nearest 5 mm. Actually, this distribution should indicate that greater care in reading will provide a much more accurate description of blood pressure distributions than is possible with fewer reading points.

When the read points are grouped 0-4 and 5-9, it is seen that the proportions fall close to the expected 60%-40% distribution. This distribution is expected since three reading positions (0,2,4) are contained in the 0-5 portion of the dial, and only two positions (6,8) in the 5-9 portion.

Systolic	0-4 = 65.6%
	5-9 = 34.4%
Diastolic	0-4 = 64.8%
	5-9 = 35.2%
Expected (both)	0-4 = 60%
	5-9 = 40%

It is of interest that proportions for systolic and diastolic are very similar. Although some observers showed varying patterns in reading positions for systolic as opposed to diastolic, the general distribution remained much the same.

In summary, the analysis of terminal digits demonstrates that even with care in reading, some individual variation is seen between observers on reading the same variable, e.g., systolic pressure, and that the pattern may vary somewhat with a different variable (diastolic pressure). However, these differences are seen to be not incompatible with expectations and do not prejudice the distribution. It is also seen that a quite good approximation of a continuous distribution may be measured by more precise reading of the instrument.

Previously noted was the finding in the components of variance test that no significant systematic difference was apparent between observers in the reading of blood pressure.

Table 5.2

TERMINAL DIGIT ANALYSIS

PROPORTION OF READINGS BY TERMINAL DIGIT PER EXAMINER

NASSAU, 1958

Systolic (first reading)

Examiner	Number of Obser-vations	Terminal Digit 0	1	2	3	4	5	6	7	8	9
1	602	30.2		20.0		20.9	0.3	10.0		18.8	
2	714	44.7		10.5	0.2	21.3	1.1	12.6		9.5	
3	534	27.7	0.2	13.3	0.2	16.1	3.4	20.6	0.4	18.0	0.2
4	530	36.3		13.2	0.2	16.0	18.4	6.9	0.6	8.9	
5	677	17.9		17.2		19.8		23.2	0.1	21.32	
	3057	30.85%	0.03%	14.528%	0.13%	18.656%	4.03%	14.50%	0.19%	14.88%	0.03%

Diastolic (fifth phase, first reading)

Examiner	Number of Obser-vations	Terminal Digit 0	1	2	3	4	5	6	7	8	9
1	602	35.5		11.3		16.45	1.8	15.9		18.9	
2	714	55.3		3.8		17.2	0.9	15.5		7.1	
3	534	27.7		14.8	0.2	14.4	3.4	21.0	0.4	18.2	
4	530	36.0		14.5	0.2	13.8	9.1	10.9		15.5	
5	677	20.1		17.4		22.9		20.5		19.1	
	3057	34.69%		11.81%	0.6%	16.87%	2.69%	16.51%	0.06%	15.14%	

CHAPTER VI

COMPARISON OF DIASTOLIC READING METHOD

It was previously noted in the chapter on observer variation that observers were able to read the fourth of diastolic pressure (muffling of sounds) equally as accurately as the fifth phase (disappearance of sounds).

The questions as to which reading method approximates more closely the true diastolic pressure and which method is the most reliable and reproducible by different observers constitute a minor international disagreement. From the present data it appears that there is ample justification for each side.

Since, in this study, both fourth and fifth phases were recorded and age-sex-race specific means and standard errors were computed, further knowledge on this question was sought.

Table 6.1 shows the age-sex-race specific mean differences between the two readings. It is seen that the greater differences are in the young, with a gradual diminution with age. However, the mean of the mean differences is only 3.6 mm. The difference between the races and sexes appears negligible.

In regard to the question of which reading may be more variable (as evidenced by the standard deviations of the diastolic pressure distributions of both fourth and fifth phases for age-sex-race specific groups), a sign test was performed. This test showed that the variability of diastolic (fourth phase) was the greater in 24 groups, diastolic (fifth phase) was the greater in 22 groups, and a tie resulted in 2 groups,

Table 6.1

DIFFERENCES BETWEEN DIASTOLIC READING METHOD
DIASTOLIC (Fifth Phase)- DIASTOLIC (Fourth Phase)
BY AGE, SEX, AND RACE
NASSAU, 1958

Age	White Male	White Female	Negro Male	Negro Female
6-9	4.62	3.13	3.27	4.04
10-14	7.50	4.00	4.55	4.54
15-19	5.54	4.45	5.84	5.30
20-24	5.94	3.91	5.06	4.77
25-29	4.20	1.76	4.43	3.05
30-34	3.89	4.45	4.33	3.03
35-39	4.09	1.78	4.39	2.79
40-44	3.09	1.56	3.58	3.05
45-49	2.45	1.90	2.35	2.83
50-54	3.00	0.40	3.92	5.43
55-59	1.99	1.87	3.00	2.66
60 +	2.14	2.60	3.45	4.15
Mean Difference	4.04	2.56	4.01	3.80

Mean of Mean Differences = 3.60mm.
Mean Difference (Negro) = 3.91mm.
Mean Difference (White) = 3.29mm.

and a tie resulted in 2 groups. Thus, no significant difference in variability between the two reading methods was apparent. In most of the sex-race categories, there was no definite relationship to age in regard to greater variability of one diastolic reading method as compared with the other. However, and for reasons unknown, the Negro male group showed a regular pattern with the fifth phase more variable up to the 25-29 age group, and the fourth phase more variable thereafter. No such pattern existed in the other race-sex groups.

It must be noted again that four of the five examiners were medical students who by training are more accustomed to listening for and recording the fifth phase.

In summary, the findings of this study in regard to diastolic reading method are: 1) the difference between fourth and fifth phase is somewhat smaller than expected from previous data, 2) these differences tend to be greatest in the young, and 3) there appears to be little to choose in regard to variability and reproducibility of either method.

CHAPTER VII

THE DISTRIBUTION OF BLOOD PRESSURE READINGS BY AGE, SEX AND RACE

It is hoped that the material presented in this paper will be such that it may be compared with any existing or future population studies on blood pressure. For this reason, the recommendations of the American Heart Association in regard to the use of data from casual first readings and the use of the fifth phase of diastolic pressure in the analysis. Data describing distributions of the fourth phase of diastolic pressure are presented for potential comparison with studies using this method alone.

A. Arithmetic Means and Standard Errors of the Distributions

All participants in the study were classified by a post-stratification procedure into age, sex and race specific groups. The age span within groups was five years, with the exceptions of the 6-9 year group, and the "60 and over" year group. Race categories were pure Negro, pure white, and "mixed". A few Asians who fell in the sample were not included in the analysis. As previously noted, the "mixed" group was too small to permit detailed study. There were then 48 age-sex-race specific groups, categorized by two races, two sexes, and twelve age groups.

In order to compare different variables in these specific groups it was desirable to obtain measures of central value and variability within groups. To do this we must know something of the underlying distributions, since for full utilization of means and standard errors we must be assured of an approximately normality of the distributions. It was noted by Boe[1] that systolic pressure showed a definite positive skewness in all age groups, becoming more skew as age progresses.

However, Boe's distributions of systolic pressure by age were shown to approximately the logarithmically normal distribution. The diastolic pressure distributions, on the other hand, agreed much more closely with the normal distribution, particularly in the young age groups. The results of the present data corroborate these findings and are also shown graphically in Figures 7.1 (eight parts). Systolic pressure distributions in several age groups were plotted on log normal probability paper; the results agreed generally with these conclusions.

It is known that the means of samples from non-normal distributions will be normally distributed. The use of a standard deviation for comparison is further strengthened by the fact that the distributions compared across age groups are skewed in the same direction, varying somewhat in degree.

The findings for the age-sex-race specific groups in terms of the mean, standard error of the mean, standard deviation of the distribution and coefficient of variation are shown in Table 7.1.

It is seen that the standard errors of these means are generally small enough to give reasonable assurance of the probable true population values. These standard errors were computed by the method of Keyfitz[10].

MEANS OF BLOOD PRESSURE READINGS IN AGE, SEX AND RACE GROUPS, WITH STANDARD ERROR OF MEAN, DISTRIBUTION STANDARD DEVIATION AND COEFFICIENT OF VARIATION. NASSAU, 1958

Systolic Blood Pressure, White Race, by Sex and Age

Males					Females				
Age	Systolic Mean	Standard Deviation	$s/\bar{S}$	No. In Group	Age	Systolic Mean	Standard Deviation	$s/\bar{S}$	No. In Group
6-9	104.33 ± 2.18	14.78	.142	45	6-9	105.40 ± 1.28	8.78	.083	47
10-14	114.82 ± 1.78	9.42	.082	28	10-14	116.86 ± 2.21	13.26	.113	36
15-19	129.51 ± 1.38	7.92	.061	33	15-19	119.68 ± 2.81	15.65	.131	31
20-24	128.94 ± 2.43	14.17	.110	34	20-24	121.81 ± 3.46	22.70	.186	43
25-29	129.53 ± 2.83	15.51	.120	30	25-29	119.46 ± 2.99	18.69	.156	39
30-34	124.24 ± 3.11	19.16	.154	38	30-34	121.06 ± 3.17	18.20	.150	33
35-39	125.45 ± 3.51	16.46	.131	22	35-39	121.33 ± 3.19	16.59	.137	27
40-44	134.45 ± 2.44	11.44	.085	22	40-44	147.76 ± 5.59	27.95	.189	25
45-49	130.45 ± 4.39	19.62	.150	20	45-49	142.40 ± 2.50	11.18	.079	20
50-54	139.71 ± 2.18	8.15	.058	14	50-54	146.73 ± 3.91	15.13	.103	15
55-59	138.91 ± 7.17	23.80	.171	11	55-59	156.06 ± 6.17	24.68	.158	16
60+	145.25 ± 4.79	25.34	.174	28	60+	153.77 ± 5.02	27.51	.179	30

Systolic Blood Pressure, Negro Race, by Sex and Age

Males					Females				
Age	Systolic Mean	Standard Deviation	$s/\bar{S}$	No. In Group	Age	Systolic Mean	Standard Deviation	$s/\bar{S}$	No. In Group
6-9	101.59 ± 1.02	12.66	.125	154	6-9	102.60 ± 0.50	6.44	.063	166
10-14	109.31 ± 0.63	7.53	.068	143	10-14	111.70 ± 1.01	11.91	.107	139
15-19	125.01 ± 1.41	16.62	.133	139	15-19	118.84 ± 1.20	14.84	.125	153
20-24	128.00 ± 1.22	13.53	.106	123	20-24	119.67 ± 1.45	18.91	.158	170
25-29	132.90 ± 1.83	18.12	.136	98	25-29	126.84 ± 2.01	22.73	.179	128
30-34	135.84 ± 2.68	20.42	.150	58	30-34	132.29 ± 1.49	13.81	.104	86
35-39	142.89 ± 5.03	37.32	.261	55	35-39	140.31 ± 2.15	22.45	.160	109
40-44	142.22 ± 3.19	26.13	.184	67	40-44	149.15 ± 4.89	45.62	.306	87
45-49	144.81 ± 2.88	23.59	.163	67	45-49	152.13 ± 2.17	18.79	.124	75
50-54	155.76 ± 4.90	29.79	.191	37	50-54	155.72 ± 5.39	36.54	.235	46
55-59	144.31 ± 9.10	36.40	.252	16	55-59	182.10 ± 5.95	32.61	.179	30
60+	168.21 ± 8.40	48.22	.287	33	60+	176.02 ± 3.45	26.94	.153	61

Table 7.1 Cont'd

Diastolic Blood Pressure, Fourth Phase, White Race, by Sex and Age

Males					Females				
Age	Diastolic Mean	Standard Deviation	$s/\sqrt{D}$	No. In Group	Age	Diastolic Mean	Standard Deviation	$s/\sqrt{D}$	No. In Group
6-9	66.11 ± 2.41	16.17	.245	45	6-9	69.94 ± 0.98	6.72	.096	47
10-14	68.79 ± 1.75	9.26	.135	28	10-14	71.11 ± 1.23	7.38	.104	36
15-19	76.55 ± 2.39	13.72	.179	33	15-19	70.97 ± 1.27	7.07	.100	31
20-24	78.82 ± 3.17	18.48	.234	34	20-24	77.12 ± 1.57	10.30	.134	43
25-29	78.53 ± 2.11	11.56	.147	30	25-29	77.79 ± 0.81	5.06	.065	39
30-34	81.00 ± 1.43	8.81	.109	38	30-34	80.79 ± 2.22	12.74	.158	33
35-39	82.45 ± 3.29	15.43	.187	22	35-39	79.67 ± 0.85	4.42	.055	27
40-44	87.18 ± 1.63	7.64	.088	22	40-44	90.04 ± 2.36	11.80	.131	25
45-49	81.80 ± 2.83	12.65	.155	20	45-49	86.95 ± 2.30	10.28	.118	20
50-54	89.21 ± 1.50	5.61	.063	14	50-54	87.87 ± 1.93	7.47	.085	15
55-59	84.55 ± 1.77	5.88	.070	11	55-59	85.75 ± 2.46	9.84	.115	16
60+	81.82 ± 2.12	11.21	.137	28	60+	82.10 ± 1.93	10.58	.129	30

Diastolic Blood Pressure, Fourth Phase, Negro Race, by Sex and Age

Males					Females				
Age	Diastolic Mean	Standard Deviation	$s/\sqrt{D}$	No. In Group	Age	Diastolic Mean	Standard Deviation	$s/\sqrt{D}$	No. In Group
6-9	66.98 ± 0.76	9.43	.141	154	6-9	68.64 ± 1.12	14.43	.210	166
10-14	70-78 ± 0.60	7.18	.101	143	10-14	71.78 ± 1.17	13.79	.192	139
15-19	79.42 ± 1.05	12.38	.156	139	15-19	76.36 ± 0.88	10.89	.143	153
20-24	83.78 ± 1.13	12.53	.150	123	20-24	78.61 ± 1.18	15.39	.196	170
25-29	87.34 ± 1.46	14.45	.165	98	25-29	83.53 ± 1.13	12.78	.153	128
30-34	91.90 ± 2.25	17.14	.187	58	30-34	87.58 ± 1.07	9.92	.113	86
35-39	95.80 ± 2.86	21.22	.222	55	35-39	90.78 ± 1.70	17.75	.196	109
40-44	95.80 ± 1.94	15.89	.167	67	40-44	93.68 ± 2.65	24.72	.264	87
45-49	96.54 ± 2.27	18.59	.193	67	45-49	94.63 ± 1.30	11.26	.119	75
50-54	97.11 ± 2.71	16.48	.170	37	50-54	96.91 ± 2.61	17.70	.183	46
55-59	89.94 ± 4.82	19.28	.214	16	55-59	100.63 ± 1.55	8.49	.084	30
60+	93.03 ± 4.89	28.07	.302	33	60+	93.56 ± 2.96	23.12	.247	61

Table 7.1 Cont'd

Diastolic Blood Pressure, Fifth Phase, White Race, by Sex and Age

Males					Females				
Age	Diastolic Mean	Standard Deviation	$s/\sqrt{D}$	No. In Group	Age	Diastolic Mean	Standard Deviation	$s/\sqrt{D}$	No. In Group
6-9	61.48 ± 2.10	14.09	.229	45	6-9	66.83 ± 1.84	12.62	.189	47
10-14	61.29 ± 1.96	10.37	.169	28	10-14	67.11 ± 1.59	9.54	.142	36
15-19	71.00 ± 1.87	10.73	.151	33	15-19	66.52 ± 1.29	7.18	.108	31
20-24	72.88 ± 1.99	11.60	.159	34	20-24	73.21 ± 1.23	8.07	.110	43
25-29	74.33 ± 2.71	14.85	.200	30	25-29	76.02 ± 0.67	4.19	.055	39
30-34	77.10 ± 1.43	8.81	.114	38	30-34	77.45 ± 3.11	17.85	.230	33
35-39	78.36 ± 3.69	17.31	.221	22	35-39	77.89 ± 1.13	5.88	.075	27
40-44	84.09 ± 1.93	9.05	.108	22	40-44	88.48 ± 2.38	11.90	.134	25
45-49	79.35 ± 2.08	9.30	.117	20	45-49	85.05 ± 1.86	8.31	.098	20
50-54	86.21 ± 2.13	7.97	.092	14	50-54	87.47 ± 2.14	8.28	.095	15
55-59	82.54 ± 2.10	6.97	.084	11	55-59	83.88 ± 7.25	29.00	.346	16
60+	79.68 ± 1.83	9.68	.121	28	60+	79.50 ± 0.95	5.21	.066	30

Diastolic Blood Pressure, Fifth Phase, Negro Race, by Sex and Age

Males					Females				
Age	Diastolic Mean	Standard Deviation	$s/\sqrt{D}$	No. In Group	Age	Diastolic Mean	Standard Deviation	$s/\sqrt{D}$	No. In Group
6-9	63.71 ± 0.90	11.17	.175	154	6-9	64.59 ± 0.79	10.18	.158	166
10-14	66.23 ± 0.99	11.84	.179	143	10-14	67.24 ± 1.12	13.20	.196	139
15-19	73.58 ± 1.27	14.97	.203	139	15-19	71.05 ± 1.17	14.47	.204	153
20-24	78.73 ± 1.22	13.53	.172	123	20-24	73.84 ± 1.14	14.78	.201	170
25-29	82.92 ± 1.35	13.37	.161	98	25-29	80.48 ± 1.25	14.14	.176	128
30-34	87.57 ± 2.10	16.00	.183	58	30-34	84.55 ± 1.12	10.38	.123	86
35-39	91.42 ± 2.46	18.25	.200	55	35-39	87.99 ± 1.55	16.18	.184	109
40-44	91.57 ± 1.73	14.17	.155	67	40-44	90.63 ± 2.65	24.72	.273	87
45-49	94.19 ± 2.21	18.10	.192	67	45-49	91.80 ± 0.98	8.49	.092	75
50-54	93.19 ± 1.93	11.73	.126	37	50-54	91.47 ± 2.52	17.09	.186	46
55-59	86.94 ± 4.00	16.00	.184	16	55-59	97.97 ± 1.42	7.78	.079	30
60+	89.58 ± 4.29	24.62	.275	33	60+	89.38 ± 1.69	13.20	.148	61

Table 7.1 Cont'd

Pulse Pressure, White Race, by Sex and Age

Males					Females				
Age	Mean Pulse Pressure	Standard Deviation	$s/\sqrt{P}$	No. In Group	Age	Mean Pulse Pressure	Standard Deviation	$s/\sqrt{P}$	No. In Group
6-9	44.18 ± 1.91	12.82	.290	45	6-9	38.57 ± 2.29	15.71	.407	47
10-14	53.54 ± 3.54	18.73	.350	28	10-14	49.81 ± 1.01	6.06	.122	36
15-19	58.52 ± 1.64	9.41	.161	33	15-19	53.48 ± 1.72	9.58	.179	31
20-24	56.06 ± 2.18	12.71	.227	34	20-24	48.51 ± 2.68	17.58	.362	43
25-29	55.20 ± 2.18	11.95	.216	30	25-29	43.44 ± 2.81	17.56	.404	39
30-34	47.13 ± 1.92	11.83	.251	38	30-34	41.79 ± 2.17	12.46	.298	33
35-39	47.09 ± 1.45	6.80	.144	22	35-39	43.52 ± 2.69	13.99	.321	27
40-44	50.64 ± 1.53	7.18	.142	22	40-44	59.28 ± 3.84	19.20	.324	25
45-49	51.05 ± 6.12	27.36	.536	20	45-49	57.35 ± 2.28	10.19	.178	20
50-54	53.50 ± 1.84	6.88	.129	14	50-54	59.27 ± 2.08	8.05	.136	15
55-59	56.36 ± 8.20	27.22	.483	11	55-59	72.19 ± 3.71	14.84	.206	16
60+	65.57 ± 3.19	16.88	.257	28	60+	74.37 ± 4.91	26.91	.362	30

Pulse Pressure, Negro Race, by Sex and Age

Males					Females				
Age	Mean Pulse Pressure	Standard Deviation	$s/\sqrt{P}$	No. In Group	Age	Mean Pulse Pressure	Standard Deviation	$s/\sqrt{P}$	No. In Group
6-9	38.57 ± 0.97	12.03	.312	154	6-9	37.89 ± 0.80	10.30	.272	166
10-14	49.81 ± 0.74	8.85	.178	143	10-14	43.10 ± 1.41	16.62	.386	139
15-19	53.48 ± 1.38	16.27	.304	139	15-19	51.50 ± 0.82	10.14	.197	153
20-24	48.51 ± 1.18	13.09	.270	123	20-24	49.28 ± 1.01	13.17	.267	170
25-29	43.44 ± 0.77	7.62	.175	98	25-29	49.60 ± 1.18	13.35	.269	128
30-34	41.79 ± 1.51	11.51	.275	58	30-34	48.26 ± 1.18	10.94	.227	86
35-39	43.52 ± 3.29	24.41	.561	55	35-39	52.20 ± 1.26	13.15	.252	109
40-44	59.28 ± 2.43	19.90	.336	67	40-44	50.72 ± 2.65	24.72	.487	87
45-49	57.35 ± 4.50	36.45	.635	67	45-49	59.57 ± 1.91	16.54	.278	75
50-54	59.27 ± 3.24	19.70	.332	37	50-54	62.57 ± 3.48	23.59	.377	46
55-59	72.19 ± 6.39	25.56	.350	16	55-59	57.37 ± 3.48	23.59	.504	46
60+	74.27 ± 4.95	28.41	.383	33	60+	78.73 ± 2.68	20.93	.266	61

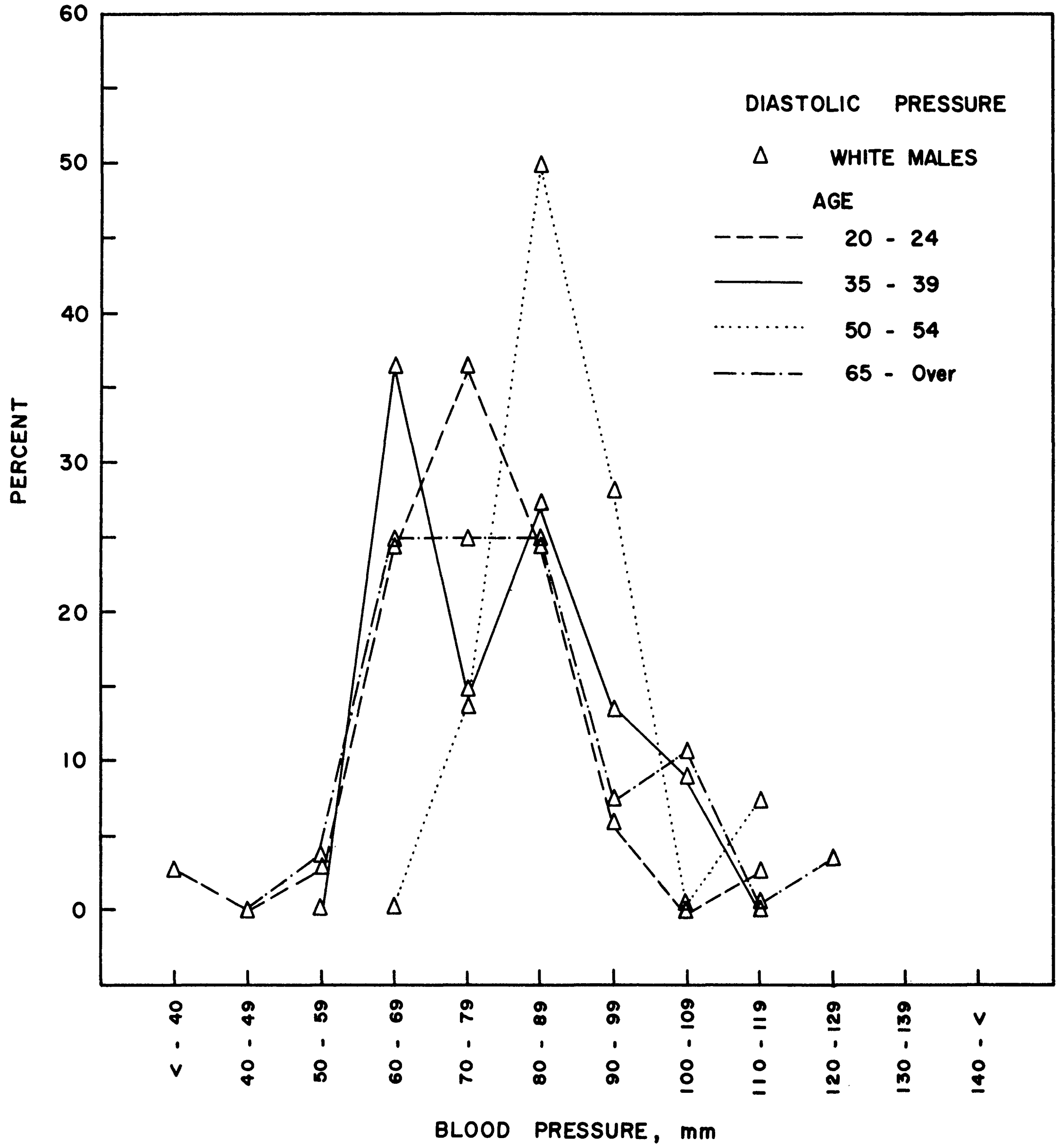


Figure 7.1 Frequency Distributions of Systolic and Diastolic Pressures by Sex, Race and Selected Age Groups, Nassau, 1958

(Eight Parts)

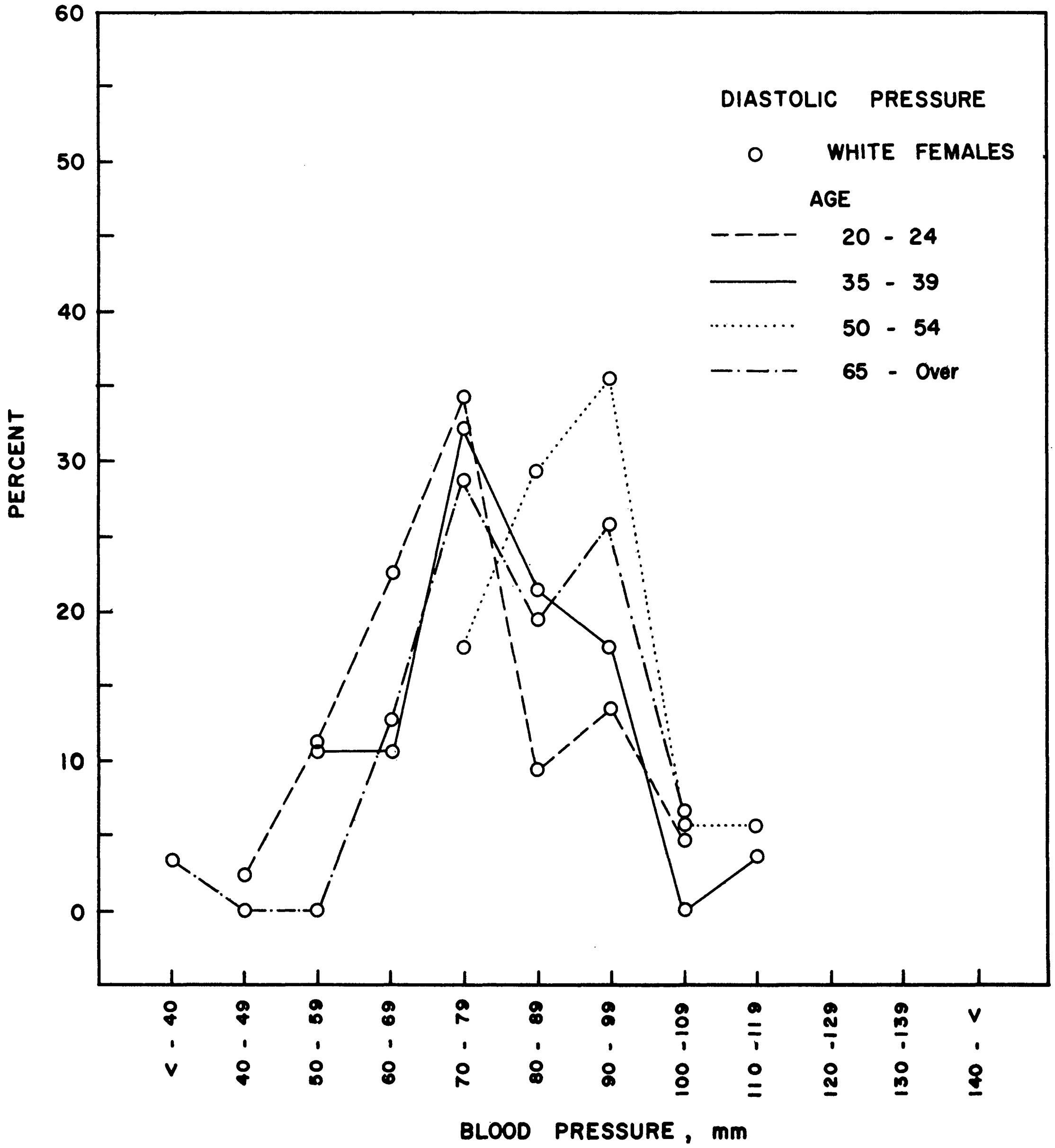
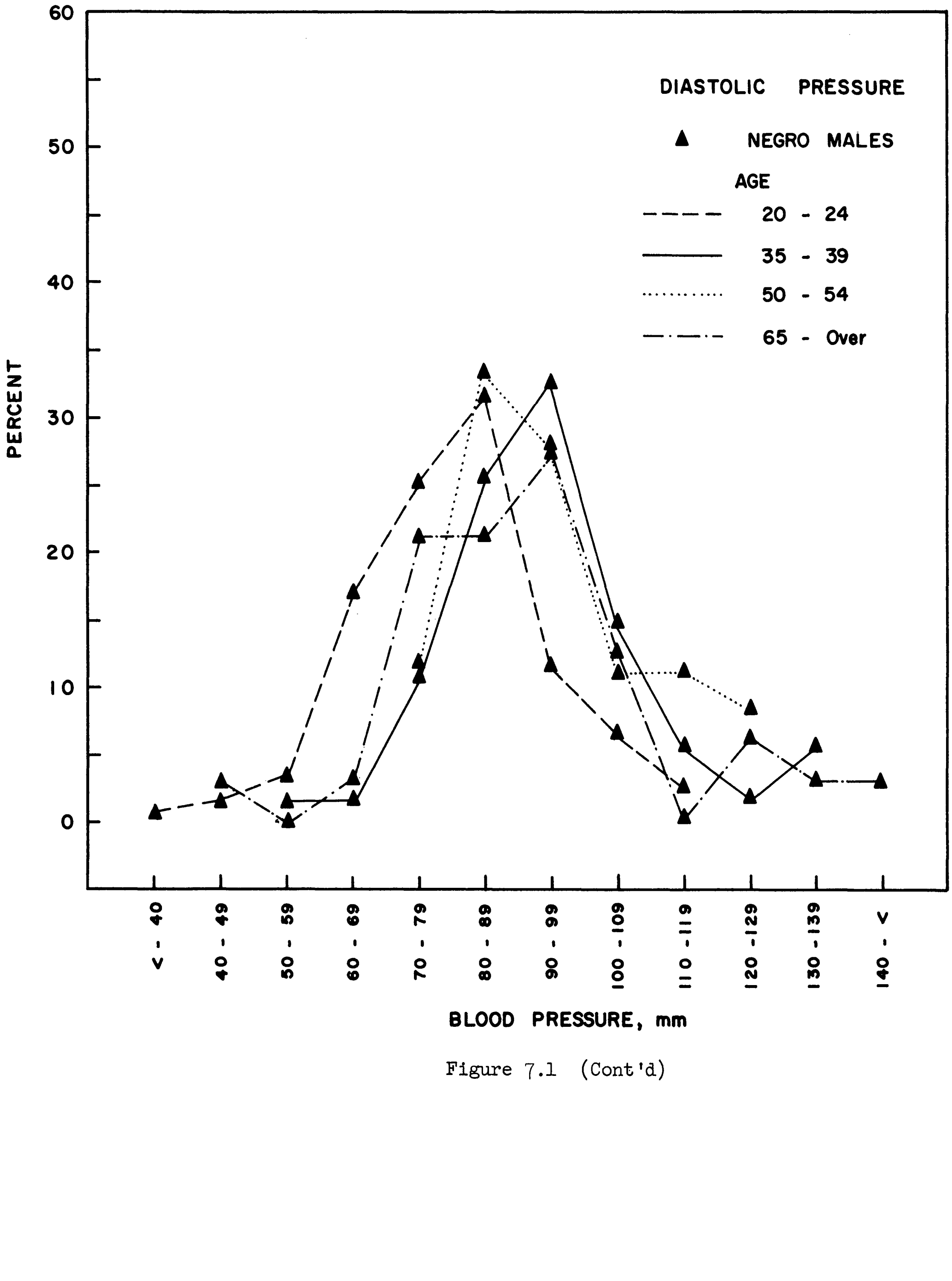


Figure 7.1 (Cont'd)



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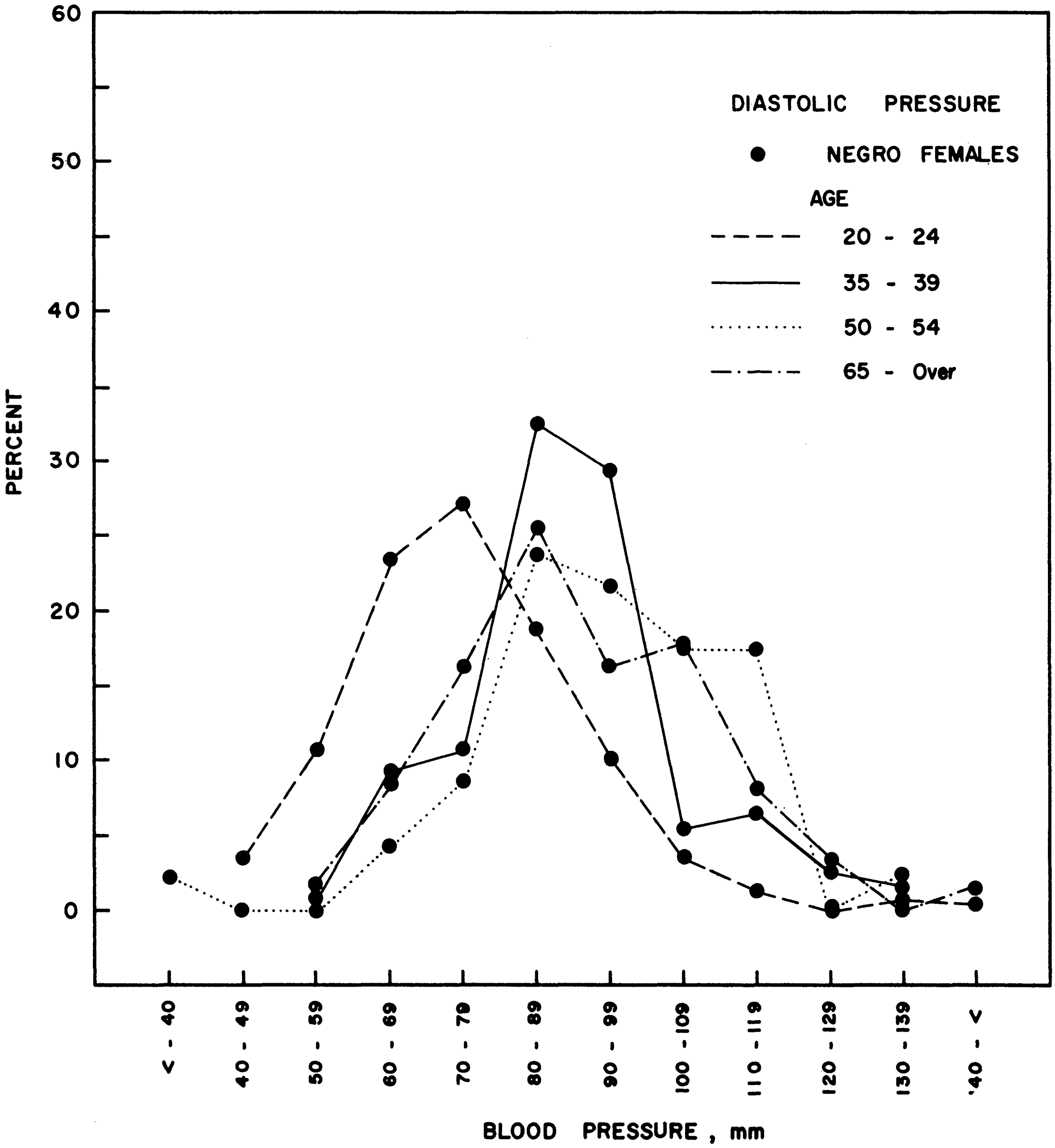

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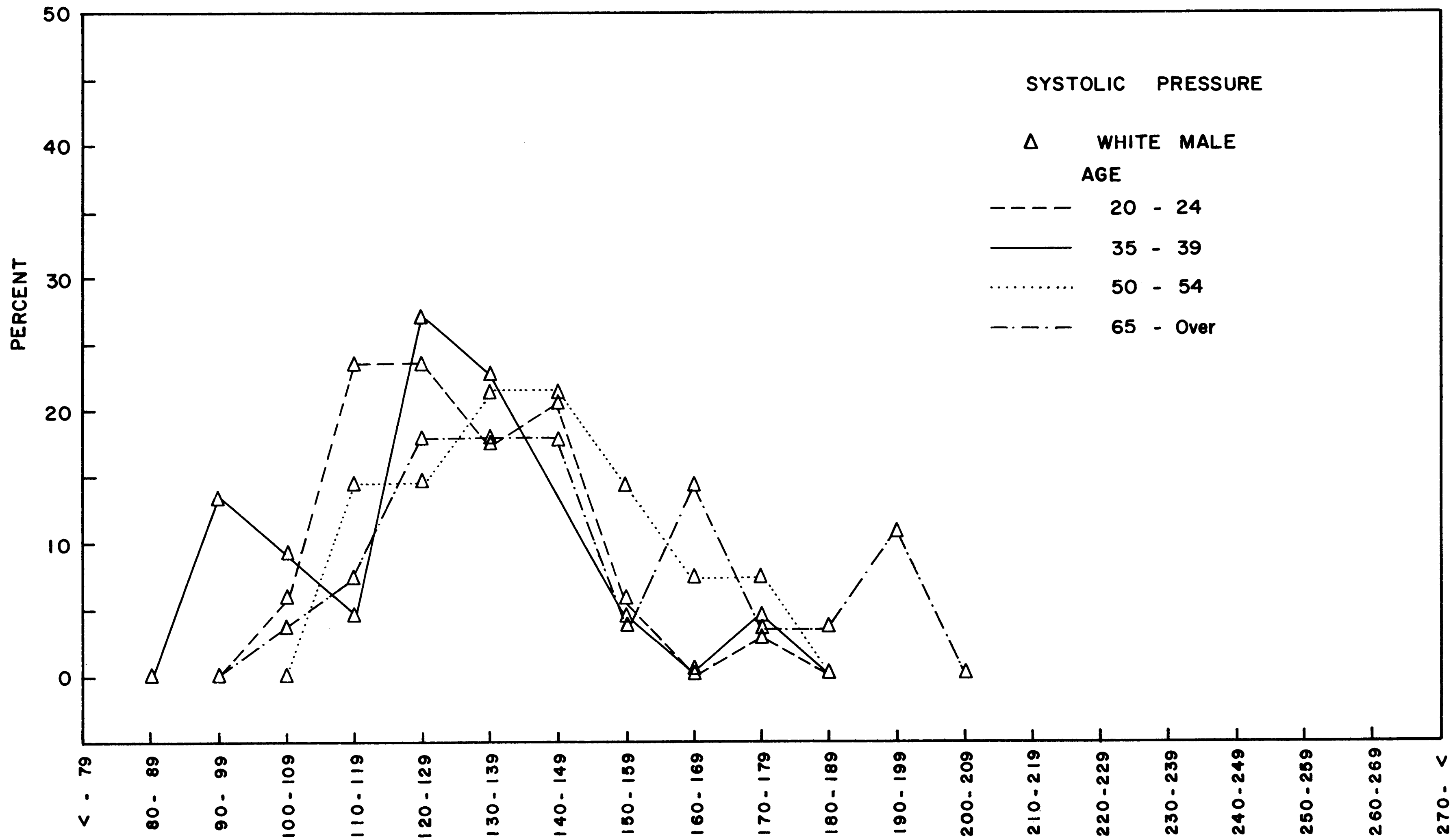

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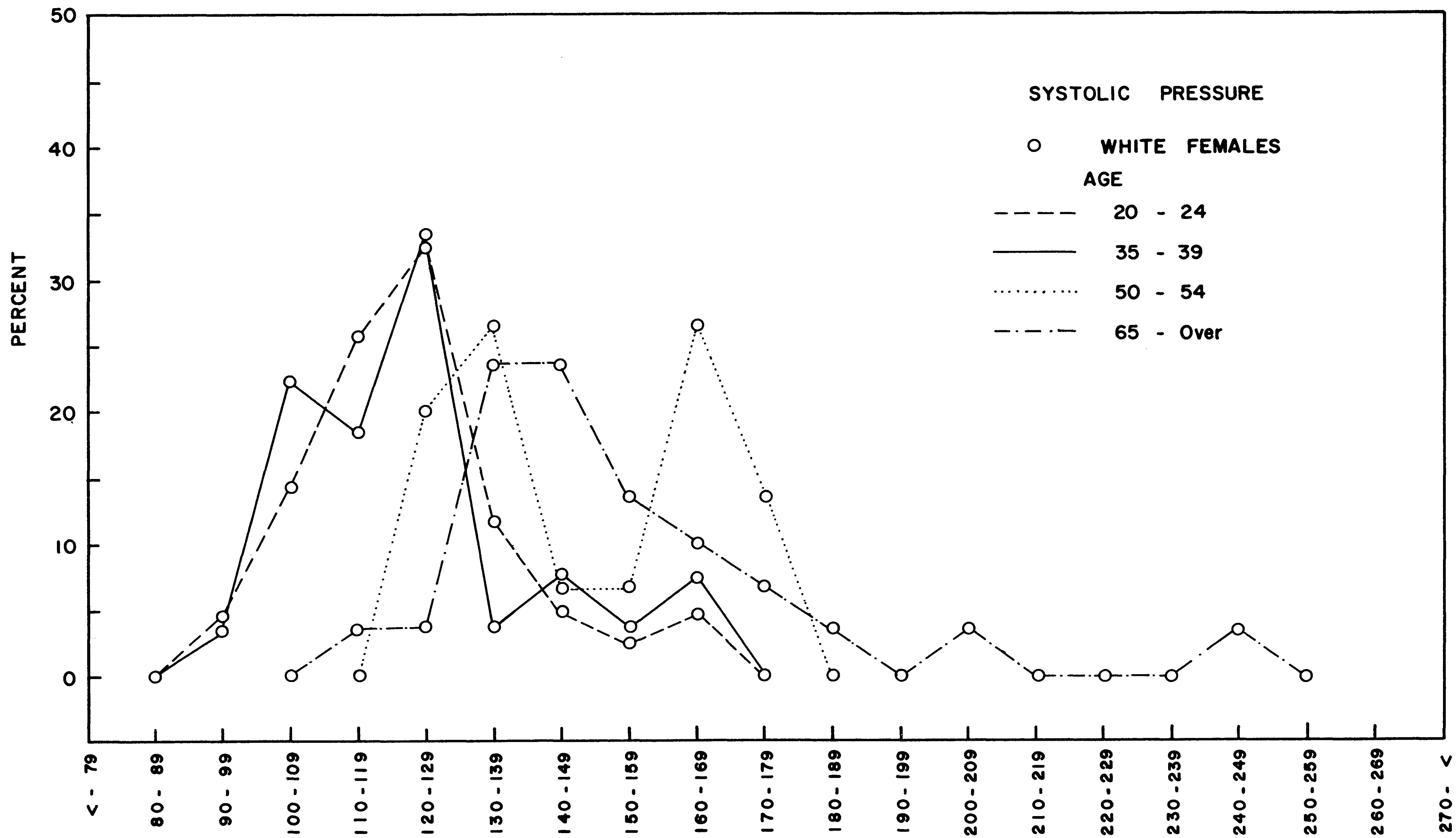

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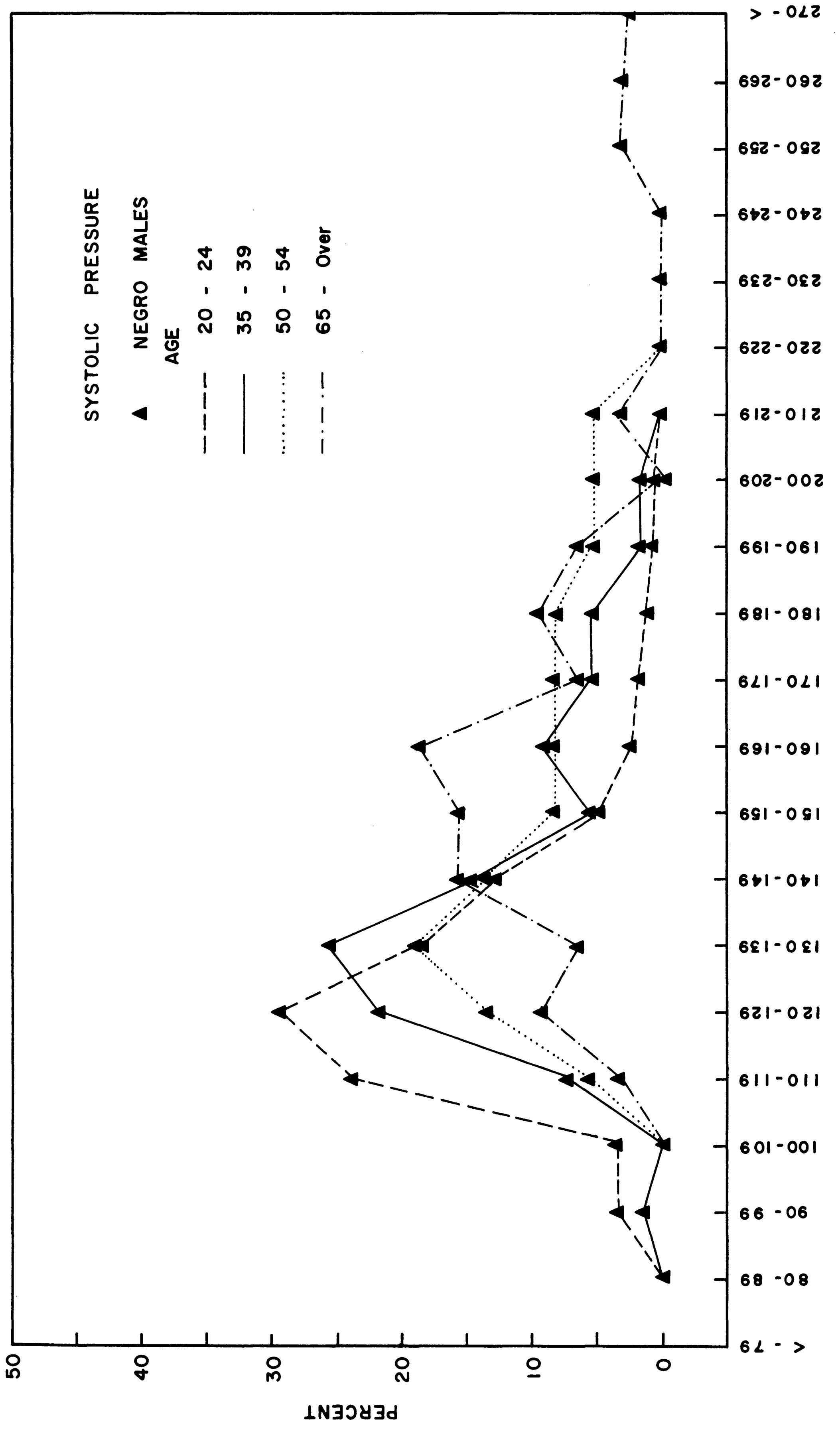

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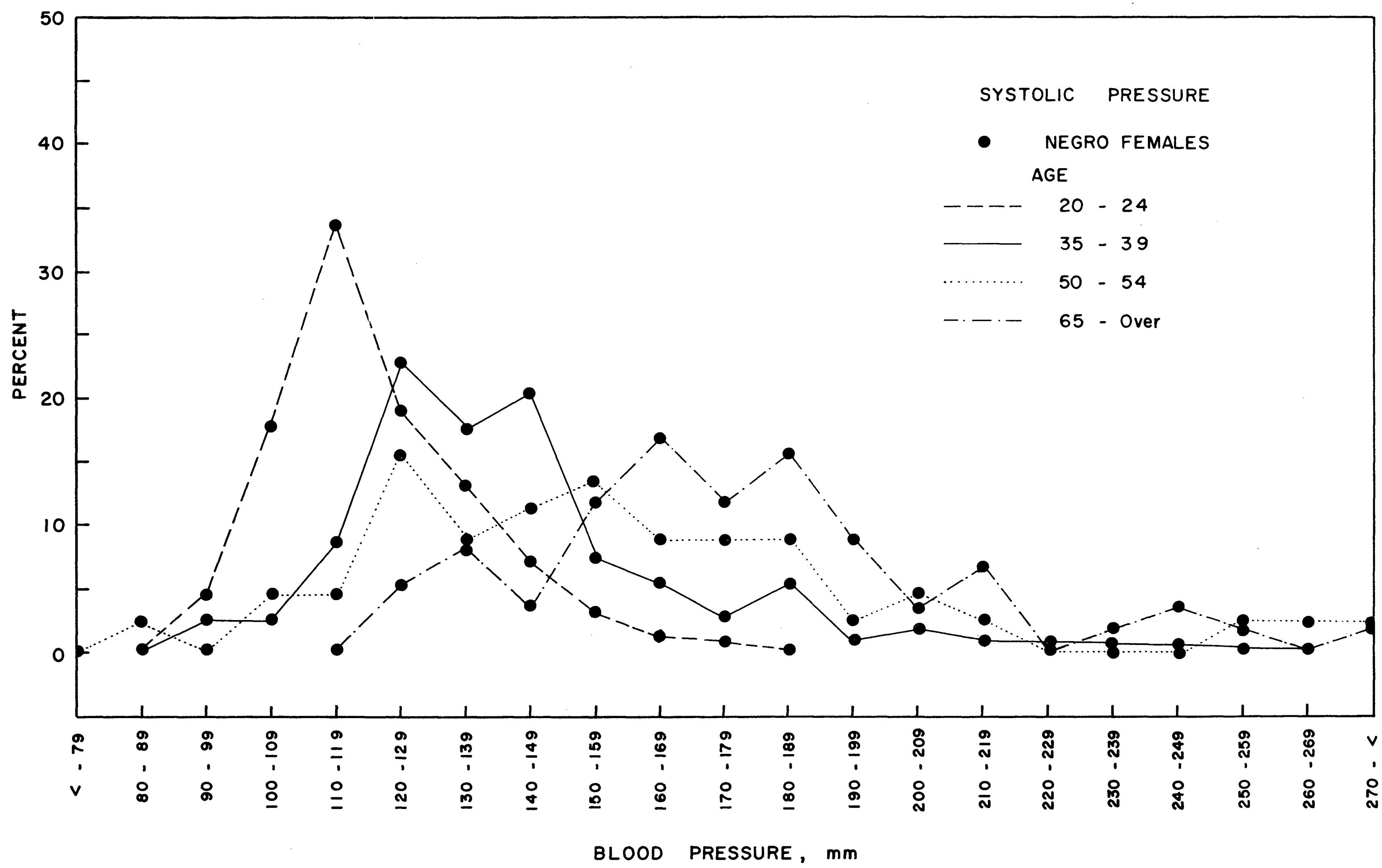


Figure 7.1 (Cont'd)

The standard deviations of the distributions were calculated by multiplying the standard error of the mean by the square root of the number in the specific group. This calculated deviation has been based on the assumption of a low intra-class correlation, since the calculation contains components of variation due to differences between strata, units and households in addition to variation between individuals within age-sex-race specific groups.

Boe's exhaustive work in Norway provides the best basis for comparison. His findings were that the distribution standard deviations as well as the means show an orderly progression from the youngest age group to the oldest (with some diminution in the very old). To demonstrate this relationship a ratio of the distribution standard deviation to its corresponding mean (coefficient of variation) has been calculated. If this ratio remains constant, the standard deviation of the distribution is increasing or decreasing in direct relationship with the magnitude of the mean. If the coefficient of variation increases, the distribution standard deviation is increasing proportionately more rapidly with age than is the mean.

In Boe's[1] study as well as Comstock's[3] the latter effect is noted for systolic pressures, i.e., that the distribution standard deviation increases proportionately more with age than does the mean. The present study shows this same trend for systolic pressures. Diastolic pressures follow this pattern only for Negro males. Boe's and Comstock's works also show a trend toward stability of coefficients of variation in regard to diastolic pressure.

In regard to the distribution standard deviations in the present study and the two studies mentioned, it is seen that the range of magnitude is roughly similar in spite of differences in numbers of persons studied. This similarity would be expected, since the dispersion of blood pressures at a given age might be expected to be generally similar even though values of the means might vary to some extent.

It might be mentioned at this point that the above two studies risk a considerably greater potential bias as a result of nonrespondents in the population than does the present study. This does not imply that their results are in error, but only that the risk of error is greater.

In this section, then, it has been seen that the means and standard deviations of the distributions of systolic pressure all progress upward with age. A general similarity is noted with two similar studies. The increasing trend with age is seen to be proportionately greater for the standard deviations of the systolic distributions than for their corresponding means. The same parameters for the diastolic distributions fail to demonstrate a similar trend, since the means progress upward with age while the standard deviations are quite variable. However, it is felt that a slight trend similar to the systolic pressure trend is present.

Means of the distributions for several studies will be compared in a later section. This trend of coefficients of variation enables one to predict that the curves of systolic pressure at a given age will become more platykurtic as age progresses. In addition to flattening, a positive skewness becomes evident with increasing age, as will be seen in the following section. One might also predict that the diastolic curves will show a lesser trend toward flattening and skewness.

diastolic means). It is also true that the true variability (between persons) of blood pressure increases with age as well as the means themselves. These seem to be the most important reasons for this observed phenomenon.

B. Graphs of the Distributions

In studying the graphs of mean blood pressures by age (Figure 7.2), two aspects are considered: 1) the magnitude of the respective means, and 2) the general configuration of the line.

1. White Race

Considering first the white race separately, the general configuration of the systolic pressure line with age shows a definite sigmoid curve in both sexes. These curves (reading to mid-points of age groups) cross in only two places, at: 1) about age 13, and 2) about age 38. These crossover points result from females having slightly higher systolic pressures prior to age 13, males then having considerably higher average pressures to age 38, and finally female pressures becoming markedly higher than the male after that age.

The male curve rises sharply to an adult level by age 17, then remains relatively stable until about 40 years of age after which it rises slowly. The female curve shows that the adult level is reached at about the same time as the male, but the early adult plateau is lower, hovering at about 120 from age 17 to 37. The corresponding male plateau is closer to 130 during this period. Between the ages of 37-42

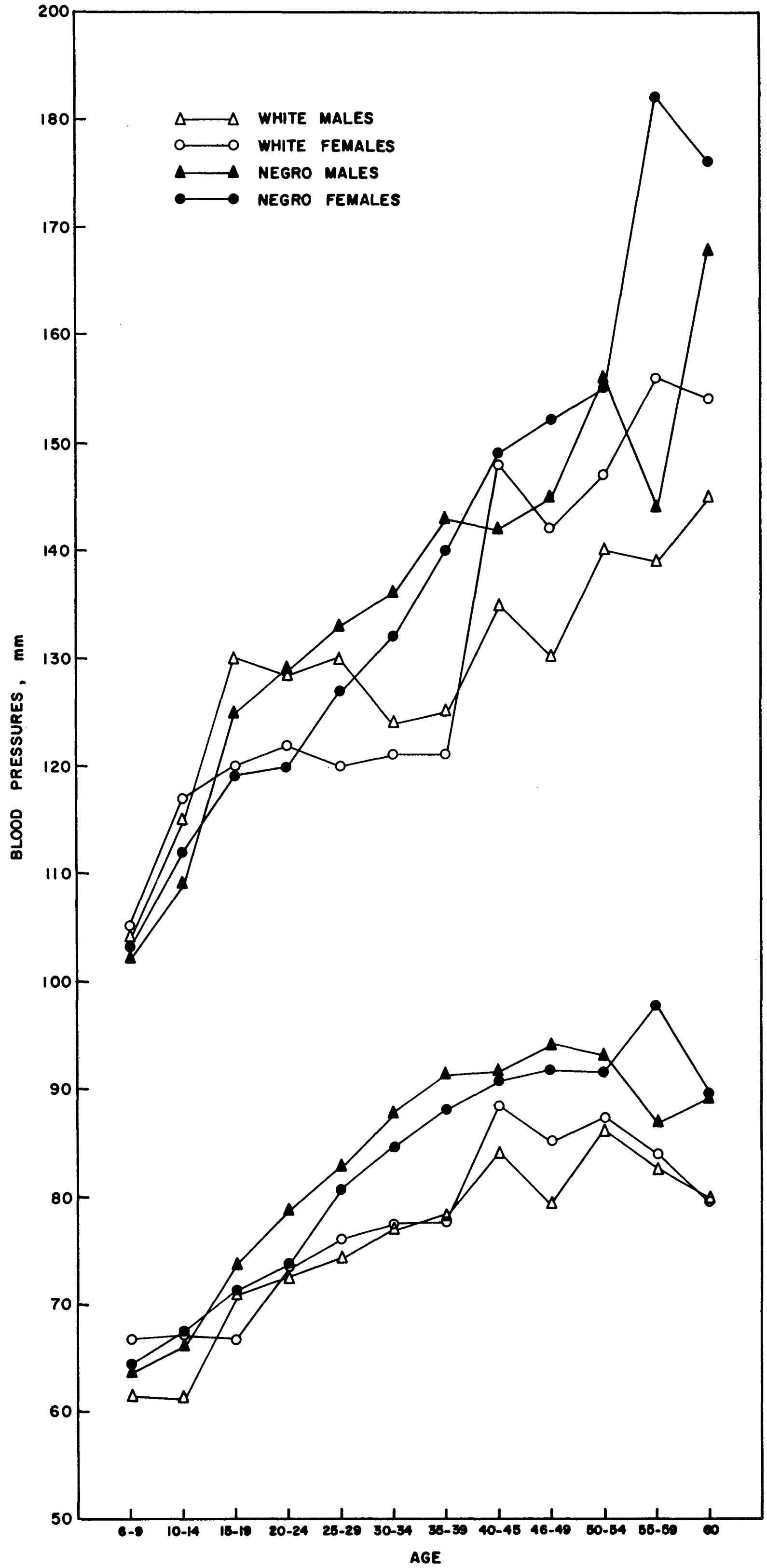


Figure 7.2 Mean Systolic and Diastolic Blood Pressure by Sex, Race, and Year Age Group. White and Negro Races, Nassau, 1958.

a sharp rise in systolic mean occurred in the white female group. The means for the females after this age are not markedly different from the Negro male, but still lower than the Negro female. This sharpness has not been noted by other investigators. It is possible that the magnitude of this increase may be made more apparent by sampling variation. However, the standard errors of these means show that a true increase does occur at this time. After the age of 42, the female curve progresses upward slowly.

Substantiating evidence for these configurations is found in the analysis of break-points (proportion greater than 150 mm. systolic) as shown in Figure 8.1. Here the crossover points are less distinct, but the configurations are substantially the same.

The curve for diastolic pressure means shows little difference between the sexes. The range of the means is only about 20 mm., which tends to mask any differences. However, the same crossover points are present. The cross-over at puberty is now followed by a zone of no difference between sexes until the point of cross at age 38, after which the female is considerably higher. This is further illustrated in Figure 8.1 by the break-point graph (proportion greater than 100 diastolic).

Comparing sexes by mean pulse pressures in relation to age (Figures 7.3 and 7.4) shows much the same relationship

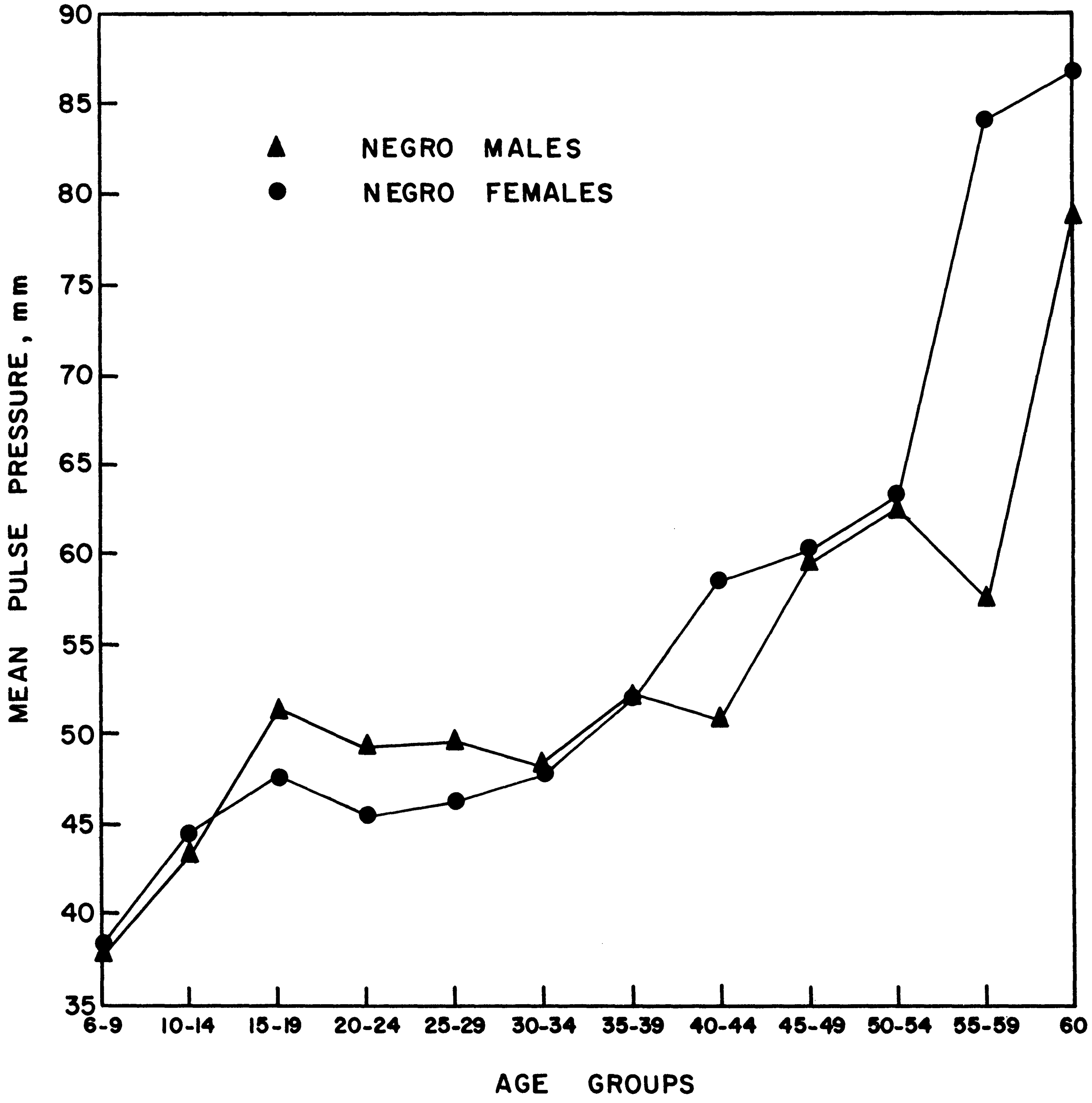


Figure 7.3 Mean Pulse Pressure (Systolic-Diastolic V) (First Reading) by Sex and Age, Negroes, Nassau, 1958.

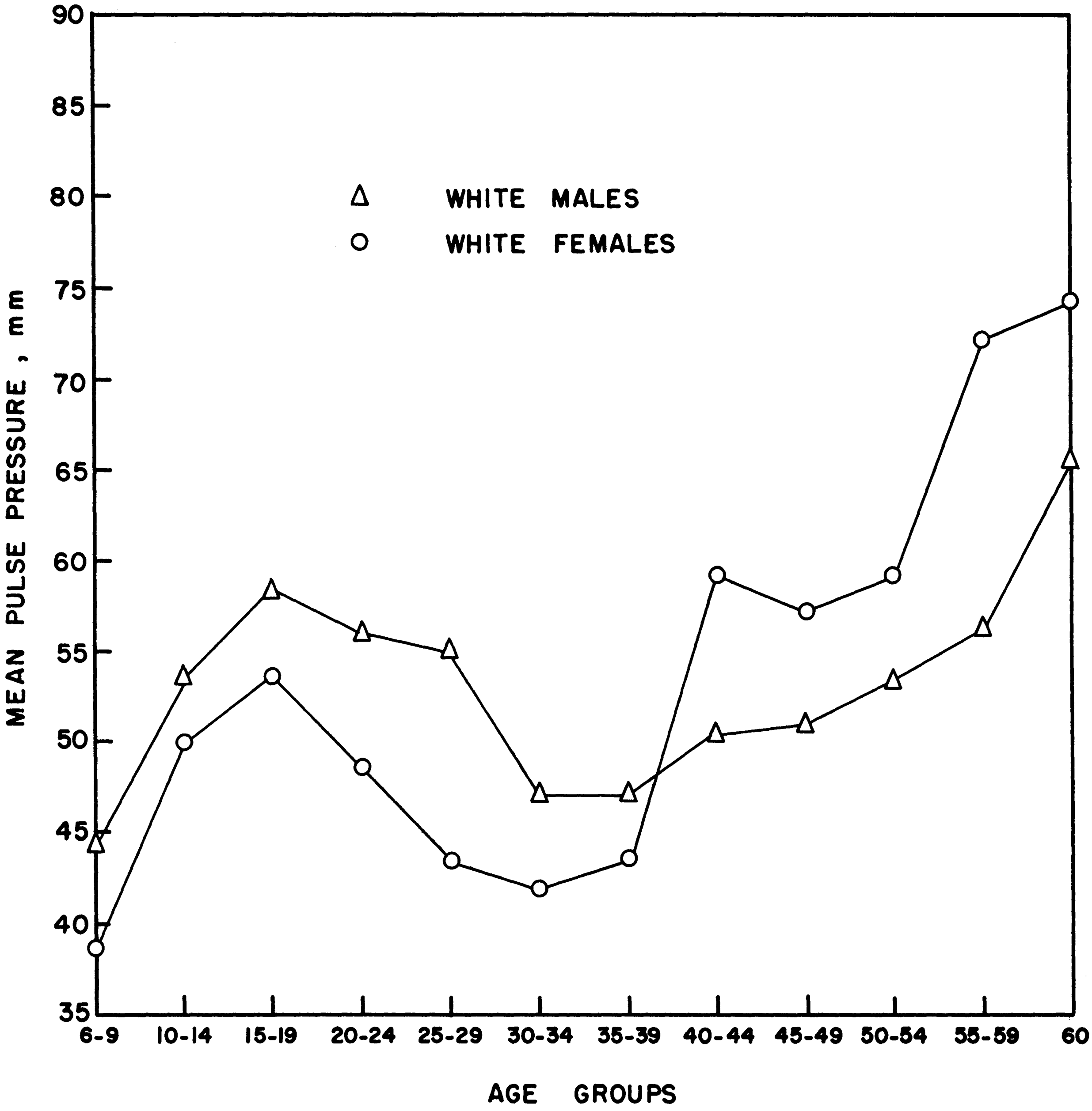


Figure 7.4 Mean Pulse Pressure (Systolic-Diastolic V) (First Reading) by Sex and Age, White Race, Nassau, 1958.

except that the adolescent crossover is obliterated because of comparatively lower diastolic means in these young ages. The general configuration is retained, however, and shows an even deeper S-shaped curve. The point of cross in middle life remains the same.

2. Negro Race

It is of notable interest that the mean systolic pressure histograms for Negroes have few points of similarity to the white race except in childhood. In neither sex in the Negro is there any indication of a slowing down in the march of blood pressure elevation as age progresses. These curves indicate that blood pressure in the Negroes studied here progresses in an almost perfectly linear fashion from the youngest to the eldest.

The difference in the curves between the sexes seems to be much smaller than for the white race, although the same temporal relationships exist. Until puberty, the female is slightly higher, crossing the male curve at almost the identical point as that for the white race, at about age 13. After this time the male is somewhat higher until the apparently identical point of cross at about age 38.

The curve for diastolic means in the Negro shows, somewhat surprisingly, that after the pubertal crossover the male remains slightly but uniformly higher than the female until the upper ages when the curves coalesce.

3. <u>Comparison of Negro with White Race</u>

It has been noted that the configuration and slope (magnitude) of the systolic curve is markedly different between the races. These differences include: a) linear progression of the curves in the Negro as contrasted with the plateau effect seen in the white; b) slightly lower levels for Negroes than whites until late adolescence when the white plateau begins and the Negro curve continues to rise; c) diminution of sex difference as to blood pressure in the Negro as compared to the white, while the major points of cross in the sex curves remain almost identical.

The comparison of races in the diastolic curves is somewhat different. The range of means for the Negro is only about 30 mm., while in the white the range is about 20 mm. In this restricted range the race-sex curves do not show such a manifest difference in configuration as in the systolic curves. However, after adolescence the Negro is consistently higher than the white. Sex differences are less distinct, but still present in the white. The same basis crossover points hold but there is diminution of sex differences during the early adult plateau. In the Negro significant crossover points are less evident and the male is slightly higher in almost all ages.

Pulse pressure curves demonstrate again the smaller sex difference in the Negro and the tendency to linearity in the Negro as opposed to a sigmoid curve in the white. Pulse pressure is seen to be slightly higher in the young whites (under 25-30 years) than the Negro, after which age the Negro has considerably higher mean pressures.

4. Comparison with Similar Studies

Of the many attempts as description of blood pressure patterns, most are eliminated as potential sources of comparison by lack of similarity in choice of study population as well as differences in procedure and methods of measurement. Relatively few have attempted to define a complete population or to utilize adequate sampling methods.

Comstock's[3] study in Georgia provides the points of comparison of 1) sampling method, 2) biracial community in same type of climate as the present study. Miall and Oldham's[13] work in Wales represents a sampling study in a community of the white race. Boe, et al.,[1] in Bergen, Norway attempted to study all of the persons in a major city. These studies are felt to be the most nearly comparable of current studies for purposes of comparison with the study here reported.

The question of major concern in this study was "Is there a real difference between the patterns seen in the Negro and white races"? The present data support an affirmative answer to this question. It must now be ascertained whether this is a finding restricted to a comparatively isolated group, geographically and genetically, or if there is a comparable pattern present in racial counterparts elsewhere in the world.

Figure 7.5 describes the pattern for Negroes in Comstock's study in Georgia. These persons would seem to be very similar in racial origin (West Africa) to the Bahamian Negro, although isolated geographically from each other for over 100 years. From the appearance of these mean blood pressures by age group curves, they indeed appear to come from the same population. In the systolic curves, the same unrelenting linearly upward progression is seen except for a slight wave in the young adult female. This may be due to sampling variation or small numbers in the group. It is of interest to note that the major point of cross of the female over the male curve is at precisely the same point for both sets of data. However, Comstock's mean pressures apply to a ten year age group. The present data was converted to the same measure with the consequence that the crossover point is moved slightly to the left or to a younger age (about 36).

Comparison of the Georgia Negroes' diastolic curve with the Bahamian Negroes' shows even less difference. The Bahamians seem to be slightly higher at the upper extreme of age, but this is of doubtful significance.

Such a degree of similitude between two studies done at different times and places, using slightly different methods is truly surprising. Since, however, both studies were performed on seemingly valid population samples, one is encouraged to believe that this represents a fair picture of the blood pressure distribution by age and sex for Negroes of West

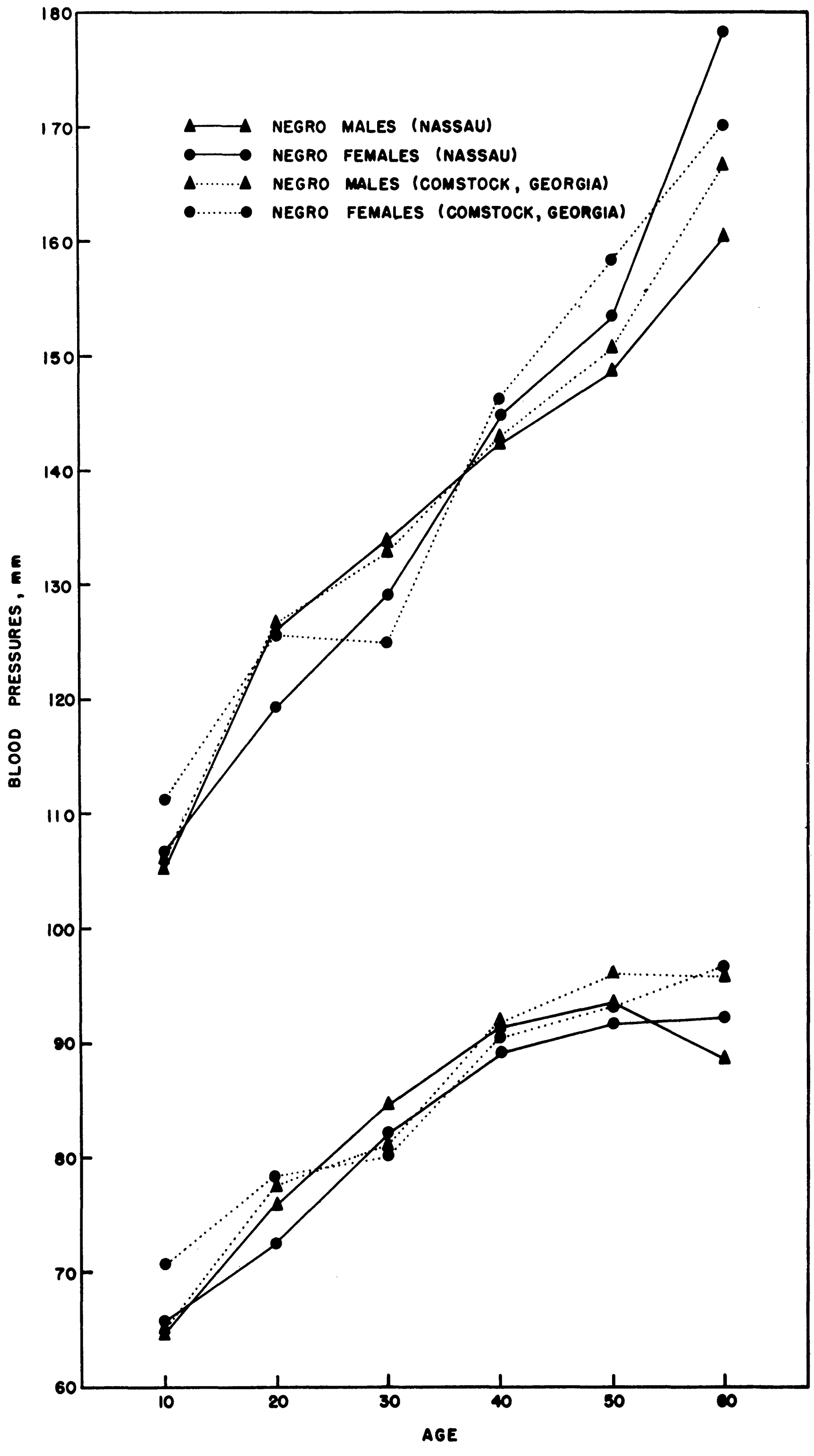


Figure 7.5 Mean Systolic and Diastolic Blood Pressures by Age Group. Negro Race, Nassau, 1958 and Georgia (Comstock[3]).

African descent. One must remember, unfortunately, that the fact of one study supporting another is similar to the house of cards where one card supports another. One additional card (or study) may be disastrous. Two other investigations are currently being done on the Negro race, one in Liberia and another in the Caribbean. The results of these will clarify the present knowledge regarding the Negro race.

Preliminary data of one of these, that of Page, Corcoran and Schneckloth (unpublished), done on the island of St. Kitts in the Leeward Islands is shown in comparison with Nassau Negroes in Figure 7.6. Although there were considerable differences in the method of study, the general similarity of the curves for systolic and diastolic means is evident. Disregarding minor differences in degree, the linear configuration of the St. Kitts Negro systolic means by age group is similar to that shown for Bahamian and Georgia Negroes.

The similarity in blood pressure findings in the Negro in these three studies in different areas suggests that there is no underlying cause related to geographical location or environment which would account for this elevated pattern in the Negro. It must now be seen if this is also true of the white race.

The numbers of white persons seen in the present study are considerably smaller than the Negro. However, it is seen that standard errors of the means for age-sex groups were sufficiently small to permit comparison.

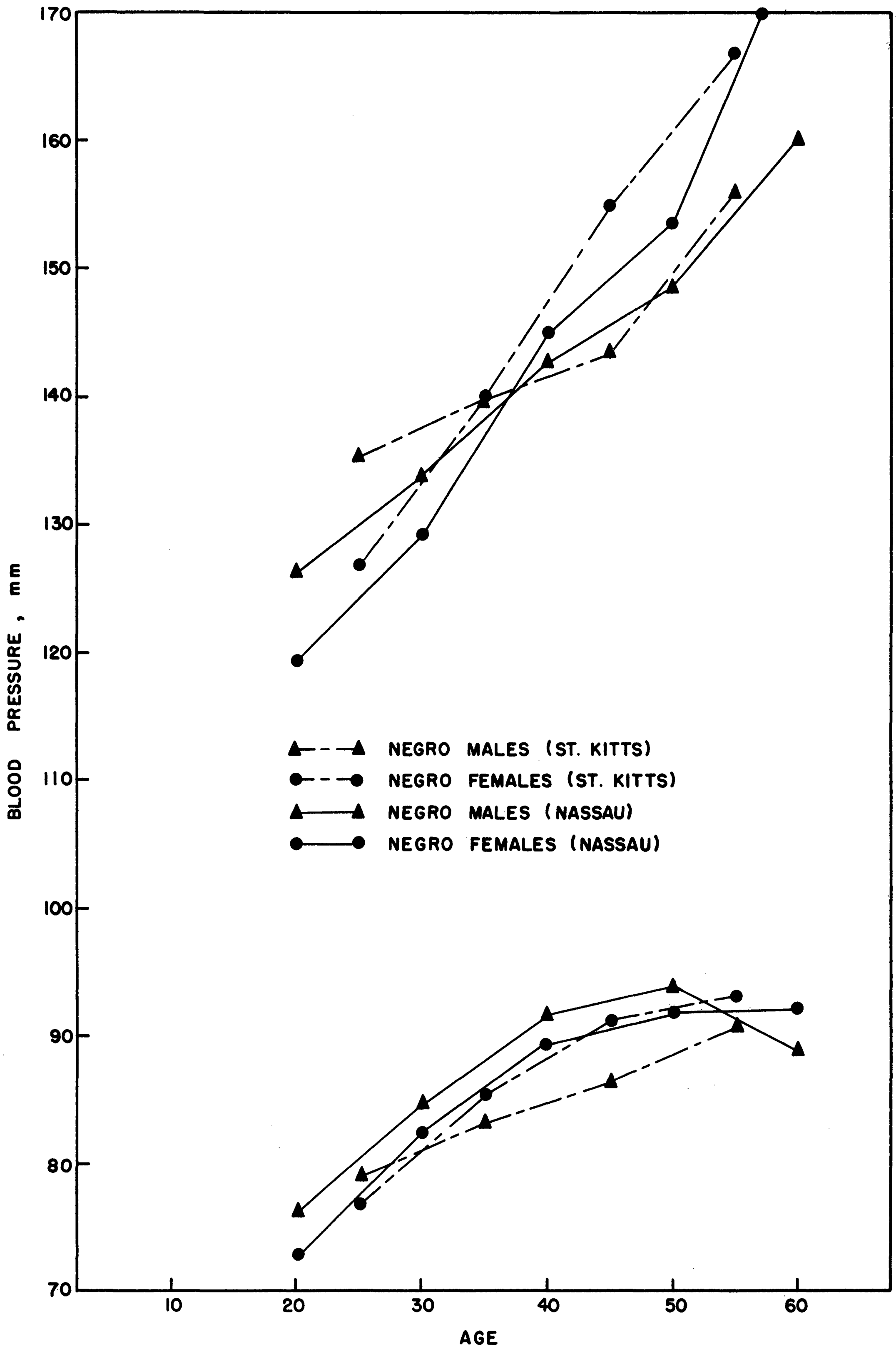


Figure 7.6 Mean Systolic and Diastolic Blood Pressures by Sex and Age Group. Negro Race, Nassau, 1958, and St. Kitts, Leeward Islands (Corcoran and Schneckloth[4] 1958).

In Figure 7.7 the Bahamian white persons are compared with the white persons in Comstock's Georgia study. The curve for Bahamians for systolic pressure is seen to be of generally similar configuration (sigmoid in shape rather than linear). However, the crossover point is considerably delayed in the Georgia white persons (about age 43). Also, after the crossover the sex difference is greatly reduced. There also appears to be a significantly higher systolic curve for Bahamians than for the Georgians. This is apparent for the female sex where the lines run parallel for the entire age curve. In the male systolic curves this difference is less distinct with convergence of the two curves in the young and in the old. In the diastolic curves no apparent difference is seen. The configuration is similar and the sex curves for Bahamians fall midway between their Georgia counterparts. The considerable difference between the sexes in the diastolic pressure curves seen in the Georgians is not found in the Bahamians.

In viewing these curves one hesitates to attach significance to systematic differences of the magnitude seen in the systolic curves. It will be seen later that in the Norwegian study (Boe, et al.[1]) that two large samples from the same population showed, inexplicably, a systematic difference. It seems likely that slight differences in methodology may partially account for the differences between the Georgia

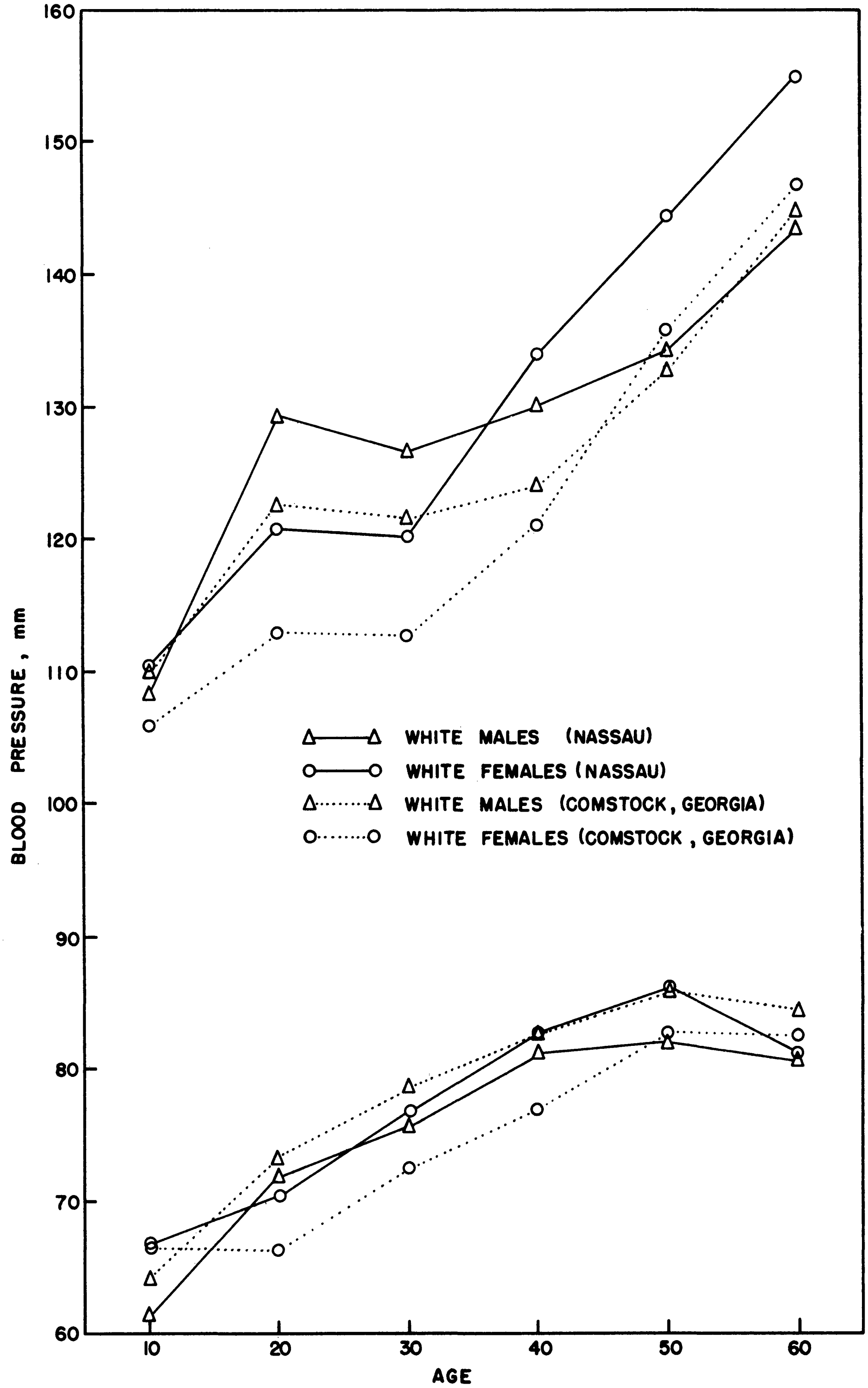


Figure 7.7 Mean Systolic and Diastolic Blood Pressures by Age Group, White Race, Nassau, 1958 and Georgia (Comstock[3]).

Negroes and the Bahamian Negroes. Perhaps the most important feature to compare is configuration which is generally similar except for the points noted.

Although the Georgia white community studied might be expected to be primarily of Anglo-Saxon origin (as are the Bahamians), it is of interest to compare the Bahamian white persons with those in other parts of the world.

Miall and Oldham's[13] work in Wales provides data which are shown in Figure 7.8. There is a remarkable agreement in both magnitude and configuration in the curves for systolic and diastolic means by age group.

The largest single group of white persons for comparison is that of Boe, et al.[1] in Norway. This study is more truly a population study than many others. It encompasses a large segment (75-80%) of an entire large city. In spite of large numbers, it is still hindered by the unmeasured portion of the people (nonrespondents) in regard to interpretation of results, just as in a sampling survey. This fact is borne out by the difference between the first half of Boe's data and the second half. These two groups in Boe's study are not actually different samples but are parts of the same population studied separately. The first group represents those studied in the first portion of the study and the second group is the remainder of the study. Theoretically they represent the same population, separated only by time of presentation for examination. It is not known if

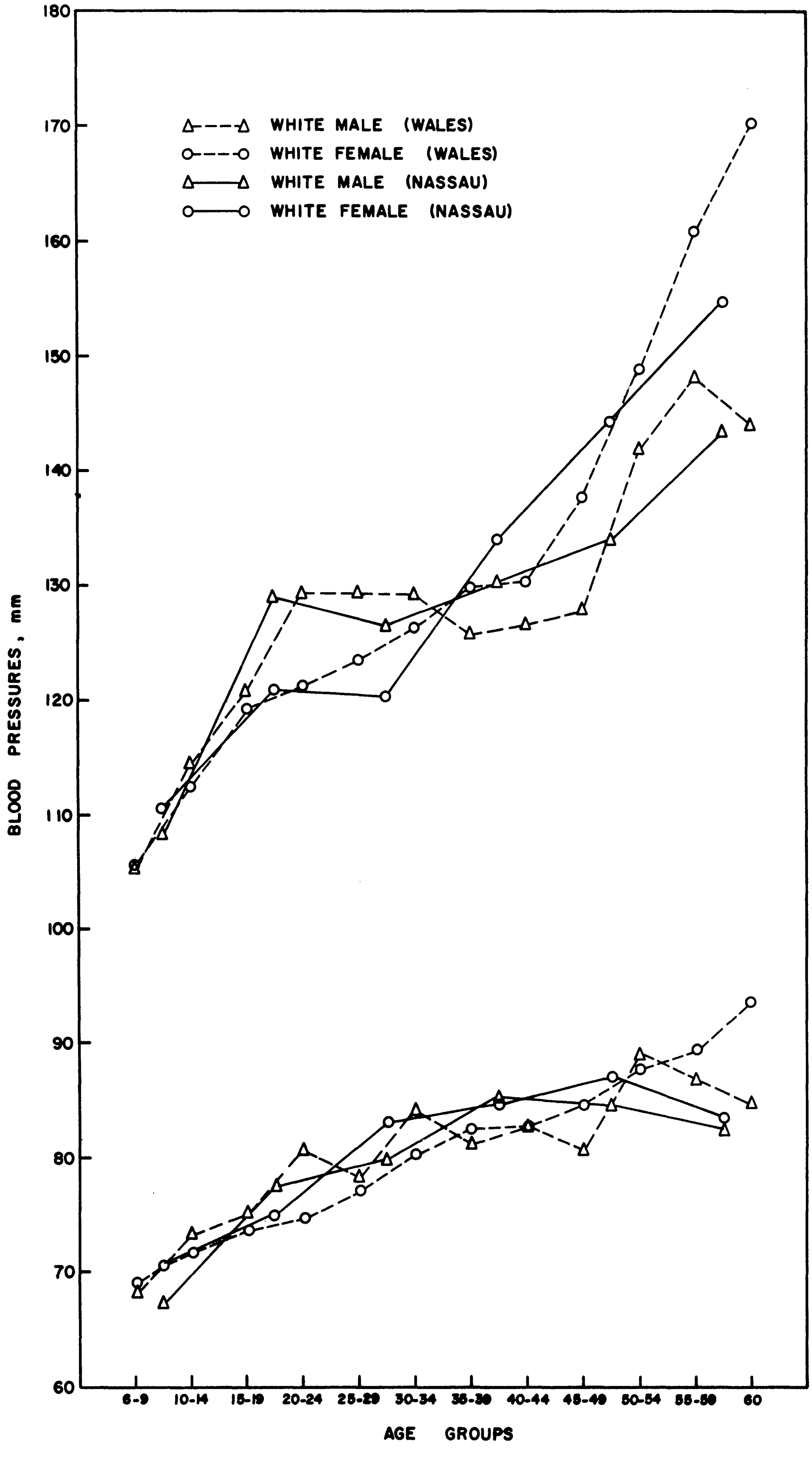


Figure 7.8 Mean Systolic and Diastolic* Blood Pressure by Sex and Age Group. White Race, Nassau, 1958 and Wales (Miall and Oldham[12])
*(Fourth Phase Diastolic).

these two groups represent different types of people, or if a possible methodological difference was present. It seems that a more true picture of the distribution would have been shown by pooling the two groups. Conceivably, the unmeasured portion of the population could show a still different pattern. The two groups are shown in Figures 7.9 and 7.10, and the Nassau white sample is contrasted, sex specifically.

Whatever the reason for the systematic difference in Boe's study, evidenced in both male and female histograms for means of systolic and diastolic pressure by age group, the data for Nassau whites show the following points of comparison: 1) systolic curves show the same general configuration as the Norwegian data; 2) Nassau white male systolic curve seems to approximate quite closely in magnitude the second group of the Norwegian, while the Nassau white female curve strikes midway between Boe's two groups. In regard to diastolic pressure the Nassau males are slightly but uniformly lower than the Norwegian, while the Nassau white females approximate Boe's except in the extremes of age.

C. Summary

In this section has been presented the accumulated data regarding distributions of systolic, diastolic and pulse pressure in the Nassau study. Distributions have been compared for Negro and white

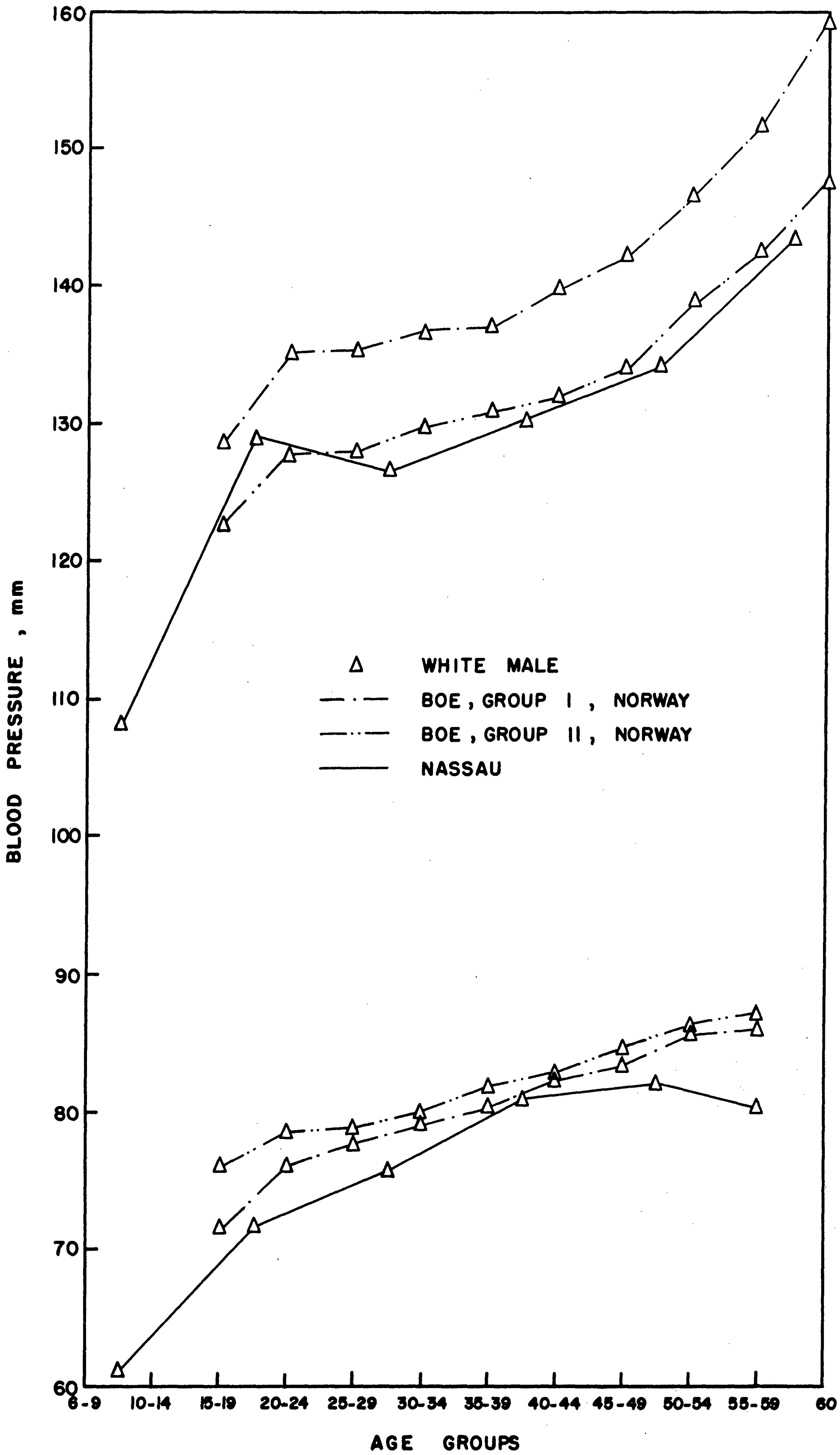


Figure 7.9 Mean Systolic and Diastolic Blood Pressure by Age Group. White Males, Nassau, 1958 and Bergen, Norway (Boe[1]).

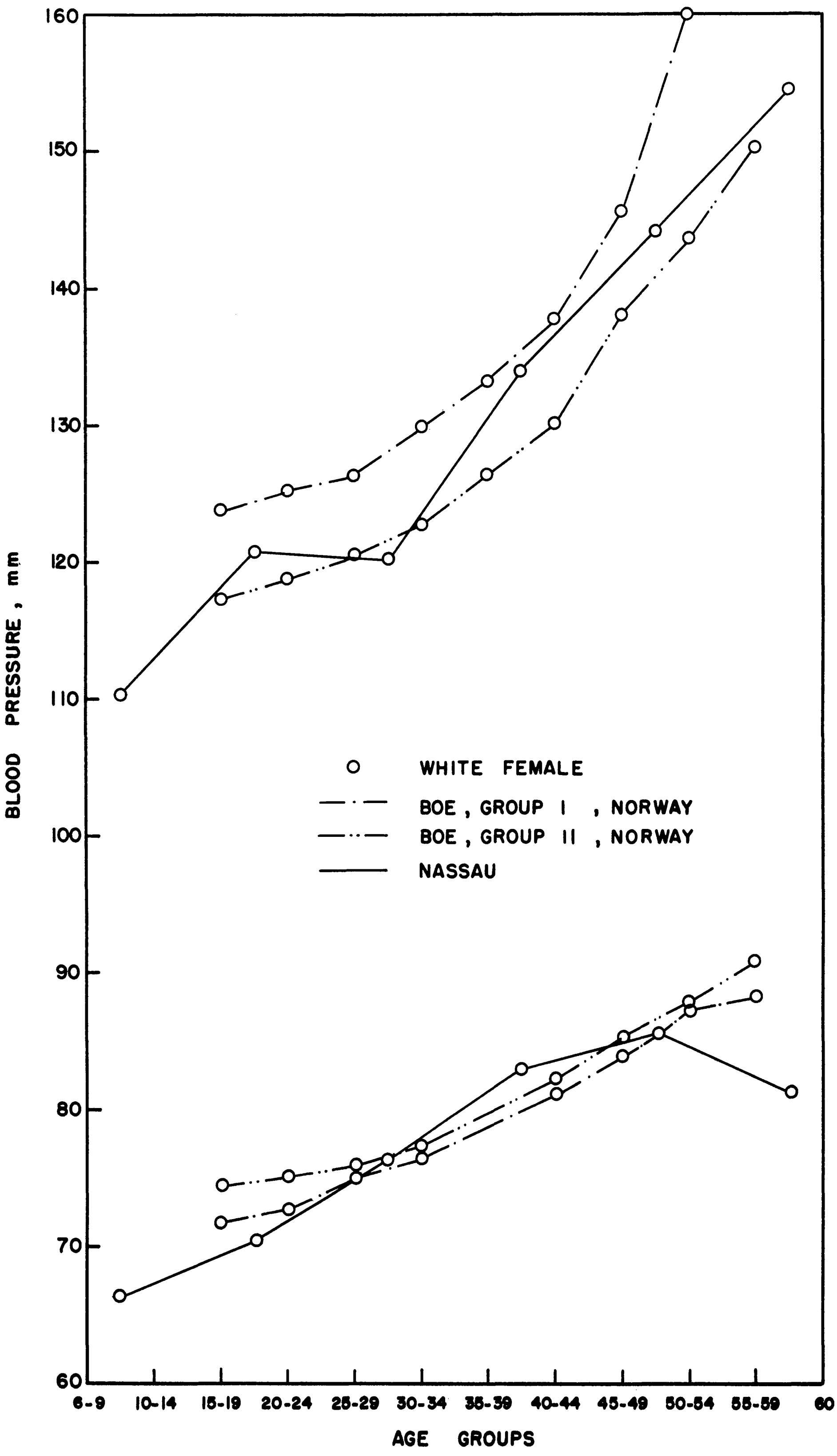


Figure 7.10 Mean Systolic and Diastolic Blood Pressures by Age Group. White Females, Nassau, 1958 and Bergen, Norway (Boe[1]).

races and for the male and female sexes. Standard errors of means and of the distributions within age-sex-race specific groups have been shown. The principal points of contrast were:

1. Systolic means progress upward with age, almost linearly upward in the Negro from childhood to the oldest groups measured. The white race shows a more sigmoid curve attaining an "adult" level of systolic pressure slightly earlier and resting in a plateau until middle life, then continuing the upward progression.
2. Diastolic means progress with age in a much more restricted range, but both races showing approximately the same configuration. The Negro is only slightly higher than the white.
3. Sex differences were somewhat similar between races, especially in systolic means. The curves cross in adolescence and again in middle life. It is of interest that these crossover points are almost identical for the two races. Sex differences in the diastolic are less distinct. The cross points are still present in the white diastolic curve but almost indistinguishable in the Negro. These differences in pressure in regard to sex appear somewhat smaller generally in the Negro than in the white, principally because of the greater difference in white persons after middle life when the female systolic curve becomes much higher than the male.

4. The pulse pressure curves reflect the same general relationships in regard to configuration. The sex differences are now apparent in the white and less distinguishable in the Negro.

The Nassau data were then compared to other studies of similar nature in other parts of the world. The point of greatest interest is that the blood pressure curves for the races are quite comparable to those of similar racial groups studied elsewhere. This suggests that there is not an environmental factor present here (for example, salt intake) which is not present elsewhere which may possibly elevate blood pressures. Although these people, both white and Negro, have been somewhat of a geographic and genetic isolate for more than 100 years, they still retain the blood pressure features characteristic of their race.

It is still possible, of course, that an environmental factor is common to all populations studied, which in some way affects blood pressure. On the basis of the comparisons mentioned, however, it seems more logical to think in terms of a true racial difference rather than an environmental difference.

CHAPTER VIII

ANALYSIS OF SPECIFIC BREAK POINTS OF BLOOD PRESSURE

Data shown in the previous chapter illustrate again the belief of Pickering[15] regarding the continuous distribution of blood pressure and the lack of any indication that hypertensive persons differ in any way from "normal" persons except in degree. There was no break in the distribution to suggest two separate populations, e.g., hypertensive and normal. Nevertheless, to describe proportions of the population above certain arbitrary break points of blood pressure may be helpful as a further descriptive measure of these distributions. Break points, e.g., 150mm. systolic or 100mm. diastolic, are used clinically in orientation of thinking and in therapy. There are, of course, differences in thinking in this regard and differing reference points are used. Perhaps the most commonly used cutting points are the 150/100 and 140/90 readings, singly or in combination. These will be used in the present analysis. However, in the Appendix Table A the full distribution of systolic by diastolic readings are shown in order that later investigators may choose almost any point of reference desired. In these tables, the total data were classified by 5mm. diastolic groups and 10mm. systolic groups. Each five year age group in each race is tabled separately.

A. Break Points Considered Singly

The tables were then studied in regard to specific break points, e.g., all over 140 systolic. The results are shown in Table 8.1 and shown graphically in Figure 8.1. It is seen that in these figures, the general configuration of the lines mimics those in the

Table 8.1

PROPORTIONS IN AGE-SEX GROUPS WITH DIASTOLIC BLOOD PRESSURES GREATER THAN 90 AND 100
Negro Race, Nassau, 1958

Diastolic Break-Points (Colored Race)
(Unadjusted)

Negro Male

	90 or over		100 or over		N
Age	Number	Prop.	Number	Prop.	
6-9	0	0	0	0	154
10-14	2	1.40%	0	0	143
15-19	13	9.35%	3	2.16%	139
20-24	25	20.32%	11	8.94%	123
25-29	31	31.63%	14	14.29%	98
30-34	19	32.76%	12	20.70%	58
35-39	33	60.00%	15	27.27%	55
40-44	32	47.76%	20	29.85%	67
45-49	45	67.16%	22	32.84%	67
50-54	21	56.76%	11	29.73%	37
55-59	8	50.00%	3	18.75%	16
60+	17	51.52%	8	24.24%	33
	246		119		990

Negro Female

	90 or over		100 or over		N
Age	Number	Prop.	Number	Prop.	
6-9	1	0.60%	0	0	166
10-14	3	2.16%	0	0	139
15-19	12	7.84%	4	2.61%	153
20-24	26	15.29%	10	5.88%	170
25-29	35	27.34%	16	12.50%	128
30-34	25	27.07%	13	15.12%	86
35-39	50	45.87%	18	16.51%	109
40-44	41	47.13%	29	33.33%	87
45-49	37	49.33%	19	25.33%	75
50-54	28	60.87%	17	36.96%	46
55-59	21	70.00%	10	33.33%	30
60+	29	47.54%	19	31.15%	61
	308		155		1250

Table 8.1 (Cont'd)

PROPORTIONS IN AGE-SEX GROUPS WITH SYSTOLIC BLOOD PRESSURES
GREATER THAN 140 AND 150
White Race, Nassau, 1958

Systolic Break-Points (White Race)

White Male

	140 or over		150 or over		N
Age	Number	Prop.	Number	Prop.	
6-9	0	0	0	0	45
10-14	1	3.57%	1	3.57%	28
15-19	8	24.24%	3	9.09%	33
20-24	10	29.41%	3	8.82%	34
25-29	8	26.67%	0	10.00%	30
30-34	8	21.05%	0	0	38
35-39	5	22.73%	2	9.09%	22
40-44	7	31.82%	5	22.73%	22
45-49	7	35.00%	5	25.00%	20
50-54	7	50.00%	4	28.57%	14
55-59	4	36.36%	3	27.27%	11
60+	15	53.57%	10	35.71%	28
	80		39		325

White Female

	140 or over		150 or over		N
Age	Number	Prop.	Number	Prop.	
6-9	0	0	0	0	47
10-14	2	5.56%	1	2.78%	36
15-19	2	6.45%	0	0	31
20-24	5	11.63%	3	6.98%	43
25-29	2	5.13%	1	2.56%	39
30-34	4	12.12%	3	9.09%	33
35-39	5	18.52%	3	11.11%	27
40-44	15	60.00%	11	44.00%	25
45-49	9	45.00%	7	35.00%	20
50-54	8	53.33%	7	46.67%	15
55-59	10	62.50%	8	50.00%	16
60+	20	66.67%	13	43.33%	30
	82		57		362

Table 8.1 (Cont'd)

PROPORTIONS IN AGE-SEX GROUPS WITH SYSTOLIC BLOOD PRESSURES GREATER THAN 140 AND 150
Negro Race, Nassau, 1958

Systolic Break-Points (Colored Race)
(Unadjusted)

Negro Male

	140 or over		150 or over		N
Age	Number	Prop.	Number	Prop.	
6-9	1	0.65%	0	0	154
10-14	5	3.50%	0	0	143
15-19	20	14.39%	11	7.91%	139
20-24	27	21.95%	11	8.94%	123
25-29	36	31.63%	19	19.39%	98
30-34	17	29.31%	13	22.41%	58
35-39	24	43.64%	16	29.09%	55
40-44	29	43.28%	18	26.87%	67
45-49	41	61.19%	27	40.30%	67
50-54	23	62.16%	18	48.65%	37
55-59	9	56.25%	8	50.00%	16
60+	27	81.82%	22	66.67%	33
	254		145		990

Negro Female

	140 or over		150 or over		N
Age	Number	Prop.	Number	Prop.	
6-9	1	0.60%	0	0	166
10-14	1	0.70%	0	0	139
15-19	9	5.88%	5	3.27%	153
20-24	21	12.35%	9	5.29%	170
25-29	27	21.09%	14	10.94%	128
30-34	27	31.40%	16	18.60%	86
35-39	47	43.12%	25	22.94%	109
40-44	48	55.17%	37	42.53%	87
45-49	43	57.33%	33	44.00%	75
50-54	29	63.04%	24	52.17%	46
55-59	26	86.66%	24	80.00%	30
60+	53	86.89%	51	83.61%	61
	332		238		1250

Table 8.1 (Cont'd)

PROPORTIONS IN AGE-SEX GROUPS WITH DIASTOLIC BLOOD PRESSURES
GREATER THAN 90 AND 100
White Race, Nassau, 1958

Diastolic Break-Points (White Race)

White Male

	90 or over		100 or over		N
Age	Number	Prop.	Number	Prop.	
6-9	0	0	0	0	45
10-14	0	0	0	0	28
15-19	1	3.03%	0	0	33
20-24	3	8.82%	1	2.94%	34
25-29	3	10.00%	0	0	30
30-34	6	15.79%	2	5.26%	38
35-39	5	22.72%	2	9.09%	22
40-44	7	31.82%	3	13.63%	22
45-49	6	30.00%	1	5.00%	20
50-54	5	35.71%	1	7.14%	14
55-59	3	27.00%	0	0	11
60+	6	21.43%	4	14.29%	28
	45		14		325

White Female

Age	Number	Prop.	Number	Prop.	N
6-9	2	4.26%	0	0	47
10-14	2	5.56%	0	0	36
15-19	0	0	0	0	31
20-24	8	18.60%	2	4.65%	43
25-29	4	10.26%	1	2.57%	39
30-34	5	15.15%	3	9.09%	33
35-39	6	22.22%	1	3.70%	27
40-44	13	52.00%	6	24.00%	25
45-49	8	40.00%	3	15.00%	20
50-54	7	46.67%	1	6.67%	15
55-59	7	43.75%	4	25.00%	16
60+	10	33.33%	2	6.67%	30
	72		23		362

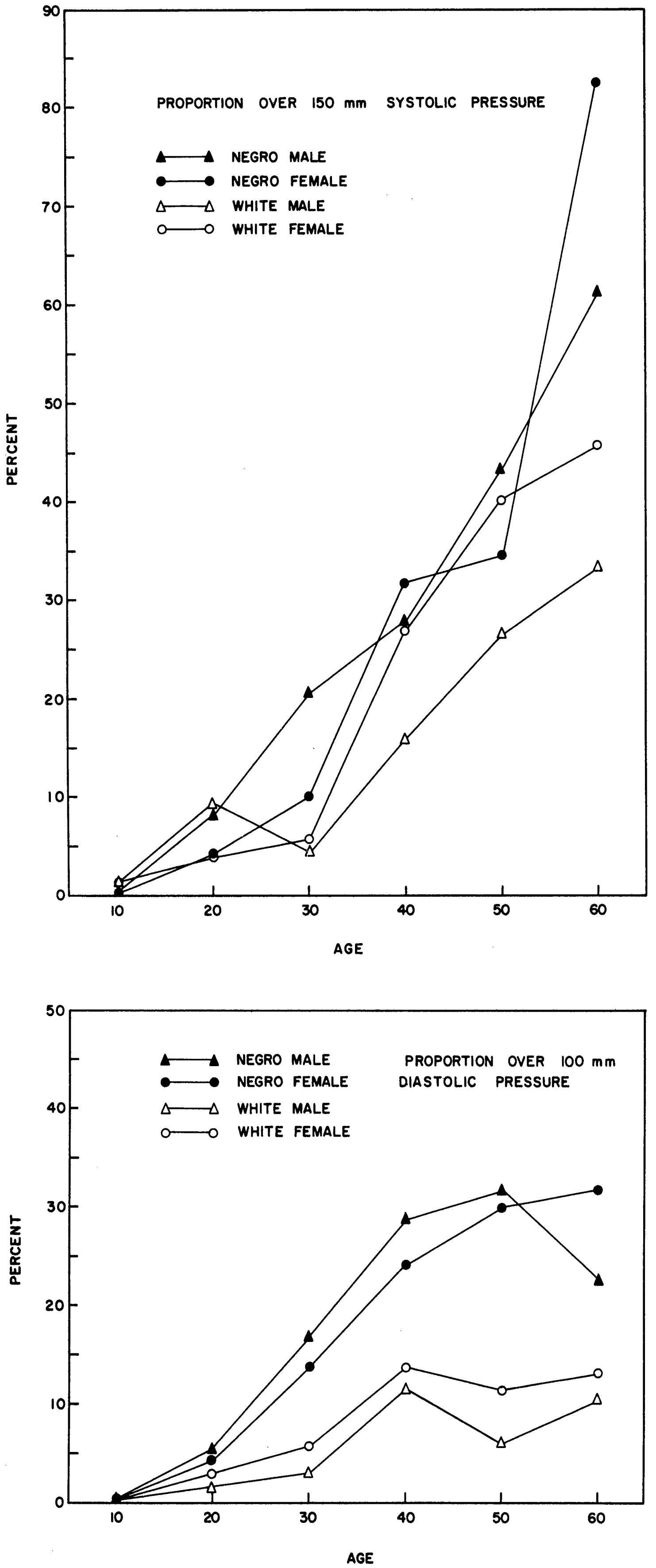


Figure 8.1 Proportion of Persons Within Age-Sex-Race Group with Blood Pressure Over Arbitrary Break Points Negro and White Race, Nassau, 1958.

graphs on the means. However crossover points are less evident, particularly in the white race.

It was seen that a composite rate over all ages for these points would be prejudiced by the differences in age and sex composition between the two races. Accordingly, the data were standardized for age and sex. The white sample population was taken as a standard and the Negro population was adjusted according to the white age and sex proportions. Then, the "expected" numbers by break point in each age group. The new totals thus generated were then used for racial comparisons.

In Tables 8.2 through 8.4 the race and sex specific rates for break points are compared. The differences between compared rates are subjected to the test for the standard error of a difference.

$$t = \frac{R_1 - R_2}{\sqrt{\frac{P_1q_1}{n_1} + \frac{P_2q_2}{n_2}}}$$

When one or both of the rates are adjusted rates, the formula for standard error of an adjusted rate is used:

$$\text{SE adjusted rate} = \Sigma\sqrt{w_i^2 \frac{P_iq_i}{m_i}} \quad \text{where}$$

$w_i = \frac{n_i}{\Sigma n_i}$ or the adjusted sample population proportions for each age group, P_i = the observed proportion over a specific break point, and m_i = the original group n on which P_i is based.

It is seen that in the racial comparisons, Table 8.2, the overall rates for Negroes are consistently higher than whites. The only difference of borderline significance is for males at the 140mm.

Table 8.2

RACE DIFFERENCES FOR PROPORTIONS ABOVE SPECIFIC BREAK-POINTS
Negro and White Races, Nassau, 1958

Race Differences (All Ages Included)

Break-Point (mm. Hg.)	Negro Male	White Male	Difference	S.E. Diff.	Diff./S.E. Diff.
Over 140S	30.66	26.23	4.43	3.05	1.45
" 150S	21.23	12.79	8.44	2.49	3.39 *
" 90D	29.15	14.75	14.40	2.71	5.31 *
" 100D	14.53	4.59	9.94	1.90	5.23 *

Break-Point (mm. Hg.)	Negro Female	White Female	Difference	S.E. Diff.	Diff./ S.E. Diff.
Over 140S	30.81	22.65	8.16	2.46	3.32 *
" 150S	23.43	15.75	7.68	2.41	3.19 *
" 90D	26.99	19.89	7.10	2.42	2.93 *
" 100D	13.84	6.35	7.49	1.67	4.49 *

Race Differences (Adults over 25 years)

Break-Point (mm. Hg.)	Negro Male	White Male	Difference	S.E. Diff.	Diff./S.E. Diff.
Over 140S	48.19	32.97	15.22	3.87	3.93
" 150S	35.41	17.30	18.11	3.22	5.62
" 90D	47.15	22.16	24.99	3.55	7.04
" 100D	24.35	7.03	17.32	2.39	7.25

Break-Point (mm. Hg.)	Negro Female	White Female	Difference	S.E. Diff.	Diff./ S.E. Diff.
Over 140S	51.76	35.61	16.15	3.46	4.67
" 150S	40.61	25.85	14.76	3.21	4.60
" 90D	43.66	29.27	14.39	3.37	4.27
" 100D	23.21	10.24	12.97	2.35	5.52

Note: 1) Age-sex standardized rates calculated for Negros.
2) * Indicates statistical significance at 5% level.

Table 8.3

SEX DIFFERENCES FOR PROPORTIONS ABOVE SPECIFIC BREAK POINTS, ALL AGES COMBINED, NEGRO AND WHITE RACES
Nassau, 1958

Sex Differences (All Ages Included)

Break Point	Negro Male	Negro Female	Difference	S.E.Diff.	Diff. / S.E.Diff.
Over 140S	30.66	30.81	0.15	2.14	0.07
" 150S	21.23	23.43	2.20	1.96	1.12
" 90D	29.15	26.99	2.16	2.24	0.96
" 100D	14.53	13.84	0.69	1.85	0.37

Break Point	White Male	White Female	Difference	S.E.Diff.	Diff. / S.E.Diff.
Over 140S	26.23	22.65	3.58	3.28	1.09
" 150S	12.79	15.75	2.96	2.86	1.03
" 90D	14.75	19.89	5.14	2.87	1.79
" 100D	4.59	6.35	1.76	1.73	1.02

NOTE: No significant differences at 5% level.

Table 8.4

SEX DIFFERENCES FOR PROPORTIONS ABOVE SPECIFIC BREAK POINTS
ACCORDING TO BROAD AGE GROUP (PRE-MIDDLE-LIFE AND POST-MIDDLE LIFE)
Negro and White Races, Nassau, 1958

Age Group	Category	White Male	White Female	Difference	S.E. Diff.	C.R.
6-39	over	21.74	7.81	13.93	3.19	4.37 *
40-60+	140S	31.58	58.49	26.91	6.75	3.99 *
6-39	over	5.22	4.30	0.92	-	-
40-60+	150S	28.42	43.40	14.98	6.68	2.24 *
6-39	over	7.83	10.55	2.72	2.61	1.04
40-60+	90D	28.42	42.45	14.03	6.67	2.10 *
6-39	over	2.17	2.73	0.56	-	-
40-60+	100D	9.47	15.10	5.63	4.59	1.23

Age Group	Category	Negro Male	Negro Female	Difference	S.E. Diff.	C.R.
6-39	over	16.88	13.99	2.89	1.73	1.67
40-60+	140S	56.36	66.56	10.20	4.31	2.37 *
6-39	over	9.10	7.26	1.84	1.04	1.76
40-60+	150S	34.09	56.52	22.43	3.19	7.03 *
6-39	over	15.97	15.98	0.01	-	-
40-60+	90D	55.91	52.17	3.74	4.43	0.84
6-39	over	7.14	6.41	0.73	-	-
40-60+	100D	29.09	31.44	2.35	4.07	0.58

* = Significant difference at 5% level.

systolic break point. It is also generally true that differences and significance values are greater at the diastolic break points, particularly at 100mm. diastolic. These rates are computed on the adjusted Negro population proportions. In Table 8.2 the race differences are calculated only for adults over 25 years of age which is the area of greatest concern in hypertensive disease, and overall differences are seen to be highly significant at all break points listed.

Differences between sexes of the same race were analyzed in regard to overall rates and also in terms of pre-middle life and post-middle life (at point of crossover). In Table 8.4 the latter is shown and the finding of some differences between the sexes after the cross-over at age 40 (approximately) is verified. In the white race, statistically significant differences were found in the "over 140 systolic" break, males having greater proportions prior to age 40, the females after that point in life. In the "over 150 systolic" and "over 90 diastolic", female proportions are shown to be higher than the male in upper part of the life span, but in the lower ages significance of difference is lost. In the Negro race a similar relationship holds. However, the only differences of statistical significance are in the systolic break points where female proportions are higher in the upper age group than the male. There is a tendency toward the reverse in the younger ages, but of borderline significance. The reduced sex difference by these age groupings in the diastolic break points is what may be expected from the distribution previously shown.

However, in Table 8.3, the same proportions by break point are calculated for the total sample, ignoring age. The inverse differences by the above age grouping was sufficient to render the overall sex difference by race negligible.

A. Study of Break Points in Combination

It would be of interest to ascertain from these data if a relationship exists between systolic and diastolic readings in the sense that if systolic pressure is greater than an arbitrary point, the diastolic pressure is also high. The opposite situation may also be studied.

It is difficult to compare proportions of persons with both a "high" systolic pressure and a "high" diastolic pressure in regard to racial differences because of the varying distributions of blood pressure between the races. It is apparent that if one race demonstrates a great number of persons with very high systolic pressures that the number of high diastolic pressures would also be proportionately high.

Considering the races separately, then, in Table 8.5 is shown the number of persons by race and sex who show elevation by both systolic and diastolic criteria (e.g. 150S and also 100D, 140S and also 90D). The table shows in the first portion these numbers for all persons in the sample race-sex groups, and in the second portion, only those persons under 55 years. The second portion was calculated so that the data might more truly represent essential hypertension rather than arteriosclerotic blood pressure elevations. These rates are unadjusted, since they are not compared across race.

Rates then are calculated in the following manner: Of the persons recorded as both 150/100, the proportion is determined of all persons in the total group who showed at least 150 systolic pressure when this break point was considered separately. This combination break point is then considered in relation to all persons showing at least 100 diastolic pressure when this break point was considered separately. The same procedure is followed for the 140/90 combination.

Considering first the white female, it is seen in Table 8.5 that of those recorded as both systolic and diastolic readings in excess of 150/100, this number represents only 33.3% of all white females who showed at least 150 in systolic pressure when this reading was considered alone. Therefore, in the white female, two-thirds of persons with systolic readings over 150 do not also have diastolic readings in excess of 100.

The reverse of this relationship would be that of white females recorded as both pressures in excess of 150/100, compared with the total white females with at least 100 diastolic pressure. The combination break point represents 82.6% of all white females who showed at least 100 in diastolic pressure when this reading was considered alone. Therefore, less than 18% of persons with diastolic pressures over 100 do not have systolic readings in excess of 150.

This relationship is maintained for the 140/90 combination. It is also maintained, although slightly diminished, when the older persons are excluded. In the white male the pattern is similar in all respects.

Table 8.5

PROPORTION OF PERSONS IN RACE-SEX GROUPS WITH BOTH SYSTOLIC AND DIASTOLIC PRESSURE ELEVATIONS, IN RELATION TO EITHER PRESSURE ELEVATED SINGLY, (ALL AGES), NASSAU, 1958

Race-Sex Group	Persons at Least 150 S and 100 D	Persons at Least 140 S and 90 D	Of those 150/100		Of those 140/90	
			Prop. of Total in Sample Over 150 S	Prop. of Total in Sample Over 100 D	Prop. of Total in Sample Over 140 S	Prop. of Total in Sample Over 90 D
Negro Male	94	178	64.83%	78.99%	70.07%	72.36%
Negro Female	131	241	55.04%	84.52%	72.59%	78.25%
White Male	12	32	30.77%	85.71%	40.00%	71.11%
White Female	19	49	33.33%	82.61%	59.76%	68.06%
All Persons Under 55 Years of Age						
Negro Male	84	154	73.04%	77.78%	70.64%	69.68%
Negro Female	103	191	63.19%	81.75%	75.49%	74.03%
White Male	8	24	30.77%	80.00%	39.34%	66.67%
White Female	13	32	36.11%	76.47%	61.54%	58.18%

In the Negro, distributions of systolic and diastolic pressures are considerably higher and the above relationship cannot be demonstrated clearly at these break point combinations.

From this discussion of break points in combination it is seen that the commonly used combination points, e.g., 140S and/or 90D, and 150S and/or 100D are somewhat fallacious. Proportionately more persons reach these systolic points without also reaching the corresponding diastolic points than is true of the reverse situation. This is true even when older persons are excluded. The above relationship suggests that diastolic pressure elevated to these points (90 or 100) should carry with them higher systolic values than usually set if the same clinical interpretation is to apply. Perhaps 150/90 and 160/100 would be more realistic if these two points were to convey similar significance in terms of the overall distribution of blood pressure.

In summary, it has been shown by analysis of break points that:

1. Over the entire sample, Negroes show a greater proportion of persons with systolic and diastolic pressures over all break points chosen than do whites. This is even more true when the diluting effect of persons under 25 years is excluded.

2. Sex differences within race in regard to break points show no significant differences when viewed in total over the entire age span. When divided at age 40 (cross over point) white females are seen to have the higher pressures than males after 40 years while males have higher below 40 years.

Only a slight white female increase over white males in diastolic pressure is seen, this being mainly at the 90 diastolic break point. No significant sex differences for diastolic pressure were seen in the Negro race in any age grouping or over the entire age span.

3. Considering break points of blood pressure in combination, e.g., 150S and/or 100D, as commonly used, it appears that 150 and/or 90 and 160 and/or 100 would more closely equate these values in terms of the overall distribution of blood pressure.

CHAPTER IX

RELATIONSHIP OF BLOOD PRESSURE TO BODY BUILD

The assessment of degree of obesity is an extremely difficult problem, even in the individual. It is even more difficult to measure in a population. The measurement of the proportion of body weight which is adipose rather than muscular or skeletal, is done best by a difficult laboratory method involving water immersion. Other methods, such as measurement of subcutaneous fat by calipers is relatively simple but requires special instruments. Within the scope of this study only simple measurements of height and weight were possible.

Height and weight, considered separately in regard to blood pressure, would appear to yield unrewarding results since a relationship of blood pressure would more likely be to the entire body build. Boe, et al.[(1)] conducted a thorough anthropometric study in this regard yielding little of note in regard to height and weight separately.

Many methods have been proposed to combine height and weight measurements into an index of body build. An index of this type should yield a constant figure for comparable body builds disregarding height. The index used in this study is $HT/\sqrt[3]{WT}$, measured in inches and pounds. This has been referred to as the "ponderal index." The difficulty in comparing indices lies in the problem of stating comparability between similar builds but of differing height. In effect, one places a human being in a cylinder and judges weight per unit of height. However, it may well be that a taller person tends more toward ectomorphy on the average, and therefore, one might expect a slight rise in the index in the upper extremes of height. Boe compared different indices in an attempt to find the best descriptive index, finally using WT/HT^2, measured in centimeters and kilograms. He refers to a variant of the index used in the present study, stating that this index tends to fall slightly with increasing height.

Disregarding the controversy about the best possible index, however, for the present purposes it was felt that the index used was sufficiently valid. It must also be said that this or any index so contrived is not a direct indicator of obesity or overweight. For example, a person with a broad skeletal structure with heavy musculature may have the same index as a person of the same height but with a light frame and considerable obesity. However, this does not render the use of the index entirely invalid. Although occasionally a heavy muscular person will confuse the picture, in the majority of persons, a lowering of the index indicates a greater obesity for a given height.

It is difficult to compare across race in regard to this index because of the factor of different types of build. The Negro appears to be somewhat heavier in frame, on the average, and comparatively more muscular. In spite of this, the white man shows (Figure 9.1) a lower (heavier) mean index than the Negro male throughout most of the age span (except middle life). This tends to indicate that this heaviness in the white is probably a greater relative obesity. Figure 9.1 also shows that the white female roughly parallels the curve for the Negro female, but the Negro women are slightly heavier than the white women, except in childhood. It seems probable that the women

Table 9.1

RELATIONSHIP OF HEIGHT-WEIGHT INDEX (HT/ $\sqrt[3]{WT}$) TO BLOOD PRESSURE WITHIN AGE-SEX GROUPS
White Race, Nassau, 1958

Males						Females (Non-pregnant)			
Ht.Wt.	Systolic	Diastolic	Pulse Pressure	No. in Group	Ht.Wt. Index	Systolic Mean	Diastolic Mean	Pressure Mean	No. in Group
				Age 6-9					
10	-	-	-	-	10	-	-	-	-
11	104.3	62.8	41.4	18	11	107.1	70.6	36.5	22
12	103.2	59.4	46.5	22	12	102.5	61.6	40.9	16
13	-	-	-	-	13	-	-	-	-
14	-	-	-	-	14	-	-	-	-
				Age 10-19					
10	132.8	80.0	52.8	5	10	-	-	-	-
11	118.8	64.4	54.4	50	11	120.1	66.2	54.0	22
12	129.1	69.3	59.9	7	12	115.1	67.0	48.3	48
13	-	-	-	-	13	104.0	68.0	36.0	1
14	-	-	-	-	14	-	-	-	-
				Age 20-29					
10	140.0	79.3	60.7	6	10	134.1	83.2	52.6	12
11	123.4	73.7	57.4	47	11	118.5	72.8	45.7	69
12	114.7	65.3	49.3	3	12	108.0	76.0	32.0	1
13	-	-	-	-	13	-	-	-	-
14	-	-	-	-	14	-	-	-	-
				Age 30-39					
10	-	-	-	-	10	123.2	81.4	41.7	13
11	128.3	80.2	48.1	41	11	119.1	74.7	43.1	45
12	117.4	70.5	46.9	24	12	114.7	80.7	34.0	3
13	-	-	-	-	13	-	-	-	-
14	-	-	-	-	14	-	-	-	-
				Age 40-49					
10	-	-	-	-	10	151.1	92.6	58.5'	19
11	132.6	81.9	50.8	27	11	140.6	84.5	56.0	24
12	133.5	82.8	51.5	17	12	157.0	78.0	79.0	2
13	-	-	-	-	13	-	-	-	-
14	-	-	-	-	14	-	-	-	-
				Age 50-59					
10	126.1	82.2	43.9	7	10	157.6	91.2	66.4	15
11	141.3	84.3	57.1	19	11	146.8	86.3	62.7	28
12	-	-	-	-	12	-	-	-	-
13	-	-	-	-	13	-	-	-	-
14	-	-	-	-	14	-	-	-	-
				Age 60 +					
10	-	-	-	-	10	169.2	84.8	85.2	13
11	137.9	77.9	60.0	16	11	160.2	81.6	78.6	29
12	155.3	83.4	71.8	12	12	148.0	68.7	79.3	3
13	-	-	-	-	13	-	-	-	-
14	-	-	-	-	14	-	-	-	-

Table 9.2

RELATIONSHIP OF HEIGHT-WEIGHT INDEX (HT/ $\sqrt[3]{WT}$) TO BLOOD PRESSURE WITHIN AGE-SEX GROUPS
Negro Race, Nassau, 1958

Males						Females (Non-pregnant)			
Ht.Wt. Index	Systolic Mean	Diastolic Mean	Pulse Pressure Mean	No. in Group	Ht.Wt. Index	Systolic Mean	Diastolic Mean	Pulse Pressure Mean	No. in Group
				Age 6-9					
10	100.0	60.0	40.0	1	10	-	-	-	-
11	-	-	-	-	11	99.5	42.0	52.5	2
12	101.2	64.5	36.7	40	12	102.4	65.7	36.6	30
13	100.8	62.9	37.8	78	13	102.4	64.3	38.1	92
14	95.0	63.0	32.0	2	14	101.3	64.2	37.1	9
				Age 10-19					
10	-	-	-	-	10	188.0	120.0	68.0	1
11	135.5	73.0	62.5	2	11	126.2	68.4	57.8	9
12	119.6	72.8	46.8	57	12	117.0	69.0	48.0	92
13	114.4	67.7	46.7	202	13	110.0	67.9	42.1	153
14	108.5	67.8	40.8	29	14	110.2	65.9	44.3	27
				Age 20-29					
10	-	-	-	-	10	188.0	120.0	68.0	1
11	136.9	88.5	47.9	12	11	128.8	81.8	46.9	39
12	131.5	80.2	51.3	97	12	123.2	77.7	45.3	131
13	128.6	79.7	48.7	115	13	122.5	78.1	44.3	92
14	111.8	70.7	41.2	6	14	116.5	72.0	44.5	4
				Age 30-39					
10	-	-	-	-	10	138.6	89.4	49.2	13
11	146.1	98.7	51.0	11	11	139.3	90.3	49.0	43
12	140.6	88.8	51.9	54	12	134.8	86.5	48.4	75
13	133.5	85.9	47.7	47	13	132.5	80.9	51.8	36
14	184.0	110.0	74.0	2	14	111.3	68.7	42.7	3
				Age 40-49					
10	139.0	81.0	58.0	2	10	159.3	98.3	61.0	11
11	148.8	96.5	52.2	13	11	160.6	95.5	64.9	56
12	142.1	93.7	48.4	63	12	146.2	90.8	55.3	75
13	140.3	90.4	61.0	54	13	144.7	89.9	54.7	26
14	142.0	88.0	54.0	2	14	140.3	78.0	62.3	4
				Age 50-59					
10	-	-	-	-	10	172.5	95.5	76.8	13
11	181.3	100.7	80.7	6	11	171.1	96.5	74.6	20
12	150.7	92.5	58.2	31	12	156.1	91.7	66.1	37
13	144.6	87.3	57.2	26	13	158.4	91.1	61.0	16
14	-	-	-	-	14	-	-	-	-
				Age 60 +					
10	174.0	84.0	90.0	1	10	196.8	95.0	101.8	4
11	170.9	98.3	73.0	7	11	186.1	94.6	92.1	17
12	186.1	90.5	95.6	8	12	171.0	88.5	82.5	22
13	151.6	84.0	67.6	17	13	172.5	85.3	87.3	18
14	210.0	110.0	100.0	2	14	153.0	90.0	63.0	2

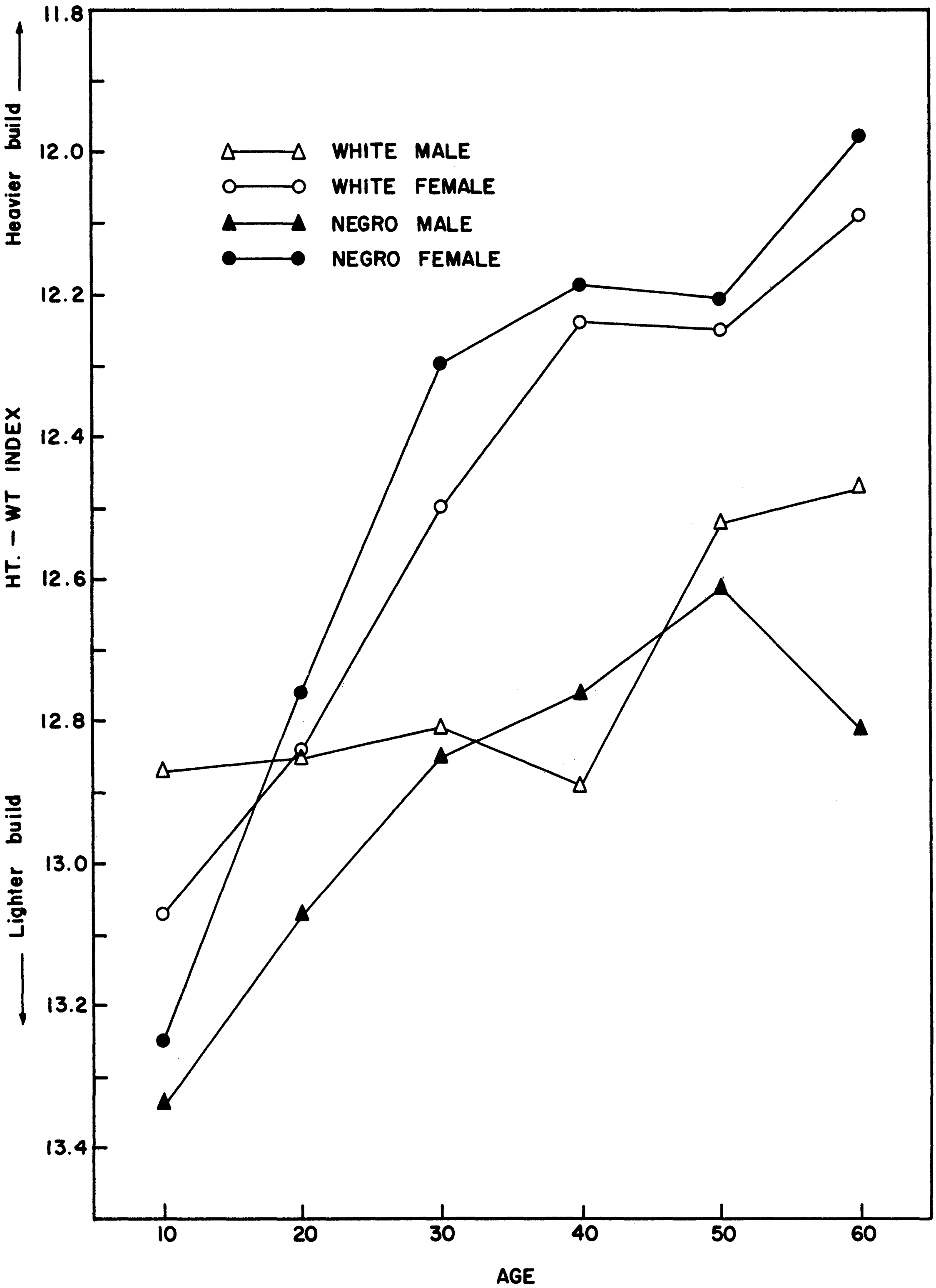


Figure 9.1 Mean of Height-Weight Index by Age.
Negro and White Races. Nassau, 1958.

of both races are nearly equally obese and relatively obese compared to the men of their respective races.

In regard to variations in blood pressure corresponding with changes in the ponderal index, comparisons can only properly be made within age, sex and race specific groups. Table 9.2 demonstrates these comparisons for the Negro race. As the ponderal index increases from the heavy to the lean (10-14), the mean systolic, diastolic and pulse pressure are recorded. If only those groups with larger than 5 persons are considered, it is seen that throughout the age span and for both sexes there is, as a rule, an orderly elevation of systolic and diastolic blood pressure as the index reflects increasing heaviness of build. These increases are of similar magnitude to those seen with arm girth, from about 5-25 or more mm. systolic pressure and from about 5-15 mm. diastolic pressure. The magnitude of the change is not detectably related to age.

Data for the white race is unfortunately not as distinct. Number of persons were smaller; the white persons tended to be less variable in regard to this index (only one white person in the total had an index of 13 or over). When viewed by finer divisions of the index, differences are not obvious. In Table 9.1 the mean pressures are calculated in the same index groups as the Negro. It appears that the same trend is present, but these data are inadequate for verification of this trend.

In summary, data have been presented regarding the height-weight index and its relation to blood pressure. The following points were noted:

1. The mean height-weight index by age shows that women of both races are considerably heavier in build than their male counterparts.

2. The curve on these means by age is similar for women of both races and men of both races, although Negro women are generally heavier than white women and the reverse true for males, white males being heavier than Negroes.

3. Analysis of mean blood pressure for leanness or heaviness within age group for Negroes showed a definite trend to higher pressures in the heavier body builds. Such a trend could not be shown for whites in this study because of inadequate numbers, although a suggestion of a similar trend was present.

4. The ponderal index used in the above analysis represents heaviness per unit of height and in no sense may this index be judged as a measure of obesity, per se.

CHAPTER X

RELATIONSHIP IN BLOOD PRESSURE TO ARM GIRTH

It has long been felt that obesity is an important factor in elevating human blood pressure. Certainly there appears to be ample physiological grounds for this belief since added fatty tissue causes increased work for the heart, an increase in stroke volume and an increase in at least the systolic aspect of blood pressure. In addition to this, the excess adipose tissue in the arm would seem to alter the mechanical process of compressing the arm and the artery under the sphygmomanometer cuff. Both of these effects have been postulated in greater or lesser degree by many investigators.

Pickering[15] finds that the increase in blood pressure is fairly well correlated with arm girth up to the age of 50. Hamilton, Pickering, Roberts and Sowry[6] suggest correction factors for increase in arm girth to obtain a more nearly true reading. However, use of this correction factor seems to indicate that it tends to overcorrect.

In Figure 10.1 is seen the progression of the mean arm girth in regard to age, sex and race. This demonstrates that in both races there is little progression in mean arm girth after adulthood and an actual mean decrease in size after age 50. Although the curves are quite similar in magnitude, Negro men and women are seen to have quite consistently larger arms than their white counterparts. However, as seen in the preceding section, the height-weight index (heaviness of build) study shows that white men at nearly all ages are heavier

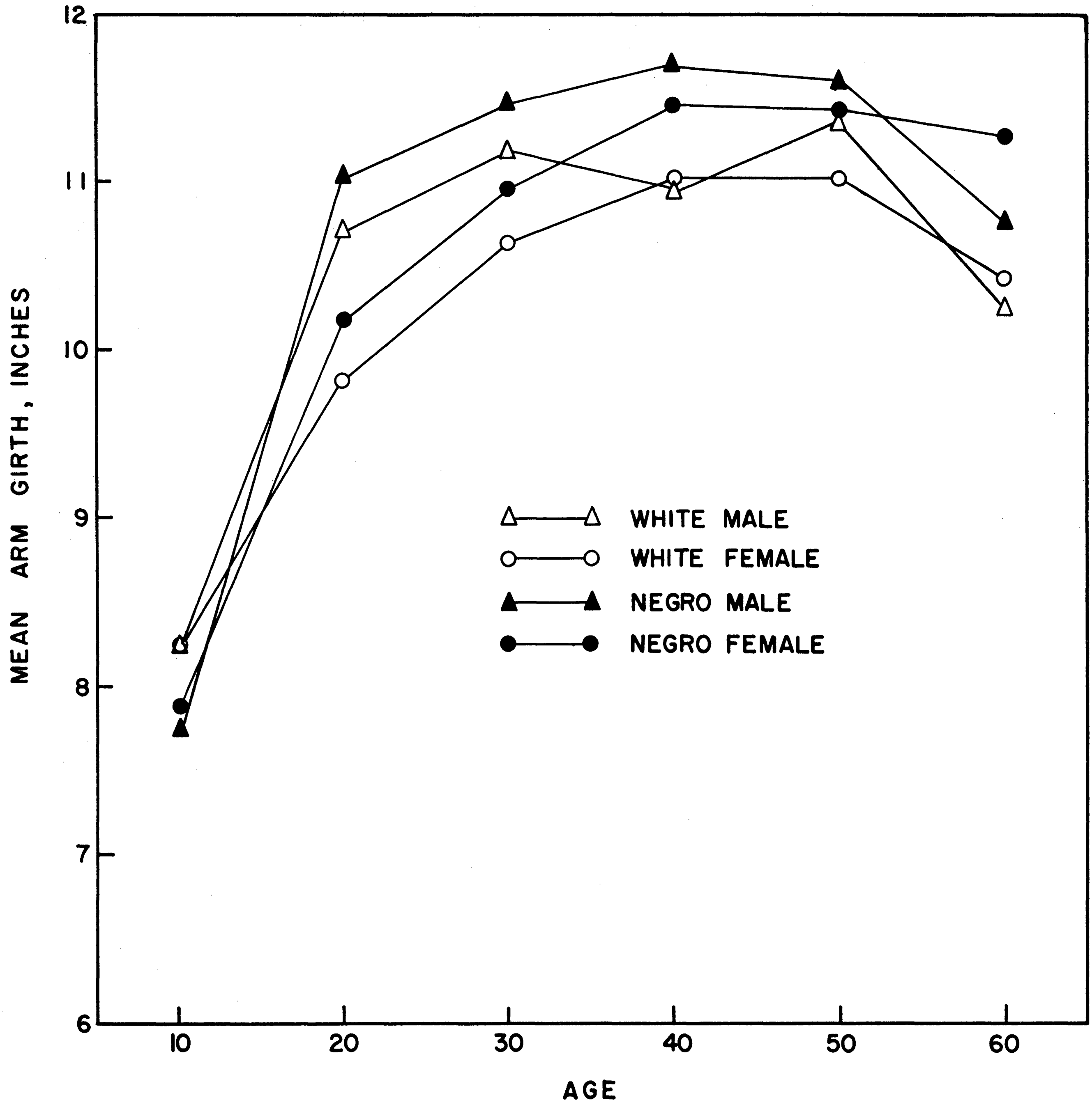


Figure 10.1 Mean Arm Girth by Age. Negro and White Races. Nassau, 1958.

in build than Negro men, whereas Negro women are generally heavier than white women. The Negro men then, would seem to have larger arms by virtue of muscularity rather than adipose tissue. This seemed to be the case by clinical impression.

Pickering's curves of mean arm girth are quite similar to the present data. Comparing the configuration of the curve with the systolic pressure curve (sigmoid in shape) for the white race it is reasonable to suppose that a positive correlation exists between them until middle life. However, it seems highly improbable that such a relationship exists for the Negro race since the systolic curve for Negroes rises so steeply.

Disregarding means of arm girth by age, a more valid approach seems to be to study each age-sex-race group separately, comparing mean blood pressure by arm girth within these groups. This analysis is shown in Tables 10.1 and 10.2. When first computed by single inch intervals, the numbers in groups were small and obscured a possible trend. The data are shown in two inch intervals with mean systolic, diastolic and pulse pressure for each. For an analysis of this kind it would have been better to have greater numbers within groups for a more accurate idea of trend, particularly in the white race.

For age-sex units in the Negro race these data show a rather remarkable trend toward higher systolic and diastolic pressures as arm girth increases. This is true not only in the pre-adult (growth) phase but is also true in the Negro male until age 60. At that point numbers become smaller and pressure more variable. In the Negro female this relationship is identifiable throughout the age span, including those over 60 years.

Table 10.1

RELATIONSHIP OF ARM GIRTH (INCHES) TO BLOOD PRESSURE WITHIN AGE-SEX GROUPS
White Race, Nassau, 1958

Males					Females				
Arm Girth	Systolic Mean	Diastolic Mean	Pulse Pressure Mean	No. in Group	Arm Girth	Systolic Mean	Diastolic Mean	Pulse Pressure Mean	No. in Group
Age 6 - 9									
6-7	102.5	60.4	44.0	31	6-7	102.0	65.0	37.0	22
8-9	106.1	61.6	44.5	10	8-9	109.0	69.7	39.3	14
10-11	-	-	-	-	10-11	114.0	58.0	56.0	1
12-13	-	-	-	-	12-13	112.0	76.0	36.0	1
Age 10-19									
6-7	103.7	59.8	44.0	8	6-7	104.7	65.6	39.1	11
8-9	116.6	67.0	49.6	23	8-9	116.5	65.6	51.2	41
10-11	127.5	67.3	60.2	29	10-11	120.8	69.5	51.3	17
12-13	128.7	60.7	68.0	3	12-13	144.0	74.0	70.0	2
14-15	162.0	94.0	68.0	1	14-15	-	-	-	-
Age 20-29									
7-8	-	-	-	-	7-8	111.0	68.0	44.0	6
9-10	131.3	70.8	60.1	27	9-10	116.9	73.2	43.5	50
11-12	128.7	75.0	53.7	28	11-12	127.8	74.8	53.0	22
13-14	158.0	94.0	64.0	1	13-14	128.0	84.7	43.3	3
15-16	170.0	110.0	60.0	1	15-16	190.0	108.0	82.0	1
Age 30-39									
7-8	111.0	60.0	51.0	2	7-8	105.5	67.5	38.0	4
9-10	122.3	75.5	46.8	25	9-10	116.7	73.2	42.1	39
11-12	125.0	77.1	47.9	34	11-12	129.5	85.8	43.7	13
13-14	137.0	88.0	39.0	4	13-14	125.0	81.5	43.5	4
Age 40-49									
8-9	144.6	88.6	55.9	7	8-9	145.6	83.4	62.3	8
10-11	129.4	77.0	52.3	25	10-11	151.3	92.0	59.3	21
12-13	133.6	87.9	45.7	12	12-13	147.8	89.3	58.5	13
14-15	-	-	-	-	14-15	154.0	94.0	60.0	1
16-17	-	-	-	-	16-17	140.0	90.0	50.0	1
Age 50-59									
9-10	136.7	83.6	53.1	10	9-11	148.0	85.2	61.8	17
11-12	138.9	84.5	54.4	17	11-12	150.0	88.1	64.6	22
13-14	-	-	-	-	13-14	170.0	96.6	73.3	3
15-16	-	-	-	-	15-16	148.0	88.0	60.0	1
Age 60 +									
7-8	133.3	79.7	53.7	3	7-8	166.1	72.1	95.4	7
9-10	151.1	81.9	69.2	18	9-10	150.1	79.6	70.5	27
11-12	134.1	75.0	59.1	8	11-12	170.8	83.8	87.0	10
13-14	-	-	-	-	13-14	178.7	90.7	88.0	3

Table 10.2

RELATIONSHIP OF ARM GIRTH (INCHES) TO BLOOD PRESSURE WITHIN AGE-SEX GROUPS
Negro Race, Nassau, 1958

Males					Females				
Arm Girth	Systolic Mean	Diastolic Mean	Pulse Pressure Mean	No. in Group	Arm Girth	Systolic Mean	Diastolic Mean	Pulse Pressure Mean	No. in Group
Age 6-9									
5-6	99.6	63.5	36.0	62	5-6	100.1	63.3	36.5	63
7-8	102.1	63.3	38.8	59	7-8	104.2	65.0	39.1	69
Age 10-19									
6-7	103.0	64.8	38.1	67	6-7	101.0	67.4	38.3	44
8-9	112.1	66.0	46.2	108	8-9	111.8	66.3	45.4	163
10-11	122.7	73.5	49.6	98	10-11	118.3	71.3	47.2	77
12-13	135.7	74.8	60.9	16	12-13	138.0	84.3	53.7	6
Age 20-29									
7-8	126.3	84.0	42.3	3	7-8	110.0	71.2	38.8	17
9-10	127.3	77.8	49.0	67	9-10	120.4	74.6	45.7	182
11-12	129.6	80.3	49.4	145	11-12	124.9	77.8	37.0	94
13-14	142.9	87.7	55.1	15	13-14	129.8	88.5	48.3	15
15-16	-	-	-	-	15-16	175.7	88.7	87.0	3
Age 30-39									
7-8	-	-	-	-	7-8	140.8	78.0	62.8	5
9-10	139.2	89.1	50.1	28	9-10	134.7	84.2	49.7	72
11-12	136.7	86.4	50.9	65	11-12	131.7	84.8	47.0	77
13-14	145.6	96.3	49.2	21	13-14	141.6	89.3	52.2	25
15-16	-	-	-	-	15-16	144.0	92.4	51.6	5
Age 40-49									
8-9	140.0	87.8	52.2	9	8-9	139.6	85.2	54.5	27
10-11	141.4	93.4	57.8	71	10-11	149.5	90.0	55.4	80
12-13	141.6	93.4	48.2	47	12-13	158.2	95.0	63.2	59
14-15	157.3	91.7	58.0	6	14-15	156.6	98.5	58.1	2
16-17	168.0	104.0	64.0	1	16-17	189.0	102.0	87.0	1
Age 50-59									
9-10	142.7	85.9	56.8	18	9-10	157.1	90.7	63.1	30
11-12	152.1	90.8	61.3	38	11-12	156.2	91.7	64.4	28
13-14	161.6	103.8	57.9	8	13-14	184.6	102.3	82.4	11
15-16	-	-	-	-	15-16	188.3	97.8	90.5	6
Age 60 +									
7-8	186.7	100.0	86.7	3	7-8	171.2	91.2	80.0	5
9-10	149.1	84.6	84.5	13	9-10	168.0	84.3	83.9	23
11-12	173.4	82.7	90.7	12	11-12	179.3	97.0	82.3	14
13-14	147.9	105.3	76.3	6	13-14	189.4	89.7	99.7	7
15-16	-	-	-	-	15-16	178.3	99.3	79.0	3

The corresponding data for the white race are less reliable because of small numbers. However, the same trend is seen in both sexes for both systolic and diastolic pressures up to the age of 40. After this point the relationship is obscured but its presence is not ruled out.

The magnitude of the difference in blood pressure between slender arms and heavy arms is variable, but most frequently in a range of 10-20 mm. systolic pressure and 5-10 mm. diastolic pressure in both races where the trend is observed. This difference is measured only between groups with relatively larger numbers of greater validity.

From these data it cannot be said that a large arm connotes absolutely a higher than average blood pressure. Variation is too great, as was seen in the original ungrouped data. However, it seems justifiable to say that within an age-sex group, particularly for Negroes, persons with a large arm would on the average be expected to yield a blood pressure somewhat higher than a person with a slender arm, throughout the age span. For the white race these data cannot demonstrate such a relationship beyond the age of 40 years.

The data cited here consider the effect of arm girth separately, although it is undoubtedly very closely related with body build.

CHAPTER XI

PARITY IN RELATION TO BLOOD PRESSURE

Several studies in recent years have attempted to assess the effect of parity on blood pressure. Notable of these is Humerfelt and Wedervang(9) and Miall and Oldham(13).

It has long been felt that nothing adverse should happen to the blood pressure in normal pregnancy. If pre-eclampsia should occur, this, of course, will cause blood pressure elevation during the third trimester of pregnancy. At the termination of pregnancy the elevated blood pressure usually returns to normal within a relatively short time. Occasionally, however, the blood pressure remains elevated for long periods or even for life. It is a matter of conjecture whether cases of this sort represent renal hypertension as a result of the toxemia or if this represents the onset of essential hypertension occurring in the course of pregnancy.

Local practitioners state that toxemia was until very recently a rather serious problem on the island but one which has been greatly reduced in the past several years. Attempts were made at obtaining history of pre-eclampsia or eclampsia by interview with the woman seen during the present study but the data gained were felt to be too inaccurate for further study.

In view of this situation it seems somewhat contrary to logic to suppose that a population study of women in regard to pregnancy histories should reveal a lowering of blood pressure with increasing multiparity.

Miall and Oldham's work is most comparable with the present data since their parity and blood pressure comparisons include women 15-45 years. Humerfelt and Wedervang studied blood pressure of women only at the end of the reproductive period. However, both studies report essentially the same trend of lowering of blood pressure with increasing multiparity. Single women have the highest pressures (both systolic and diastolic). Pressure is then gradually lowered progressively for nulliparous married, those with one child and those with two or more children. Remarkably, this same relationship was also seen for fathers in these families.

Although the present study was not designed with this specific goal in mind, the available data were analyzed for this effect. The original data collection sheet provided space for only three pregnancy histories for women in a given household. If more than three were present, the pregnancy histories were frequently unrecorded. However, of a total of 826 Negro women included in the sample over 20 years of age, 676 had pregnancy histories taken. This, of course, allows for some statistical criticism, yet it is felt that if a genuine trend were present it would probably reveal itself.

The data are presented in Table 11.1, showing mean systolic and diastolic pressure for parity groups within age groups.

One is struck not by a trend in one direction or another, but the rather remarkable homogeneity over the parity groups within age grouping. These data would not support a hypothesis of either increasing or decreasing blood pressure with increasing parity.

Table 11.1

RELATIONSHIP OF PARITY TO BLOOD PRESSURE WITHIN AGE GROUP
Negro Females, Nassau, 1958

Parity	Systolic Mean	Diastolic Mean	Number In Group
Age 20-29			
0	127.7	81.7	38
1-2	122.9	78.0	89
3-4	125.8	81.5	66
5-6	120.1	79.8	19
7-8	123.8	77.6	5
9+	-	-	-
Age 30-39			
0	129.5	81.9	59
1-2	139.1	86.9	37
3-4	130.9	85.4	42
5-6	141.0	89.6	27
7-8	135.7	86.4	14
9+	134.5	88.0	11
Age 40-49			
0	163.5	96.0	21
1-2	148.5	91.6	51
3-4	151.4	91.3	36
5-6	149.7	91.6	27
7-8	150.0	93.6	16
9+	154.8	94.9	9
Age 50-59			
0	165.8	90.0	8
1-2	151.4	92.0	14
3-4	165.9	96.9	17
5-6	161.9	95.5	15
7-8	167.8	90.8	5
9+	169.7	91.2	16
Age 60+			
0	166.3	86.7	9
1-2	165.6	87.5	12
3-4	181.3	90.8	8
5-6	184.4	88.9	9
7-8	177.3	94.3	6
9+	179.3	94.5	8

A further finding of interest, however, is the study of the blood pressure of the 73 Negro women pregnant at the time of the study. Table 11.1 shows that the pregnant women had consistently lower blood pressures (both systolic and diastolic) then the mean for all women in the respective age groups (pregnant women included). Although one may not draw conclusions from this small group, this findings is provocative.

It has been postulated that blood pressure is slightly reduced in normal pregnancy, and previously hypertensive women may frequently show greater reductions. The present findings are consistent with the impression of reduced blood pressure in pregnancy.

Significance of these findings in regard to sex differences seen in the distributions by age is uncertain.

Table 11.2

MEAN BLOOD PRESSURES BY AGE GROUP FOR PREGNANT WOMEN COMPARED TO MEAN BLOOD PRESSURE FOR ALL WOMEN (INCLUDING PREGNANT), NEGRO RACE NASSAU, 1958

Age Groups	Systolic Mean		Diastolic Mean		Number in Group (Pregnant)
	All Women in Sample	Pregnant Women	All Women in Sample	Pregnant Women	
10-19	115.4	114.9	69.0	62.6	9
20-29	123.76	115.0	76.7	61.9	43
30-39	136.77	124.9	86.5	74.7	15
40-49	150.51	110.0	91.2	66.7	6

CHAPTER XII

RELATIONSHIP OF PULSE RATE TO BLOOD PRESSURE

The pulse rate measurement was shown to be less reliable in regard to differences between observers than was the blood pressure determination. This fact may be partially accounted for by the use of 15 second pulse counts. However, the pulse counts are probably sufficiently accurate for comparison.

It has been felt that the pulse in relation to blood pressure has only one connotation, that of a systolic increase with excitement or emotion. However, Remington[17] has seen that children of hypertensive parents have lower pulse rates than do children of normotensives. Corcoran and Schneckloth[4] studying Negroes in St. Kitts, Leeward Islands, show a tendency by age group to higher systolic and diastolic pressures as the pulse increases.

For the present data, Table 12.1 demonstrates that by age-sex-race group, no visible trend for increasing pulse is apparent except for a slight increase in pressures with increasing pulse in the young adult.

Since the St. Kitts study was done in a clinic situation and the present study was done in the home, the factor of emotion may have played a greater part in the former.

Table 12.1

RELATIONSHIP OF PULSE RATE TO BLOOD PRESSURE WITHIN AGE-SEX GROUPS
Negroes, Nassau, 1958

Males Pulse	Systolic Mean	Diastolic Mean	No. in Group	Females Pulse	Systolic Mean	Diastolic Mean	No. in Group
Age 6-9							
55-64	91.0	38.0	2	55-64	-	-	-
65-74	104.0	54.7	5	65-74	97.3	65.3	3
75-84	100.7	65.8	25	75-84	99.7	59.5	27
85-94	100.3	66.7	24	85-94	102.8	66.0	33
95+	101.2	62.4	65	95+	103.2	65.2	70
Age 10-19							
55-64	116.6	70.4	25	55-64	117.3	70.7	3
65-74	117.6	70.1	48	65-74	116.4	69.7	18
75-84	115.4	67.7	113	75-84	112.0	68.0	106
85-94	114.0	68.4	54	85.94	113.4	68.4	71
95+	110.7	68.9	47	95+	113.6	57.5	93
Age 20-29							
55-64	125.5	77.8	39	55-64	121.3	78.9	16
65-74	130.6	83.0	58	65-74	124.8	80.3	39
75-84	129.6	79.6	79	75-84	120.7	75.6	119
85-94	131.0	80.4	33	85-94	120.5	72.7	74
95+	134.2	76.7	19	95+	126.8	77.6	61
Age 30-39							
55-64	130.4	82.4	15	55-64	138.1	85.3	9
65-74	137.1	89.3	17	65-74	133.8	84.9	19
75-84	134.3	85.8	46	75-84	133.5	86.1	74
85-94	146.4	95.3	19	85-94	133.8	83.6	42
95+	152.7	95.1	17	95+	136.5	85.5	41
Age 40-49							
55-64	140.7	91.0	6	55-64	149.4	97.7	7
65-74	143.3	92.1	19	65-74	157.5	95.0	31
75-84	139.1	92.5	46	75-84	144.5	89.8	64
85-94	140.7	92.3	30	85-94	151.4	92.8	40
95+	146.6	90.0	33	95+	151.6	89.0	36
Age 50-59							
55-64	152.8	87.6	5	55-64	161.0	88.3	6
65-74	144.7	90.1	15	65-74	174.3	98.6	8
75-84	147.0	88.3	22	75-84	150.4	89.6	30
85-94	161.9	96.9	14	85-94	158.9	94.3	9
95+	148.0	91.1	7	95+	170.9	94.8	23
Age 60-69							
55-64	-	-	-	55-64	173.5	94.5	4
65-74	148.0	90.9	7	65-74	169.2	96.8	5
75-84	183.6	97.8	9	75-84	161.2	88.0	10
85-94	136.0	84.5	4	85-94	158.8	86.2	9
95+	150.4	74.0	5	95+	173.7	85.7	6
Age 70 +							
55-64	180.7	86.0	3	55-64	154.0	66	1
65-74	160.7	84.0	3	65-74	186.4	93.8	10
75-84	202.0	97.0	2	75-84	192.9	91.8	11
85-94	222.0	108.0	2	85-94	165.5	79.0	4
95+	-	-	-	95+	209.8	102.5	4

CHAPTER XIII

SUMMARY OF THE STUDY

The purpose of this study has been primarily to describe the distributions and characteristics of the blood pressure in a population, comparing the Negro and white races, age and sex specifically. Since the entire population could not be studied, the approach to study which is felt to provide the greatest likelihood of valid results lies in the implementation of adequate sampling techniques. The use of these techniques is finding greater use in the epidemiology of chronic disease.

Reasons for choice of site for the study were noted. These included the factors of geographic and genetic isolation, the reports of higher levels of blood pressure in the people, and the possibility of an environmental factor (salt intake) which might contribute to the elevation of blood pressure.

The sampling method was discussed and measures to judge validity were described with the conclusion that the sample is probably a valid one.

The technique of the examinations were standardized and variations between examiners were evaluated so that the information gathered would be as comparable as possible. It was found that differences between examiners were acceptably small.

Comparisons were made between two blood pressure determinations performed about one minute apart. Differences were minimal. However, first reading casual blood pressures were used in the analysis. Both fourth and fifth phases of diastolic pressure (muffling of sounds and disappearance of sounds, respectively) were measured. Difference between them was found to be greater in the young and on the average smaller than previously thought (only 3-4mm.). Variability (standard errors) of fourth and fifth phases was essentially equal. The fifth phase of diastolic pressure was used in the analysis.

Distributions of systolic and diastolic mean pressures have been presented along with measures of variability made possible by the sampling procedure. These measures included standard errors of means and standard errors of the individual age-sex-race distributions. It was found that a definite difference was apparent between the Negro and white races. For the white race, the means of systolic pressure by age group showed a sigmoid curve of increase as age progressed, with a "plateau" of relative stability in early adulthood. The Negro enjoyed no such respite. The means for Negroes of systolic pressure progressed upward inexorably from the youngest to the oldest age groups. Curves of diastolic means by age showed no great difference in configuration between the races, both being roughly parabolic in shape with Negros slightly higher than the white race.

Distributions of both systolic and diastolic pressure for age, sex, and race specific groups demonstrated again the continuous nature of the curves, with no evidence of bimodality or any clear-cut separation between normal and abnormal

In regard to sex differences, the systolic blood pressure curves for both races show that females in early childhood have higher pressures than the males. At about age 13 years the average systolic pressure of males exceeds that of females and continues to do so to age 38 years when female blood pressures again become the greater. Rather remarkably, these cross points on the curves are almost identical for the two races. Sex differences in diastolic blood pressure are less distinct but still present in the white race, but are minimal in the Negro.

These distributions were compared with other studies of similar nature for both white and Negro races. It was seen that the blood pressure distributions for each race were quite comparable to those of other studies on similar racial stocks in other parts of the world. This observation tends to speak against the likelihood of a local environmental factor such as a high salt intake in causation of elevated blood pressures.

Blood pressure was then compared in another fashion than that of arithmetic means, that of determination of proportions within the age-sex-race specific groups which have pressure readings above fixed break points on the blood pressure scale. Findings by this approach were:

1) The Negro race again showed significantly higher proportions of persons with elevated blood pressures than did white persons at all break points chosen.

2) Sex differences within race, when viewed in total over the entire age span, showed no significant differences. However, women have significantly higher systolic pressures than men after age 40 in both races. Since the total effect for sex was not significant, the expected compensating difference in favor of mean under 40 is less significant. Sex differences in diastolic pressure were much less evident, as expected from the study of means, over the entire age span or at any age grouping, with one exception. White females over 40 years have higher proportions of persons with greater than 90 diastolic pressure. This relationship was not true for the 100 diastolic reference point.

3) Data in regard to break points of systolic and diastolic pressure suggest that commonly used criteria, e.g. 150S and/or 100D, do not carry equal weight in terms of overall distribution. Perhaps 160S and/or 100D, and 150S and/or 90D would more nearly equate these values.

The data were also studied to determine the effect of varying anthropometric measurements such as girth of the arm and body build. It was demonstrated that within age-sex groups there was a definite trend toward higher pressures in heavier arms and in heavier builds, particularly in the Negro.

Blood pressure in relation to parity was seen to show no recognizable trend in the Negro race from nulliparity to multiparity. However, although only 73 Negro were pregnant at the time of the study, their mean blood pressures by age group were consistently lower than the mean pressures for all women of their respective age groups. The import of this finding is unclear.

Relationship of blood pressure to pulse rate was also investiated. Except for a slight trend toward higher pressures with higher rates in young adults, no real effect was noted.

The association of blood pressure findings with degree of salinity of water was not analyzed, partly because of the indication mentioned that a local environmental factor was probably not operative. Also, the water samples were drawn from units within strata, whereas the analysis was centered on post-stratification variables. The water samples did show a relatively high salt content and this may be investigated in the subsequent analysis.

CHAPTER XIV

DISCUSSION

The goal of this study has been to describe, as accurately as possible, the distribution of blood pressure in a population and to draw comparisons between two races, noting differences by age and sex.

The findings prompt speculations on what possible implications may be inherent therein, beyond the purely descriptive aspect.

At the outset, one feels constrained to dispute the view of Pickering[15] that essential hypertension is not a disease since blood pressure, like height, is a continuously distributed variable in the population. Distributions of blood pressure increase progressively with age, becoming more positively skewed as age progresses. Pickering's concept that no "disease" exists is a statistical one, based on the observation that at a given age the distribution curve shows no natural division point nor the presence of two peaks, one denoting the mode of "normal" persons, and the second the mode of abnormal (or "hypertensive") persons. This reasoning seems unduly restrictive and does not provide any clues to the underlying pathological process. A new concept of the meaning of these distributions is needed, and will be offered.

However, we must first reiterate that the word "disease" is, and should be, a clinical determination. Moreover, it is well known that the disease "hypertension" when established definitely, carries an increased risk of death or disability. Hence, from the distribution of blood pressures in a population it is difficult to argue that no disease entity exists.

Is there any reason to believe that separation of a pathological process by inspection of the distribution of a normal variable such as blood pressure is necessarily dependent upon the presence of a bimodal separation? Although it is conceivable that some physiological variables may behave in this manner, such a separation would imply a rather marked change in value with initiation of the pathological process such that it is clearly demarcated from the normal. This is not the case in essential hypertension. Rather, essential hypertension would appear to be usually of gradual onset, with considerable overlap of "normal" values in the early stages. It is this overlap which may explain the positively skewed, unimodal distribution curves seen.

An analogy might be drawn to the range of blood sugar values seen in diabetes mellitus. One cannot deny the existence of the disease, yet if no diagnostic aids were available other than a single determination of blood sugar, it would be extremely difficult to set a value above which diabetes is present and below which lies normality.

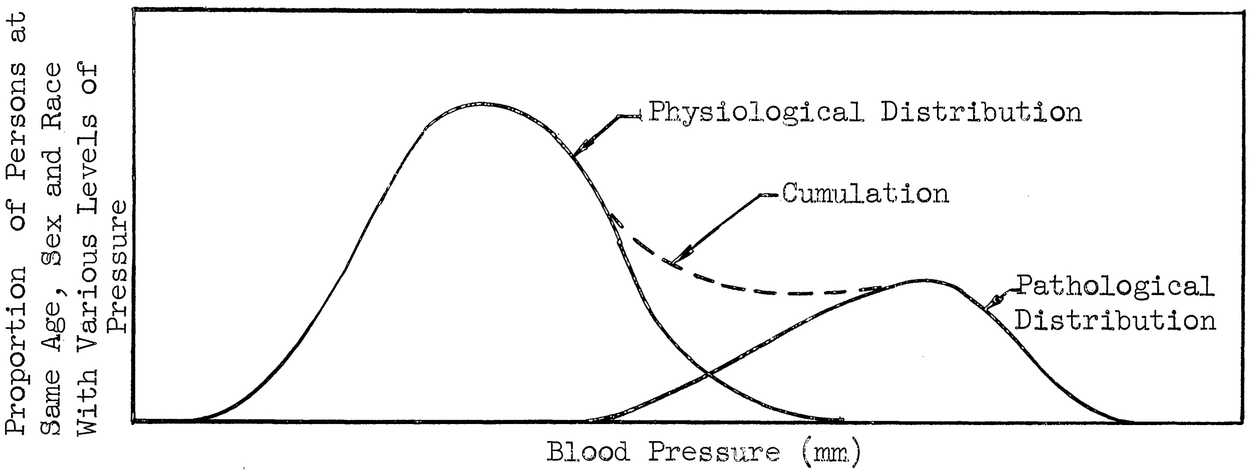
One cannot say when or how essential hypertension begins. No diagnostic tool is yet available which is analogous to the glucose tolerance test in diabetes. Assuredly, many tests of blood pressure reactivity are known, but no standardized procedure exists to classify a person at a given age, sex, race, and blood pressure as either hypertensive, pre-hypertensive, or normal.

If it is true that hypertension is a disease which has a beginning and an end, it may be postulated that the continuous distribution curves of blood pressure seen must be a composite of two basic distributions, the "physiological" and the "pathological", as seen in the accompanying diagram. Both underlying curves may approximate bell-shaped distributions, with both high and low values. These curves overlap such that a person with a given blood pressure may be in the "physiological" distribution, while another at the same pressure may actually be in the initiation of his pathological process.

It may well be possible in the future to formulate mathematical models to describe these two underlying distributions. It would then be feasible to attempt to separate these two distributions by a longitudinal study over several years to verify the postulates suggested regarding these distributions. If this could be done, the basic framework would be already available when a more precise method of identification of the susceptible person is found.

At first glance one might question the justification for laborious efforts to describe the susceptible portion of a population before specific etiology and treatment are known. Yet, the great majority, if not all, of diseases of unknown etiology were first studied in a somewhat similar manner. This is the epidemiological method. If the susceptible groups are identified, important clues may rise in the search for etiology.

Current thinking in regard to essential hypertension revolves about the varied aspects of pathogenesis, the neural, humoral, and renal mechanisms, modified in some way by the presence of a predisposing genetic disturbance. In spite of demonstrated potential relationships to disease of the above mechanism, the precise pathogenetic pattern is unknown. For example, is vasomotor lability a necessary prodromal stage in development of disease? Are all persons with vasomotor lability at greater risk of



subsequent hypertension? Do intermittent elevations of blood pressure cause subsequent vascular changes which result in permanent elevations of blood pressure, or is the vascular change the primary pathological alteration? How is pathogenesis of hypertension related to the aging process, and if so, why do some persons with marked signs of aging (as grossly estimated) demonstrate "normal" blood pressure?

In regard to aging, it must be re-emphasized that one of the principle positive effects in this study was the relationship of age to blood pressure. One is reminded of the dictum "Age is a matter of arteries--not years." However, such a phase is not entirely adequate. Numerous cases of people with the usual outward physical signs of senility demonstrate blood pressures in the normal range, both for systolic and diastolic pressure. The more usual pattern in the aged is at least a systolic elevation with increasing arteriosclerosis. Such a pattern suggests that blood pressures in arteriosclerosis are a reflection of change primarily in vascular structure resulting in decreased distensibility and increased peripheral resistance rather than a change in the vasomotor apparatus itself. However, the present study also shows that the mean but not necessarily the individual blood pressures increase progressively over all of the age span. Can this be merely a manifestation of progressive arteriosclerosis on the blood vessels? This would not appear to be a satisfactory answer.

The formulation of hyperthetical curves as shown provoke one to speculate if the increase in mean blood pressure with age is not an entirely pathological process. We note from the data that at least 30-40% of persons do not ever reach even the minimal breakpoints of 140/90.

The increase in means with age could be explained if one assumed that as age progressed, the proportion of persons leaving the "physiological" distribution to join the "pathological" increased with age. The same generalization would hold regarding overlap of the two distributions, unimodality and positive skewness.

The second major point of the present findings is the definite difference seen in the racial comparisons. The Negro tends not only to have higher mean pressures (after adolescence) but the pattern of progression with age is different. One sees a "plateau" effect in young adult life in the white race, while the Negro demonstrates an inexorable progression from the earliest ages to the oldest.

Does this difference in pattern simply represent an accelerated process of aging in the Negro? Though it may possibly be true that aging is accelerated in the Negro, (which is extremely difficult to evaluate) one feels that this is not the answer. From what has been postulated from the distributions, aging, per se, need not be a primary factor in etiology.

Could the difference be due to the inheritance of single or multiple genes which predispose the vascular system to hypertension when acted upon by a specific single stress or a combination of stressful factors? It may be possible that the gene is present in equal proportions in both races with the essential difference being that of time of expression. The time of expression may be determined by an unknown environmental factor. One is reminded of the situation in Huntington's chorea in which time of onset is variable. In this case, a possible inciting factor may be postulated, but the time of physiological surrender to this factor may be genetically determined. This "time of expression" may be the point at which the individual person leaves the distribution of "normal" persons to join the "pathological" distribution. This study points out the time of life at which divergence of the mean by age of systolic blood pressure in the two races occurs (the "plateau" effect seen in the white race). This divergence indicates that the probability of initiation of a pathological process differs with time between the races. The probability increases at a regular rate in the Negro, and remains constant or actually decreases in the white person until middle life, at which time probability of initiation of disease increases markedly.

Another genetic possibility is that of a greater frequency of the offending gene or genes in the Negro than in the white race. It is personally felt that a differential frequency is not essential to explain the differences in pattern seen, but rather that "time of expression" is the crucial point.

Many possibilities of inheritance exist, awaiting investigation. Other factors such as the demonstrated sex differences require elucidation, as well as the effects of parity. It is possible that pregnancy itself may partially explain the lowered pressures of women in the reproductive age. Body build, although undoubtedly of some effect, seems not to be of primary importance.

A desirable adjunct to the present data would have been clinical appraisals, particularly of renal disease. Although current knowledge is fragmentary, it is possible that differences in frequency of renal abnormality or susceptibility to infection may in part explain the racial differences seen.

What has been learned regarding that elusive unknown, a possible inciting factor? This was not the basic purpose of the study. Nevertheless, the question of the influence of salt intake would seem to have been partially resolved, at least in its affect on a population. A similar study in St. Kitts[4] showed considerable similarity to the present study with regard to blood pressure trends. Yet, the St. Kitts Negroes had a low salt intake in food and water while Negroes in Nassau are presumed to be considerably higher in average salt intake.

In conclusion, this study has attempted to delineate differences in patterns of blood pressure in the Negro and white races living in a similar environment. The goal has been to define, in broad terms, susceptible groups of people so that when a more definitive test of individual susceptibility is devised, one may concentrate effort in the more restricted areas in the search for possible inciting factors which may precipitate the hypertensive state. Also discussed has been the concept of hypertension as a condition in which the initiation of the disease state may be at relatively low levels of blood pressure, overlapping blood pressures of persons who are still, in truth, "normal". Identification of these "hidden hypertensives" is the important goal in understanding of the disease, its treatment and prevention.

APPENDIX

SYSTOLIC BY DIASTOLIC (5TH PHASE) BLOOD PRESSURES, CASUAL FIRST READING

White Males - Age 6-9 (45 Persons)

Nassau - 1958

	Diastolic																				
Systolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
80-89		1																			
90-99				3	3	4	2														
100-109	1 (020)		1	4	2	4	2	1		2											
110-119							5	4	1	1											
120-129				1		3															

White Males - Age 10-14 (28 Persons)

	Diastolic																				
Systolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
80-89	1 (038)																				
90-99				1		2															
100-109		1			1	1		2													
110-119			1		2		1	2	2												
120-129			1	1	1	2	1	2		1											
130-139				1																	
140-149																					
150-159				1																	

White Males - Age 15-19 (33 Persons)

	Diastolic																				
Systolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
100-109					1																
110-119						3	1	2	1												
120-129					1	1	1	2	1	2											
130-139						2	2		1	3	1										
140-149						1	1		2	1											
150-159					1	1															
160-169												1									

White Males - Age 20-24 (34 Persons)

	Diastolic																				
Systolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
100-109				1			1														
110-119						3		3	1	1											
120-129						2	1	2		2	1										
130-139						1		2		3											
140-149	1 (032)							1		1	2	1	1								
150-159						2															
160-169																					
170-179																1					

White Males - Age 25-29 (30 Persons)

	Diastolic																				
Systolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
110-119			1			2		1	2	1											
120-129						3		1	1	2											
130-139						1	1	1	1	2		1	1								
140-149					1				1	2	1										
150-159									1	1		1									

White Males - Age 30-34 (38 Persons)

	Diastolic																				
Systolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
100-109						1	2	2		1											
110-119						1	2	3		1		1									
120-129					1		1	1	1	2	1										
130-139								4	2	2	1										
140-149								1		2		3		2							

SYSTOLIC BY DIASTOLIC (5TH PHASE) BLOOD PRESSURES, CASUAL FIRST READING

White Males - Age 35-39 (22 Persons)

Systolic \ Diastolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
90-99							3														
100-109						1	1														
110-119										1											
120-129							1	1		2	2										
130-139						1		1		1		2									
140-149							1	1				1									
150-159															1						
160-169																					
170-179														1							

White Males - Age 40-44 (22 Persons)

Systolic \ Diastolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
110-119									2	1											
120-129								2	1	1	1										
130-139						2				1	1	1	2								
140-149									1	1											
150-159											1			1	1						
160-169												1									
170-179																1					

White Males - Age 45-49 (20 Persons)

Systolic \ Diastolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
100-109						1		2													
110-119						1		1		1		1									
120-129								2	1	1											
130-139										1			1								
140-149								1				1									
150-159											1	2			1						
200-209					1																

White Males - Age 50-54 (14 Persons)

Systolic \ Diastolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
110-119										2											
120-129									1	1											
130-139										1	2										
140-149								1		1		1									
150-159												1	1								
160-169																1					
170-179												1									

White Males - Age 55-59 (11 Persons)

Systolic \ Diastolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
100-109								1													
110-119										1											
120-129									1	2											
130-139										1		1									
140-149												1									
150-159									1												
160-169													1								
200-209										1											

White Males - Age 60 or Over (28 Persons)

Systolic \ Diastolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
100-109						1															
110-119				1						1											
120-129						1	2	1	1												
130-139						1	1		2	1											
140-149						1		1	1	1			1								
150-159										1											
160-169								1		1		1		1							
170-179										1											
180-189											1										
190-199														1	1				1		

SYSTOLIC BY DIASTOLIC (5TH PHASE) BLOOD PRESSURES, CASUAL FIRST READING

White Females - Age 6-9 (47 Persons)

Diastolic

Systolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
80-89				1		1															
90-99					1	4	1	4													
100-109				1		9	1	4		4											
110-119		1		1	2	1	2	2	1												
120-129					1			1		1		2									
130-139								1													

White Females - Age 10-14 (36 Persons)

Diastolic

Systolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
80-89				1																	
90-99				1		1															
100-109		1	1	1		1	2														
110-119					3	2	2	3		2											
120-129					1		1	3		1		1									
130-139						2		3			1										
140-149												1									
150-159											1										

White Females - Age 15-19 (31 Persons)

Diastolic

Systolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
100-109					1	4		1													
110-119					1	2	2	1	1	1											
120-129					2		1	4		1											
130-139				1		4				2											
140-149						1			1												

White Females - Age 20-24 (43 Persons)

Diastolic

Systolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
90-99					1	1															
100-109				1	1		1	1	2												
110-119			1			3	1	3	1	1		1									
120-129					1	1	1	4	2	2		2		1							
130-139						2		1	1	1											
140-149												1		1							
150-159				1																	
160-169												1	1								

White Females - Age 25-29 (39 Persons)

Diastolic

Systolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
90-99							1	1													
100-109						1	2	1	1	1											
110-119						1		4	3	3											
120-129				1		1		1	3	4		2									
130-139						1		1	2	2											
140-149												1									
190-199															1						

White Females - Age 30-34 (33 Persons)

Diastolic

Systolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
90-99						1															
100-109	1 (000)			1		1		2	1	1											
110-119						1		1	4	1											
120-129								2	1	2		1									
130-139									1	1	4		1	1							
140-149														1							
150-159											2					1					

SYSTOLIC BY DIASTOLIC (5TH PHASE) BLOOD PRESSURES, CASUAL FIRST READING

White Females - Age 35-39 (27 Persons)

Systolic \ Diastolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
90-99								1													
100-109				2		1	1	1		1											
110-119					1		1		2	1											
120-129									4	3	1	1									
130-139												1									
140-149									1			1									
150-159												1									
160-169													1			1					

White Females - Age 40-44 (25 Persons)

Systolic \ Diastolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
90-99						1															
100-109						1		1													
110-119									2												
120-129									1	1											
130-139							1	1		1											
140-149										2		2									
150-159												2									
160-169												1		3							
170-179												1					1				
180-189												1									
200-209																1					
250-259																				1	

White Females - Age 45-49 (20 Persons)

Systolic \ Diastolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
100-109										1											
110-119									1	1											
120-129								1	1	1											
130-139									1	2	1	1									
140-149							1					1									
150-159									1												
160-169												3		1							
170-179														1							
210-219														1							

White Females - Age 50-54 (15 Persons)

Systolic \ Diastolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
120-129									1	1		1									
130-139									2		2										
140-149										1											
150-159												1									
160-169											1	3									
170-179													1			1					

White Females - Age 55-59 (16 Persons)

Systolic \ Diastolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
90-99								1													
100-109							1														
110-119						1				1											
120-129								2													
140-149							1		1												
160-169												1	1								
170-179								1													
180-189														1							
190-199														1		1					
200-209												1									
260-269																	1				

White Females - Age 60 or Over (30 Persons)

Systolic \ Diastolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
110-119							1														
120-129									1												
130-139						1	1	2	2	1											
140-149						1		3		1		2									
150-159										1	1	2									
160-169									1	1		1									
170-179	1 (032)											2		1							
180-189												1									
200-209											1										
240-249															1						

SYSTOLIC BY DIASTOLIC (5TH PHASE) BLOOD PRESSURES, CASUAL FIRST READING

Negro Males - Age 6-9 (154 Persons)

Systolic	Diastolic Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
80-89	1 (038)	2		2	4	6															
90-99	2 (036)		1	1	6	16	4	5	1												
100-109	1 (020)			4	6	17	8	17	3	5											
110-119				3	4	8	2	9	1	5											
120-129								2	1												
130-139						1				1											
140-149									1												

Negro Males - Age 10-14 (143 Persons)

Systolic	Diastolic Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
80-89	1 (034)				1																
90-99		1		2	3	3	1	4	4												
100-109	1 (038)	1	1	7	9	9	9	14	5	2											
110-119				6	5	4	6	8	3	5											
120-129				1		3	2	6	2	4	1										
130-139				1				1		1		1									
140-149								2		1	1	1									

Negro Males - Age 15-19 (139 Persons)

Systolic	Diastolic Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
100-109				1			3	2	2	2											
110-119			1	3		4	4	12	5	6	2	1									
120-129			1	2	2	4	5	9	5	12	6	3									
130-139	1 (032)				1	3	2	6	3	3		3									
140-149							1	3			2	2		1							
150-159		1				1		1		3	1			1	1						
160-169						1															
170-179												1									

Negro Males - Age 20-24 (123 Persons)

Systolic	Diastolic Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
90-99	1 (038)						1	2													
100-109					1		1	1	1												
110-119		1	1		1	4	6	6	3	4	3	1									
120-129					1	4	3	5	2	10	5	5									
130-139						1	1	2	3	3	6	4	1	1	1						
140-149					1				4	4	1	2	1	3							
150-159								1		2	1			1							
160-169								1						2							
190-199															1						
200-209															1						

Negro Males - Age 25-29 (98 Persons)

Systolic	Diastolic Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
90-99						1	1														
100-109				1		5		1													
110-119				1			3	2	3	4		1									
120-129						1	1	3	1	5	2	2									
130-139				1		1		4	2	6	5	4	1								
140-149						1	1			2	4	4	2	1	1	1					
150-159								1		3		2	1	2	1						
160-169									1					2	1	2					
170-179																2		1			

Negro Males - Age 30-34 (58 Persons)

Systolic	Diastolic Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
100-109							1		1	1											
110-119						1	2	3		6											
120-129								2	2	5	2	3									
130-139						1		2	1	2	4		1		1						
140-149										2		1			1						
150-159									1							1					
160-169													2	2		1	1				
170-179																1				1 (210,140)	
180-189															1					1 (230,155)	
190-199																		1			

SYSTOLIC BY DIASTOLIC (5TH PHASE) BLOOD PRESSURES, CASUAL FIRST READING

Negro Males - Age 35-39 (55 Persons)

Systolic	Diastolic Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
90-99						1															
110-119								1		3											
120-129				1				3		3	1	3		1							
130-139									1	2	2	6	1	2							
140-149								1		1		4	1	1							
150-159										1		1		1							
160-169											1				2	2					
170-179													2	1							
180-189																1		1		1	
220-229																				1	
230-239																				1	

Negro Males - Age 40-44 (67 Persons)

Systolic	Diastolic Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
100-109								1	2	1											
110-119						1			1	2		1									
120-129								1	3	5	3	1	1								
130-139							1	1	2	3	2	5	1								
140-149										2	1		1	2	1	2					
150-159									1				1	1	3		1				
160-169									1		1			1	1						
170-179																1					
180-189																1	1	1			1(196,142)
200-209																				1	
210-219														1							1(224,140)
240-249													1								

Negro Males - Age 45-49 (67 Persons)

Systolic	Diastolic Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
90-99								2													
100-109				1																	
110-119									4	1											
120-129								1	1	4	2	4									
130-139										2		3		1							
140-149								1				5	5	2		1					
150-159										1		1	2	1	2						
160-169											1	2			3	1			1		
170-179										1			1	1	1	2		1			
180-189																2				1	
200-209																			1		1(200,140)

Negro Males - Age 50-54 (37 Persons)

Systolic	Diastolic Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
110-119								1		1											
120-129								1	1	1	1	1									
130-139										4	1	2									
140-149										2	1	1	1								
150-159												2				1					
160-169										1			1	1							
170-179													1			1	1				
180-189												1				1		1			
190-199														1				1			
200-209									1									1			
230-239														1	1						

Negro Males - Age 55-59 (16 Persons)

Systolic	Diastolic Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
90-99								1													
100-109										1											
110-119						1	1		1	1											
120-129											1										
140-149														1							
150-159										1		2		1							
160-169													1								
170-179												1									
190-199																		1			
240-249													1								

SYSTOLIC BY DIASTOLIC (5TH PHASE) BLOOD PRESSURES, CASUAL FIRST READING

Negro Males - Age 60 or Over (33 Persons)

Systolic	Diastolic Under 40	40-44	45-49	50-54	55-59	60-54	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
110-119								1													
120-129								1		1		1									
130-139										2											
140-149									1		1	3									
150-159								1	1	1			1	1							
160-169							1			1		3		1							
170-179										1								1			
180-189			1					1	1												
190-199													1	1							
210-219														1							1(280,140)
250-259																		1			
300-309																				1	

Negro Females - Age 6-9 (166 Persons)

Systolic	Diastolic Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
40-49	(032)																				
70-79			1																		
80-89	1 (038)			2	3	2															
90-99		2	2	6	5	15	9	9	1	2											
100-109	1 (036)	2	1	4	4	13	13	12	7	4	1										
110-119			1	3	3	3	6	4	6	6											
120-129		1		1			1	3	1	1	1										
130-139										1											
140-149												1									

Negro Females - Age 10-14 (139 Persons)

Systolic	Diastolic Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
80-89				1	1	1															
90-99			1			5	3	2	2												
100-109		2	2	2	3	11	5	6	3	5											
110-119	1 (036)	1	1	3	3	12	7	9	3	6	1	1									
120-129						7	3	5		8	2	2									
130-139			1	1	1		2	1	1	1											
140-149									1												

Negro Females - Age 15-19 (153 Persons)

Systolic	Diastolic Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
90-99			1	2	4	1	1														
100-109			1	2	2	8	4	6													
110-119			1	2	3	7	11	12	6	8	3	1									
120-129			1		5	7	4	5	4	7	3	3									
130-139						2	3	4	1	3	2	2	1	1							
140-149								1	2					1							
150-159									1												
160-169				1												2					
180-189																		1			

Negro Females - Age 20-24 (170 Persons)

Systolic	Diastolic Under. 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
90-99		1	1	1	1	2	2														
100-109		2	2	5	2	7	1	4	6	1											
110-119			1	2	6	11	8	14	3	7	2	3									
120-129				1		2	2	8	7	6	2	3		1							
130-139						2	3	2	2	7	1	3	2								
140-149										1	2	3	2	3		1					
150-159										1	1		1	1		1					
160-169														1							
170-179											1										1(210,140)

SYSTOLIC BY DIASTOLIC (5TH PHASE) BLOOD PRESSURES, CASUAL FIRST READING

Negro Females - Age 25-29 (128 Persons)

Systolic \ Diastolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
80-89					1																
90-99						3															
100-109			1	2	5	2	2	5	1	2											
110-119		1			1	4	5	3	4	8	2										
120-129							1	5	9	10	6	4									
130-139									2	4	1	7									
140-149					2							6	1	4							
150-159										1						3					
160-169															1	1		1			
170-179															1	1					
180-189															1		1				
230-239																	1			1(236,146)	
250-259												1									

Negro Females - Age 30-34 (86 Persons)

Systolic \ Diastolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
90-99						1															
100-109					1	1	3	4													
110-119						1	2	4	2	1											
120-129							2	2	4	9	5	1									
130-139									1	5	5	4	1								
140-149								1		3	2	1	1	3							
150-159										1		1	1	1		1					
160-169										1			1	1	1						
170-179														1						1	
180-189												1					2	1			
190-199																		1			

Negro Females - Age 35-39 (109 Persons)

Systolic \ Diastolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
90-99				1		2															
100-109						1	1														
110-119							1	2	1	4	1										
120-129							2	3	4	8	3	5									
130-139						1	2		1	4	2	7	1	1							
140-149									1	4	7	5	3		1	1					
150-159												5	1	1		1					
160-169											1	3	1	1							
170-179										1			1	1							
180-189																3	1	2			
190-199														1							
200-209																		1			
210-219																					
260-269																1					

Negro Females - Age 40-44 (87 Persons)

Systolic \ Diastolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
90-99				1																	
100-109						3	1			1											
110-119		1			1			2	3	4		1									
120-129									1	6	1	1									
130-139									2	2	3	3	2								
140-149										4	2		2	2	1						
150-159								1	2	1	2			3	1						
160-169											2		1	3	1						
170-179														1		1					
180-189												1		1	2	2					
190-199													1			1					
200-209																2		1		1(215,144)	
210-219															1	1		1			
230-239																		1			
250-259																				1	
																				1(280,140)	

SYSTOLIC BY DIASTOLIC (5TH PHASE) BLOOD PRESSURES, CASUAL FIRST READING

Negro Females - Age 45-49 (75 Persons)

Systolic \ Diastolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
100-109								2													
110-119						1	1	3	2	3	1	1									
120-129								1		2		1									
130-139								1	3	3	1	1									
140-149									1	3	5	3	2	1							
150-159										2		5	1		1						
160-169										1	1	1	1	2	1						
170-179											1										
180-189													1	1		2			1		
190-199													1				1	1			
200-209																1					
210-219																1	1		1		
230-239																				2	
240-249																		1			
250-259																				1	

Negro Females - Age 50-54 (46 Persons)

Systolic \ Diastolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
80-89						1															
100-109							1			1											
110-119											1					1					
120-129								2	1	1	2	1									
130-139											2	1	1								
140-149											1	2		2							
150-159	1 (008)									2		3		1							
160-169								1						2		1					
170-179												1	1	1		1					
180-189										1		1			1	1					
190-199																1					
200-209														1		1					
210-219																1					
250-259																	1				
310-319																				1	

Negro Females - Age 55-59 (30 Persons)

Systolic \ Diastolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
120-129									1	1	1										
130-139										1											
140-149									1				1								
150-159										1			1								
160-169											1		2								
170-179										1		1	1	1							
180-189										1		3									
190-199														2							
200-209															1			1			
210-219														1							
220-229												1					1				
240-249													1							1	1
																				1(300,140)	

Negro Females - Age 60 or Over (61 Persons)

Systolic \ Diastolic	Under 40	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	125-129	130-134	135-139
120-129							1	1		1											
130-139						1		1	1	1	1										
140-149										1				1							
150-159							1		1	2		3									
160-169						1	1	2		4		1		1							
170-179				1				1	1	1	1	1		2							
180-189								1		2	2	3			1						
190-199														4		1					
200-209													1					1			
210-219															1	1		1			
230-239													1							1(220,150)	
240-249														1			1				
250-259																	1				
270-279																	1				

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