BLOOD PRESSURE DISTRIBUTION IN APPARENTLY HEALTHY ADOLESCENTS

A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF MASTER OF SCIENCE

IN THE GRADUATE SCHOOL OF THE

TEXAS WOMAN'S UNIVERSITY

COLLEGE OF NURSING

BY

PATRICIA B. HOWORTH, B.N., B.N.

DENTON, TEXAS

AUGUST 1978

The Graduate School

Texas Woman's University

Denton, Texas

March 3 19 78

We hereby recommend that the Thesis prepared under our supervision by Patricia B. Howworth entitled "Blood Pressure Distribution in Apparently Healthy Adolescents"

be accepted as fulfilling this part of the requirements for the Degree of Master of Science

Committee:

Tommie L. Wallace
Chairman

Dawn M. Bruce

Alfreda Stephney

Accepted:

Phyllis Bridges
Dean of The Graduate School

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF FIGURES

LIST OF GRAPHS

CHAPTER I

INTRODUCTION

Estimates of hypertension in adults cluster around 23 million affected people. Once diastolic hypertension (greater than 90 mm Hg) has appeared, the average duration of life is about 20 years (Wolf, 1973). Therefore, it is desirable that blood pressure readings in excess of normal be recognized as early as possible in order that treatment may be instituted.

More literature is available on hypertension in adolescents than on blood pressure distribution in adolescents. However, in order to identify hypertension in adolescents, normotension needs to be defined. To date there is a lack of research, and, therefore, a lack of agreement on normal systolic and/or normal diastolic blood pressure readings in this age group.

There is a need for a replicable random study in various geographical areas by various researchers to define normotension in adolescents. These studies will have to account for the age, sex, and race of the adolescents involved as well as the apparent health status.

Statement of Problem

The problem of this study was to define blood pressure distribution in a sample population of adolescents.

Purpose

The purpose of this study was to determine the mean distribution of blood pressures in adolescents by (1) age, (2) race, and (3) sex.

Background and Significance

Hypertension affects between 10 and 20 percent of the adult population (Swartz & Leitch, 1975). The incidence of hypertension in adolescents is reported as low as 0.9 percent and as high as 36 percent (Kilcoyne, 1975). Such wide variations of reporting are due to several factors such as size of population, geography, and discrepancies between age, sex, race, and measure of presence of obesity. Perhaps the major reason for such wide variations is the fact that generally accepted blood pressure norms have not been established for adolescents. Some authorities state that normal adult levels of blood pressure are reached around the time of puberty (Haggerty, Maroney & Nadas, 1956; Barness, 1972; Ziai, 1969). Chinn stated that there is a "significant gain in systolic pressure with the onset of puberty" (1974, p. 181) and quoted the Haggerty et al.,

table of normal pressures. Wolf (1973) stated that the average blood pressures of adolescents are 114 mm Hg systolic and 70 mm Hg diastolic in females, and 116 mm Hg systolic and 72 mm Hg diastolic in males. No age is given for these averages. Other authors stated that blood pressure increases from infancy through adolescence (Kilcoyne, 1975; Marlow, 1973; Vaughan & McKay, 1975).

Hypertension is found in adolescents more frequently than previously assumed (Bennet, 1974). Since hypertension in adolescents usually is not symptomatic (Swartz & Leitch, 1975), the need for having the child's and the adolescent's blood pressure measured becomes apparent (Kotchen et al., 1974). Health professionals must agree on the normal range of blood pressure in order to determine whether a disease-state exists. If, in fact, the blood pressure does increase through adolescence, rather than reach adult levels around puberty, then defining hypertension as 140 mm Hg systolic and 90 mm Hg diastolic (Heyden et al., 1969; Kilcoyne, Richter & Alsup, 1974; Londe, Boirgorgnie & Robson, 1971; Wolfe, 1973) is too high and would miss many adolescents. If adolescents do attain adult levels of blood pressure around the time of puberty, then the definition of 140 mm Hg systolic and 90 mm Hg diastolic would reflect accurately hypertensive levels. Haggerty et al., (1956) alluded to the

fact that a persistent blood pressure of 130 mm Hg systolic, and 90 diastolic is the upper range of normal. Several authors defined hypertension simply as diastolic greater than or equal to 90 mm Hg without regard to age group (Bennett 1974; Korobkin, Perloff & Palubinskcas, 1976). Two studies defined hypertension in adolescents as above the 90 and 95 percentile of average blood pressure reading for age (Lone, Boirgorgnie & Robson, 1971; Vaughan & McKay, 1975). How these authors determined blood pressure percentile for age is not clear.

While about 90 percent of adult hypertension is considered to be essential, children and adolescents often do have a recognizable underlying cause. Most commonly these causes will be diseases of renal, neurological, cardiovascular, or endocrine origin (Haggerty et al., 1956; Vaughan & McKay, 1975; Ziai, 1969). However, Loggie et al., (1975) found abnormalities in only 5 of 74 hypertensive children. Surprisingly, Loggie's study showed that 30 to 35 percent of hypertensive children and adolescents become normotensive in adulthood even without medical intervention. For those who do remain hypertensive, the risks of congestive heart failure, renal failure, malignant hypertension, stroke, and myocardial infarct are greatly increased (Wolfe, 1973).

This study was done to investigate the distribution of blood pressures by age, race, sex, and presence or absence of obesity as determined by skin-fold thickness over the triceps muscle. It is anticipated that this study will augment the research which has been conducted in this area.

Definition of Terms

For the purpose of this study, the following definitions are given.

1. Adolescents--subjects, male and female, from age 15 through 17 years.

2. Adolescent hypertension--blood pressure reading of systolic greater than or equal to 140 mm Hg and/or diastolic greater than or equal to 90 mm Hg (Heyden et al., 1969; Kilcoyne et al., 1976; Liberman et al., 1974).

3. Essential hypertension--hypertension with no recognizable underlying cause.

4. Malignant hypertension--hypertension which quickly worsens and may end in death.

5. Obesity--excessive fat content of the body. This is determined by the measurement with calipers of the skin-fold thickness over the triceps muscle which is then compared to Rowland's table (1970) (see table 1).

TABLE 1

THE CUTOFF POINT FOR OBESITY BY AGE

Age (Years)	Triceps Skinfold Thickness Initial Level of Obesity	
	Male (mm)	Female (mm)
14	17	23
15	16	24
16	15	25
17	14	26
18	15	27
19	15	27

Source: Rowland, 1970, p. 184.

6. Korotkoff sounds--those five phases of sounds which come audible over the brachial artery during blood pressure measurement:

> Phase I: That period marked by the first appearance of faint, clear tapping sounds which gradually increase in intensity.
> Phase II: The period during which a murmur or swishing quality is heard.
> Phase III: The period during which sounds are crisper and increase in intensity.
> Phase IV: The period marked by the distinct, abrupt muffling of sound so that a soft, blowing quality is heard.
> Phase V: The point at which sounds disappear (Kirkendall et al., 1967, p. 13).

7. Systolic blood pressure--the reading of the blood pressure at the time that the first sound is heard or the first Kortokoff sound.

8. Diastolic blood pressure--the reading of the blood pressure at the time that the last sound is heard or the fifth Korotkoff sound.

Limitations

This study was limited by the following

1. The adolescents came from one urban population group.

2. The racial distribution of population in this particular geographical area was primarily white and black.

Delimitations

The delimitations for this study included

1. All subjects having a history of renal, cardiovascular, neurologic, or endocrine disease were eliminated from the study as these diseases commonly are the cause of hypertension in the child and adolescent age groups (Ziai, 1969).

2. Only those subjects 15 through 17 years of age were included.

Assumptions

For the purpose of this paper the following assumptions were made:

1. Hypertension occurs in adolescents.
2. Some hypertension in adults has its origin in childhood and adolescence.

Summary

Hypertension is a serious problem whose roots may reach back into adolescence and childhood. The variables of normotension through these years of growth and development are poorly defined. Strict delineation of blood pressure in young people studied by age, race, and sex is of significance if these factors do cause it to vary from the adult norm.

CHAPTER II

REVIEW OF LITERATURE

"The systemic arterial pressure is the driving pressure of the capillary circulation through the body" (Dollery, 1971, p. 9). Blood pressure is defined more precisely by Guyton as:

> the force exerted by the blood against any unit of the vessel wall. When one says that the pressure in a vessel is 50 mm Hg, this means that the force exerted would be sufficient to push a standard column of mercury up to a level of 50 mm (1971, p. 209).

There are a great number of variables which affect the blood pressure from the purely physical standpoint, such as the caliber of the blood vessel or the distance of the blood vessel from the prime pump, to the psychological and emotional state of the individual (Guyton, 1971).

If only one measurement of each subject's blood pressure is made, the examiner will have very little idea of its precision. In many population studies the variance of single readings of blood pressure have been attributed entirely to differences between individuals, without consideration of the possibility that an important component might arise from variability within individual subjects (Armitage & Rose, 1966). Figure 1 from the work

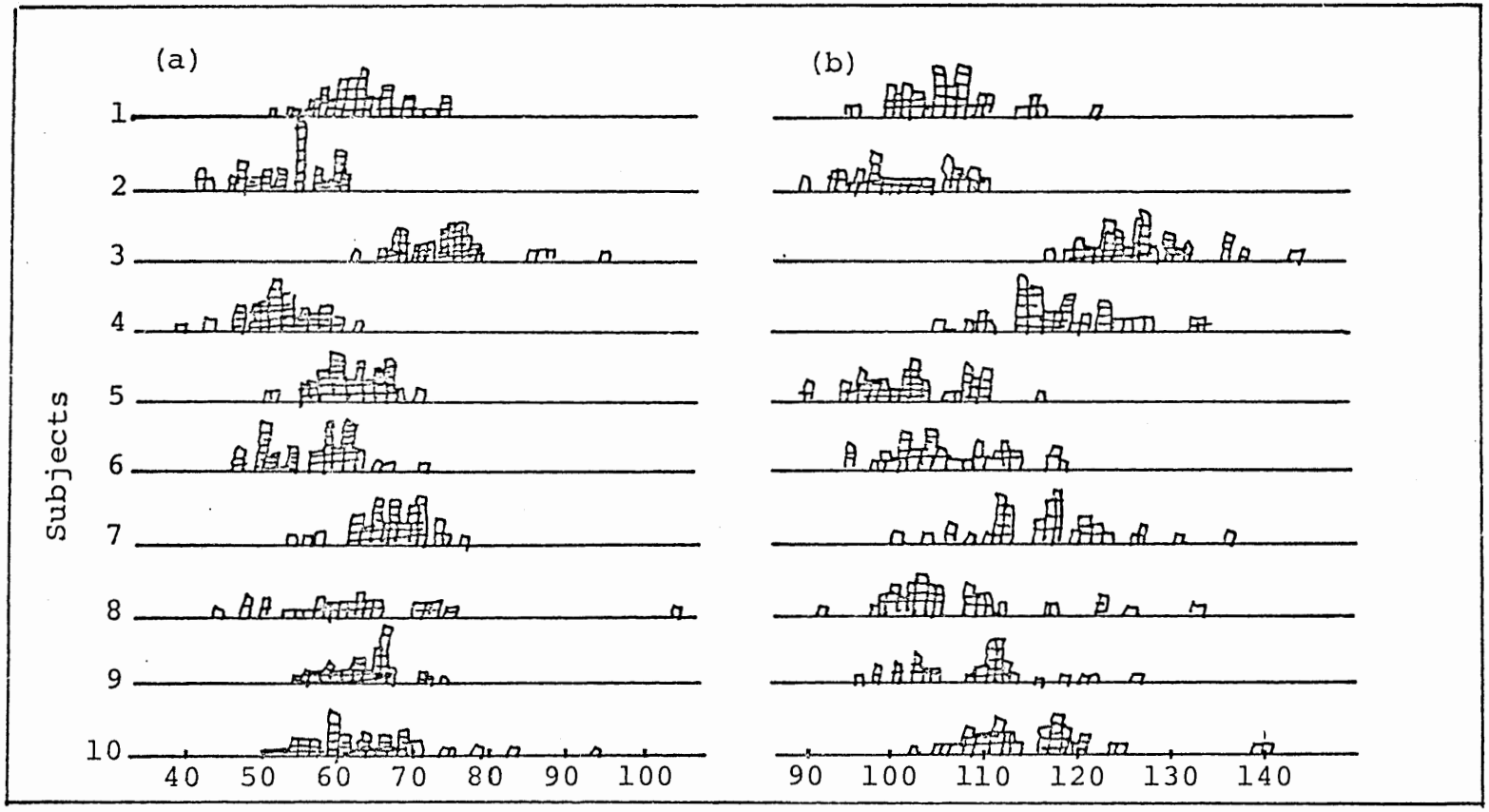


Fig. 1. Results of duplicate readings of casual blood pressure on 20 occasions for each of 10 subjects: (a) diastolic (phase 4), and (b) systolic (Armitage & Rose, 1966, p. 32).

of Armitage and Rose (1966), gives a general picture of the scatter of casual blood pressures in individuals. The mean pressures for all subjects were 111.9 mm (systolic), 65.4 mm (diastolic, phase 4), and 62.3 mm (diastolic, phase 5) (Armitage and Rose, 1966).

Smirk (1973) discussed factors which elevate blood pressure above the basal level, such as "physical, emotional, and metabolic stimuli. . . . Many of these are environmental but emotional stimuli may also be endogenous" (pp. 18-19).

In a large study done by the Department of Health, Education, and Welfare on the blood pressure of adults by age and sex, a sample of 7,710 people had a series of three blood pressures taken in a uniform manner with an attempt to achieve a fairly basal level. This study:

> . . . shows a tendency for systolic blood pressure to rise with age over the age range of 18-79 years, while diastolic blood pressures rise until age 45-54 years for men and age 55-64 for women, after which they decline. At younger ages blood pressures are higher for men than for women; at older ages this is reversed (U.S. National Center, 1964, p. 6).

These findings are illustrated by table 2 and figure 2.

Since it is imperative that the blood pressure be measured as accurately as possible and with reasonable ease for both the subject and the examiner, an indirect method of taking blood pressure using the sphygmomanometer is the more practical.

TABLE 2

MEAN BLOOD PRESSURE IN ADULTS, BY AGE AND SEX:

UNITED STATES, 1960-1962

Age	Systolic			Diastolic		
	Both Sexes	Men	Women	Both Sexes	Men	Women
	Mean blood pressure in mm hg					
All ages--18-79 years	130.9	132.1	129.9	78.7	79.4	78.1
18-24 years	116.4	121.7	111.8	70.4	71.6	69.4
25-34 years	119.9	124.7	115.6	74.6	76.4	72.9
35-44 years	125.6	128.6	122.8	79.3	80.7	78.0
45-54 years	133.8	133.8	133.8	82.6	83.2	82.0
55-64 years	143.6	140.3	146.6	84.0	83.1	84.9
65-74 years	154.8	148.0	160.2	82.5	81.0	83.7
75-79 years	155.5	154.3	156.6	79.4	79.4	79.3

Source: U.S. National Center, 1964, p. 6.

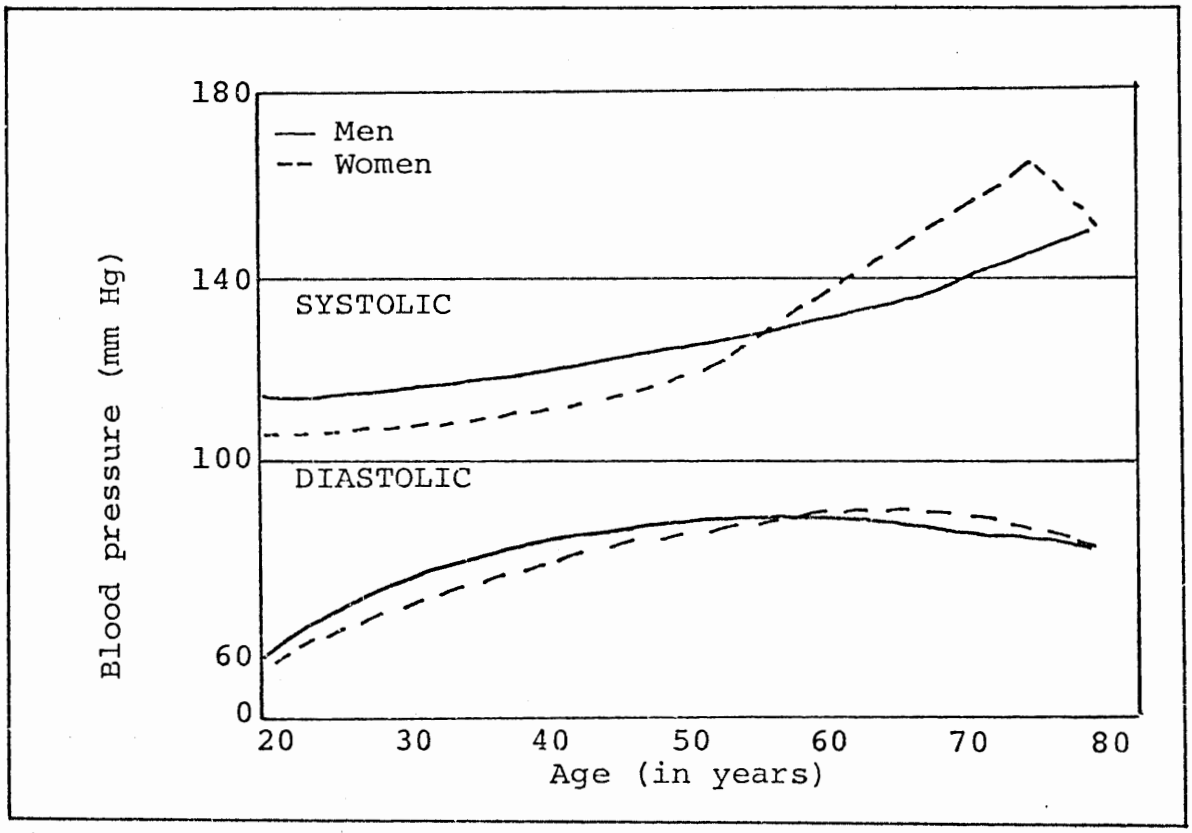


Fig. 2. Blood pressure in adults, by age and sex: United States.

Source: U.S. National Center, 1964, p. 6.

> Factors that contribute to inaccurate blood pressure readings include defective apparatus, faulty technique, clinician error, and failure to consider the client in total perspective (Lancour, 1976, p. 773).

In a study done by LaBarthe, Hawkins, and Reminton, several indirect reading devices were evaluated on the basis of ". . . suitability in clinical screening, effectiveness in continuous blood pressure monitoring, and the

measurement capability in extreme clinical states such as shock" (1973, p. 552). This evaluation suggested that the test instruments were reliable over periods of continuous use. There had to be close agreement between measurements, and there had to be close approximations to the readings with the standard mercury sphygmomanometer. The study concluded that none of the other instruments tested were an adequate replacement for the mercury shygmomanometer (LaBarthe et al., 1973). Corns (1976), in her discussion on maintenance of blood pressure equipment, validated the aneroid manometer as being as accurate as the mercury manometer subject to appropriate calibration and servicing.

Moss (1968) noted that improper technique is a cause of error in measurement of blood pressure. A cuff of appropriate width is necessary. He recommended that the subject be either recumbent or in a sitting position with the arm in a relaxed position at the level of the fourth intercostal space. Cuff selection is particularly important:

> The cuff should be made of a nondistensible material, so that as far as possible an even pressure is exerted throughout the cuff . . . . A recently devised cuff is held in place simply by mating surfaces of a special interlocking fabric (American, 1967, p. 10).

The bladder of the cuff must encircle the arm. If the bladder does not completely encircle the arm, a bias may be introduced which could influence the outcome of a study. The width of the bladder must be 20 percent greater than the diameter of the upper arm (Voors, 1973). Others stated that the width of the bladder of the cuff must cover approximately two-thirds of the length of the upper arm (Marlow, 1973; Silver et al., 1969). Alexander and Brown (1974) stated that the bladder of the cuff must not exceed two-thirds or be less than one-half the length of the upper arm.

The American Heart Association stated that, "the stethoscope should be of a standard variety and in good condition" (1967, p. 11). Also, "the stethoscope should not touch clothing or the pressure cuff" (1967, p. 13).

Moss (1968) offered several explanations for the induced vascular sounds in auscultatory syphgmomanometry. He suggested that these include sudden vessel wall expansion, the "water hammer phenomenon," the "preanacrotic phenomenon," the Bernoulli effect and blood flow turbulence (p. 60). He explained this further in discussing some of the earlier research.

In 1905, Karotkoff postulated that as the pressure in the cuff is reduced, the pulsations force apart the

relaxed wall of the collapsed distal artery. The sudden abrupt stretching of the arterial wall is believed to cause the sound. In 1916, Erlanger proposed the water hammar hypothesis. Vessel wall vibration produces the sound because of the impact of a large volume of blood proximal to the cuff with the sluggish blood column distal to the cuff. In 1920, Erlanger suggested that the preanacrotic waves exert sudden shocks on the vascular wall and produce the sounds. A negative pressure wave appears with decompression of the blood vessel just before the anacrotic limb of the arterial pulse.

The Bernoulli effect hypothesis suggested that the vessel collapses intermittently and produces intermittent vascular wall vibration. In 1956, Lange and associates postulated that rapid changes in vessel diameter cause changes in velocity profile and a turbulent flow pattern is produced (Moss, 1968).

The American Heart Association (1967) (Moss, 1968; Smirk, 1973), and the cited authors who discussed blood pressure technique recognized certain well defined sounds called Karotkoff sounds. Karotkoff recommended that the onset of the first sound phase be accepted as the index of systolic pressure and that the end of the fifth phase, the

complete disappearance of vascular sound, be considered the index of diastolic pressure. There is general agreement on the first point but the second point is controversial.

In 1915, a committee functioning under the auspices of the American Heart Association decided that the disappearance of sound is a better index of diastolic pressure. The level of muffling of sound should be accepted only when the vascular sounds persist to zero. These recommendations were roundly criticized even as "a major setback to medical science" (Moss, 1968, p. 60). The recommendations of the American Heart Association indicated that blood pressures are based mainly upon observations reported by Stele in 1942. This investigation was somewhat limited in that measurements were compared in 41 adults but could be evaluated in only 25. Subjects ranged in age from 22 to 86 years and were not screened for hypertension, arteriosclerosis, or other cardiovascular disease. It is thought that muffling is a little more accurate than cessation of sound, but the estimation of diastolic pressure in children based on either sound is not extremely reliable (Moss, 1968).

The American Heart Association (1967) recommended the following technique for taking blood pressure. The blood pressure is recorded in both arms after the patient

has been in a quiet room at a comfortable temperature and he has had no exertion, no exposure to cold, no eating, and no smoking for one-half hour before the measurement and there is no postural change for five minutes before the recording. The deflated cuff is applied with the lower margin 25 mm above the antecubital space. The bladder of the cuff is located over the inner aspect of the arm. The stethoscope is then applied to the antecubital space over the previously palpated brachial artery. The diaphragm of the stethoscope is applied firmly but with minimal pressure and with no space between the skin and the diaphragm.

When the stethoscope is in place, the sphygmomanometer pressure is raised about 30 mm of Hg above the point at which the radial pulse disappears. The pressure is then released at a rate of 2 or 3 mm of Hg per second. The pressures are read as the various pertinent Karotkoff sounds become audible. The standard positioning of the forearm at the horizontal level of the fourth intercostal space at the sternum is recommended for blood pressure measurement in the sitting and upright position because random vertical arm displacement causes a consistent increase in the blood pressure as the arm is lowered (American Heart Association, 1967).

The systolic pressure is measured by the point at which the initial tapping sound is heard for at least two consecutive beats (Phase I). The fourth phase is presently regarded as the best index of diastolic pressure and this occurs at the onset of the muffling of sound. The fifth phase occurs when the sounds become inaudible. In the event of a difference between the readings of the fourth and fifth phases, both should be recorded (American Heart Association, 1967).

In defining hypertension Guyton stated:

> Hypertension is high arterial pressure. This subject is extremely important because about 12 percent of all persons die as a direct result of hypertension and about 20 percent of all people can expect to have high blood pressure at some time during their lives (1971, p. 304).

It is imperative that the hypertensive individual be located as early as possible in order that treatment may be started to avoid the predicted morbidity and mortality of the natural history of hypertensive disease (Guyton, 1971).

In a Task Force II report, presented by the National High Blood Pressure Education Program (1973), it was noted that only about half of the people in this country who have high blood pressure are ever found and only half of these are treated and only half of the treated are treated

adequately. The report also noted that people under 45 years are much less apt to be treated in spite of the serious morbidity in that age group. The study outlined and identified some of the reasons that so few people receive adequate care. These are (1) blood pressure examinations are not routine, particularly in the young patient; (2) blood pressure may be taken, but it is not recognized as being an abnormal blood pressure; (3) the patient is not informed of an elevated blood pressure; (4) patient denial; and (5) a failure to examine certain population groups--young people and high risk black males (National High Blood Pressure, 1973).

For a long time controversy has existed about treating hypertension partially because of the lack of controlled studies. Some have felt that reduction of elevated blood pressure might even be harmful because of reduced cerebral and coronary flow and because of drug side effects (National High Blood Pressure, 1973).

In four screening surveys of adults aged 18 to 79 years, involving approximately 110,000 people using essentially the same measuring techniques, the systolic blood pressure increased with age, but for most of the age span, the rate of increase was greater with increasing age (see figures 3 and 4). With diastolic blood pressure,

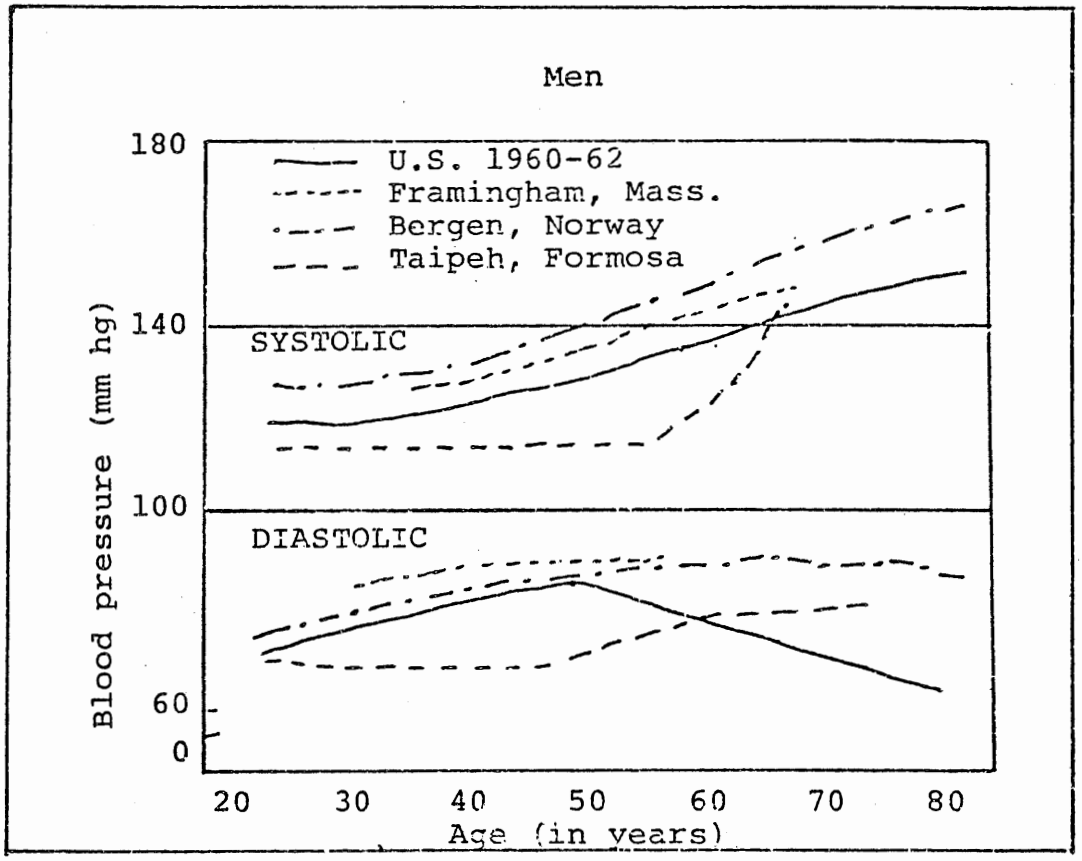


Fig. 3. Mean blood pressure, by age for men, 18-79 years for surveys.

Source: U.S. National Center, 1964, p. 10.

the rate of increase was less with increasing age. After ages 64 for men and 74 for women, the diastolic blood pressure decreased. It is possible that these surveys underestimate the tendency of blood pressure to increase as the hypertensive patient survives to an older age (U.S. National Center, 1964).

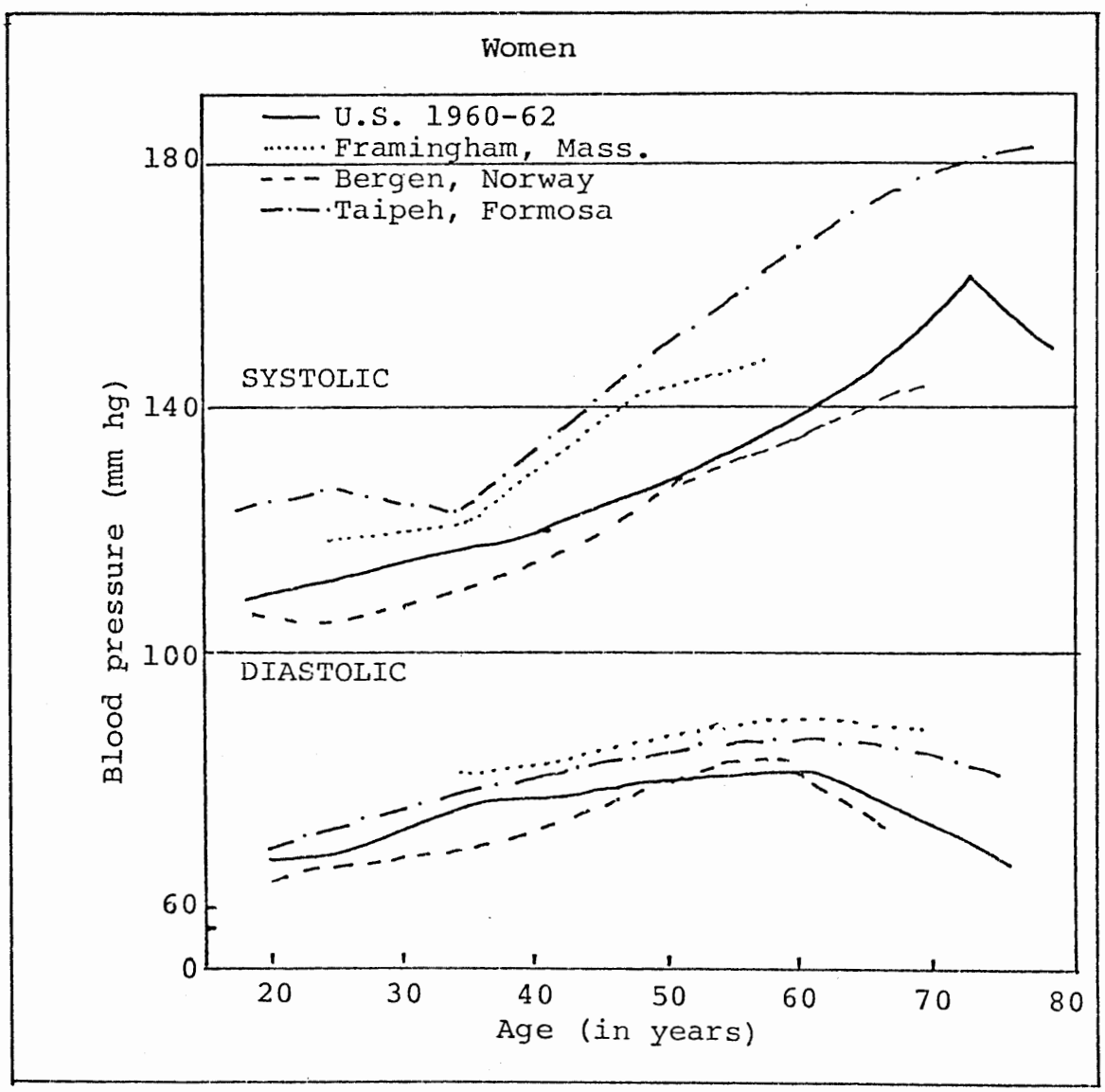


Fig. 4. Mean blood pressure, by age for women, 18-79 years for surveys.

Source: U.S. National Center, 1964, p. 10.

When all renal, endocrine, and central nervous system disorders are eliminated there are a great number of people left who still have high blood pressure. Their disease is called essential hypertension (Peart, 1975).

Peart (1975) stated that while hypertension with no recognizable cause is often called essential or idiopathic hypertension, there are genetic factors which contribute to the disease and, contributing to an even greater extent, are the environmental factors. Separated twins have developed severe and malignant hypertension at the same age.

The familial tendencies have been demonstrated by Mendlowitz (1973) when he established that if two parents have essential hypertension two out of three of their children will develop it. If one parent has the disease, one out of three of the children will have it.

Hennekins et al., (1976) found a significant correlation of blood pressure levels among siblings over the age of 15 years and have extended the study to include children age 2 to 14 years where they again found aggregations of similar blood pressure levels. Their findings indicated that there may well be genetic determinants to the tendency toward sibling aggregation of blood pressure and, therefore, hypertension.

Characteristics of blood pressure in the adolescent age group have been reported. These include a higher blood pressure in adults, in the black race, in males (particularly systole), in the obese, and in an inner-city school in one study (de Castro et al., 1976). Lower blood pressures tend to occur in children and adolescents, in the white race, in females, in athletes and the nonobese, and in those children enrolled in a private school (de Castro, 1976; Kilcoyne, 1975; Voors, 1975). However, it must always be borne in mind that individual children differ from each other (Marlow, 1973).

The various authors who do give tables with normotensive ranges for adolescents are not entirely in agreement. Wasserman and Slobody (1974) and Marlow (1974) (see table 3) each use tables beginning at birth. Wasserman and Slobody (1974) group the 10-15-year-olds and end with the "over 15 years" subjects (see table 3).

Marlow's (1974) table studied only adolescent male children and only in four-year increments (see table 4). Silver, Kempe, and Bruyn (1969) presented a table which includes a range of readings. This table is given in yearly increments up to and including 16 years of age at which point the blood pressure approaches standard adult readings (see table 5).

TABLE 3

HEART AND RESPIRATORY RATES AND BLOOD PRESSURE IN NORMAL CHILDREN

Age	Heart Rate, per Minute	Respiratory Rate, per Minute	Systolic Blood Pressure, mm Hg
Birth	140	40	60-80
6 months	110	30	90
1 year	100	28	90
3-4 years	95	25	100
5-10 years	90	24	100-110
10-15 years	85	20	110
Over 15 years	75-80	16-18	110-120

Source: Wasserman & Slobody, 1974, p. 9.

TABLE 4

AVERAGE NORMAL BLOOD PRESSURE READINGS FOR CHILDREN

Age	Systolic	Diastolic
Birth	40	--
1 month	80	--
r years	85	60
8 years	95	62
12 years	108	67
16 years (boys)	118	75
20 years (boys)	120	75

Source: Marlow, 1974, p. 72.

TABLE 5

RANGE OF NORMAL BLOOD PRESSURE
AT DIFFERENT AGES

Age (Years)	Mean Systolic (mm hg)	Mean Diastolic (mm Hg)
5	94 ± 14	55 ± 9
6	100 ± 15	56 ± 8
7	102 ± 15	56 ± 8
8	105 ± 16	57 ± 9
9	107 ± 16	57 ± 9
10	109 ± 16	58 ± 10
11	111 ± 17	59 ± 10
12	113 ± 18	59 ± 10
13	115 ± 19	60 ± 10
14	118 ± 19	61 ± 10
15	121 ± 19	61 ± 10
16	121 ± 19	61 ± 10

Source: Silver, Kempe & Bruyn, 1969, p. 205.

Haggerty, et al. (1956) are quoted frequently in relation to adolescent blood pressure readings. The authors presented variability identified as "two standard deviations." They gave yearly increments through the 13-14 age group. Using their identified standard deviations, this age child approaches accepted adult readings (see table 6).

Moss (1968) presented the most comprehensive table of readings although the sample sizes for some age groups are small. Moss' tables are divided as to sex. They

TABLE 6

NORMAL BLOOD PRESSURE FOR VARIOUS AGES

Ages	Mean Systolic ± 2 S.D.	Mean Diastolic ± 2 S.D.
Newborn	80 ± 16	46 ± 16
6 months-1 year	89 ± 29	60 ± 10
1 year	96 ± 30	66 ± 25
2 years	99 ± 25	64 ± 25
3 years	100 ± 25	67 ± 23
4 years	99 ± 20	65 ± 20
5-6 years	94 ± 14	55 ± 9
6-7 years	100 ± 15	56 ± 8
8-9 years	105 ± 16	57 ± 9
9-10 years	107 ± 16	57 ± 9
10-11 years	111 ± 17	58 ± 10
11-12 years	113 ± 18	59 ± 10
12-13 years	115 ± 19	59 ± 10
13-14 years	118 ± 19	60 ± 10

Source: Haggerty et al., 1956, p. 135.

identify the readings as means plus or minus two standard deviations. The table covers adolescents through 18.5 in yearly ranges (see tables 7 and 8).

The five previous tables all indicate that the children have reached adult levels of normotensive blood pressure at the age the table cuts off whether that be age 15, 20, 14, or 19 years. Their year-to-year comparisons of blood pressures do not correspond. The standard deviations of tables 7 and 8 put the subjects into the adult hypertensive range.

TABLE 7

RELATIONSHIP OF AUSCULTATORY BLOOD PRESSURE (mm Hg) TO AGE IN FEMALES

Age (Years)	Number	Adjusted Systolic ± Mean	Diastolic 1 Mean	Diastolic 2 Mean
2.50	3	98.0 ± 9.2	60.0 ± 11.1	26.7 ± 23.2
2.50-3.49	5	93.6 ± 5.4	63.6 ± 12.9	38.8 ± 22.7
3.50-4.49	17	99.3 ± 8.4	66.0 ± 9.8	46.6 ± 14.9
4.50-5.49	10	99.2 ± 5.9	62.2 ± 8.9	39.0 ± 16.4
5.50-6.49	16	103.5 ± 5.6	63.5 ± 8.9	37.2 ± 20.6
6.50-7.49	9	108.0 ± 7.0	73.1 ± 8.8	50.9 ± 17.1
7.50-8.49	14	105.1 ± 8.9	68.7 ± 10.6	42.9 ± 28.5
8.50-9.49	42	108.0 ± 9.1	68.0 ± 16.2	53.5 ± 23.5
9.50-10.49	49	108.3 ± 7.0	71.3 ± 8.7	60.5 ± 11.0
10.50-11.49	51	114.0 ± 11.2	67.1 ± 16.4	56.5 ± 22.1
11.50-12.49	45	117.1 ± 10.9	67.0 ± 15.0	55.4 ± 15.9
12.50-13.49	19	112.0 ± 7.2	65.5 ± 9.0	41.4 ± 25.3
13.50-14.49	7	108.9 ± 14.1	63.7 ± 12.4	52.9 ± 23.2
14.50-15.49	5	104.8 ± 7.2	75.2 ± 8.6	67.6 ± 11.3
15.50-16.49	9	106.9 ± 10.2	72.9 ± 10.6	61.8 ± 19.2
16.50-17.49	2	106.0 ± 19.8	60.0 ± 14.1	51.0 ± 21.2
17.50-18.49	2	96.0 ± 11.3	68.0 ± 11.3	66.0 ± 14.1
	305			

Source: Moss and Adams, 1968, p. 64.

TABLE 8

RELATIONSHIP OF AUSCULTATORY BLOOD PRESSURE (mm Hg) TO AGE IN MALES

Age (Years)	Number	Adjusted Systolic ± Mean	Diastolic 1 Mean	Diastolic 2 Mean
2.50-3.49	7	97.4 ± 8.8	65.1 ± 9.0	43.7 ± 20.0
3.50-4.49	10	100.2 ± 10.0	57.4 ± 23.0	37.0 ± 22.1
4.50-5.49	20	102.3 ± 6.1	61.3 ± 10.1	41.3 ± 18.5
5.50-6.49	22	106.1 ± 7.1	68.2 ± 9.8	49.0 ± 14.8
6.50-7.49	12	106.2 ± 6.4	70.2 ± 7.7	50.3 ± 15.2
7.50-8.49	26	108.2 ± 10.5	68.0 ± 7.2	47.0 ± 11.8
8.50-9.49	31	108.0 ± 9.3	65.7 ± 8.1	48.1 ± 16.2
9.50-10.49	30	107.8 ± 9.2	69.1 ± 10.2	55.0 ± 16.2
10.50-11.49	76	108.7 ± 13.0	64.7 ± 16.7	48.2 ± 22.9
11.50-12.49	189	108.3 ± 11.5	67.9 ± 15.0	49.0 ± 22.7
12.50-13.49	166	112.0 ± 8.8	67.5 ± 15.9	47.5 ± 23.5
13.50-14.49	69	112.2 ± 10.7	70.4 ± 14.4	51.0 ± 24.0
14.50-15.49	27	109.9 ± 7.7	69.0 ± 9.5	48.2 ± 22.9
15.50-16.49	18	110.8 ± 11.5	75.2 ± 9.5	59.2 ± 21.2
16.50-17.49	10	115.7 ± 9.4	79.2 ± 11.9	62.4 ± 14.3
17.50-18.49	2	125.0 ± 7.1	82.0 ± 17.0	67.0 ± 4.2
	715			

Source: Moss and Adams, 1968, p. 65.

Two authors indicated percentiles of blood pressure in the children and adolescent age groups. Vaughn and McKay (1975) presented these percentiles up to age 15 years (see figures 5 and 6). Loggie and Rauh (1975) indicated these percentiles up to 18 years of age (see figure 7). This type of analysis is different from the former in that it places a child in a percentile relationship to his age mates rather than at a more or less exact number.

Kotchen et al., (1974) did a study on the relationships between blood pressure, race, weight, and socioeconomic background in an urban adolescent population. This included approximately 800 students. They found that when differences due to obesity were adjusted, blacks had higher blood pressures than whites, and inner-city blacks had higher blood pressures than blacks attending middle-class, integrated schools. In this study more than 10 percent of black males, 1 percent of black females, and no white males or females had a systolic blood pressure greater than or equal to 140 mm Hg. These high systolic readings were found in black males at all weight levels. The study found, also, that in both blacks and white in either school environment, those with a higher body weight had a higher blood pressure (Kotchen et al., 1974).

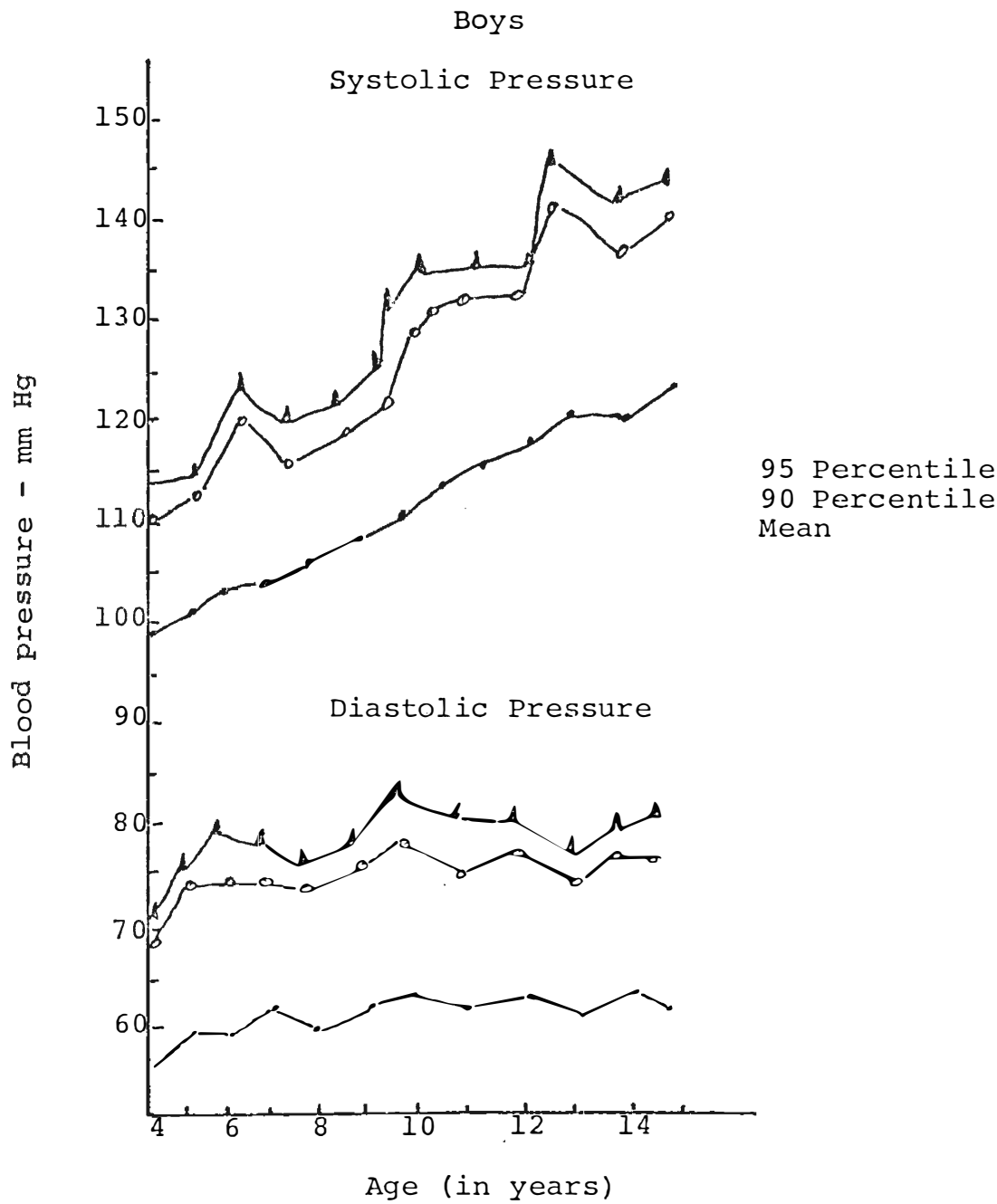


Fig. 5. Brachial artery cuff blood pressures of 735 normal boys from 4 to 15 years of age. Determinations made with children in the supine position.

Source: Vaughan & McKay, 1975, p. 1098.

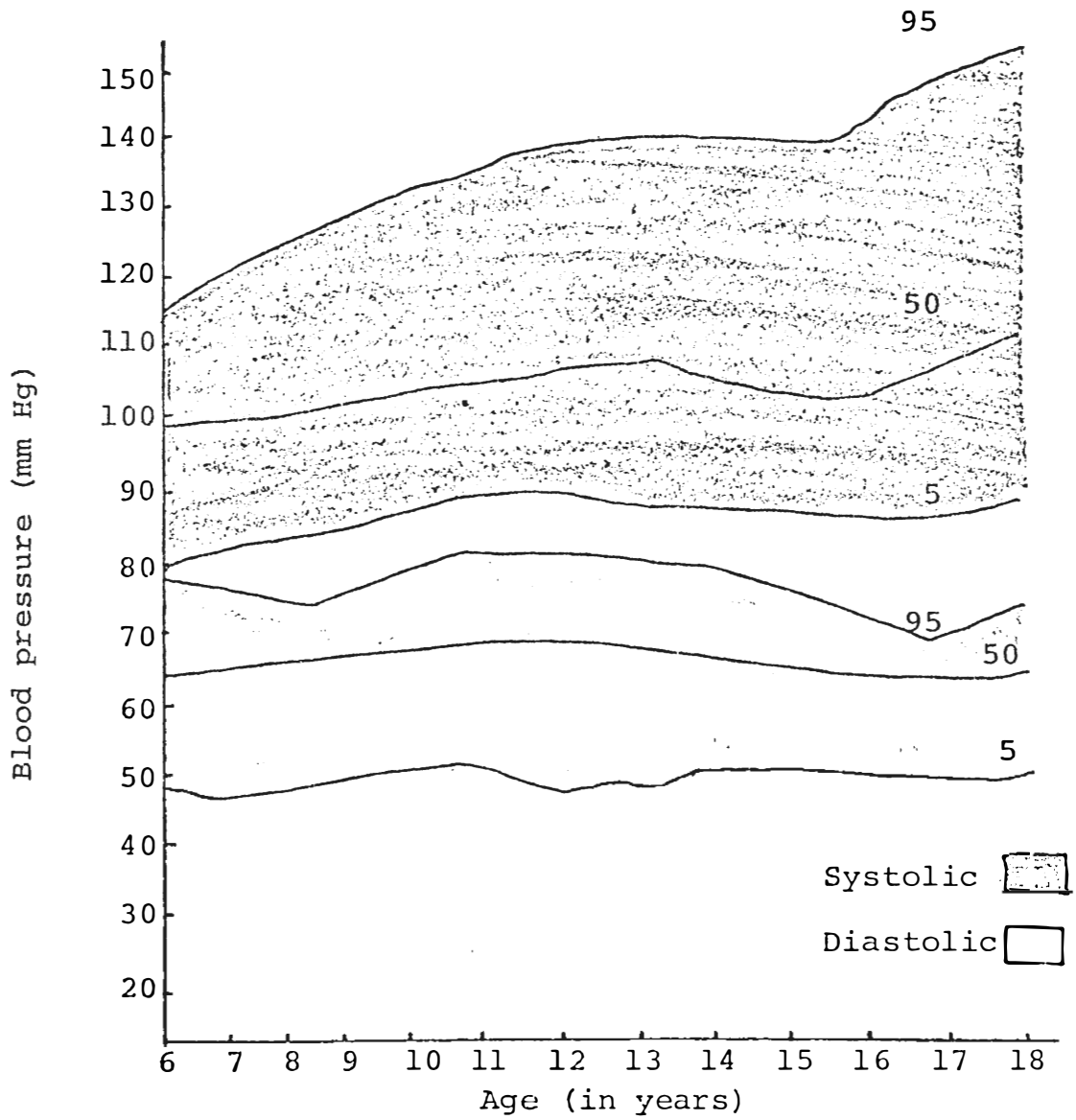


Fig. 7. Selected percentiles of systolic and diastolic blood pressure from ages 6 to 18. (There is no significant difference between males and females.)

Source: Loggie & Rauh, 1975, p. 1376.

The Bogalusa heart study evaluated blood pressure in 3,500 children in relation to height, weight, maturation, triceps skinfold thickness, serum lipids, and hemoglobin. This study identified a significant racial difference in blood pressure. However, it was thought that this was due to instrument variability. In this study the blood pressures were low compared to the other reported data and black children had significantly higher blood pressures than white children. This difference was largest in the children whose blood pressures fell in the upper 5 percent of the readings. The large blood pressure difference started before age 10 years. These authors also determined that body size raised blood pressure, as did external maturation and hemoglobin level (Voors et al., 1976).

Since hypertension is rarely symptomatic, it is easy to overlook, and it is especially easy to overlook in a child when often the blood pressure is not taken as part of a routine physical. Swartz and Leitch (1975) studied 496 subjects who were age 15 to 19 years. They studied the subjects by age, sex, ethnic origin, obesity, and familial tendency toward hypertension. Figure 8 illustrates the mean systolic and diastolic blood pressure by age and sex and table 9 expresses the blood pressures

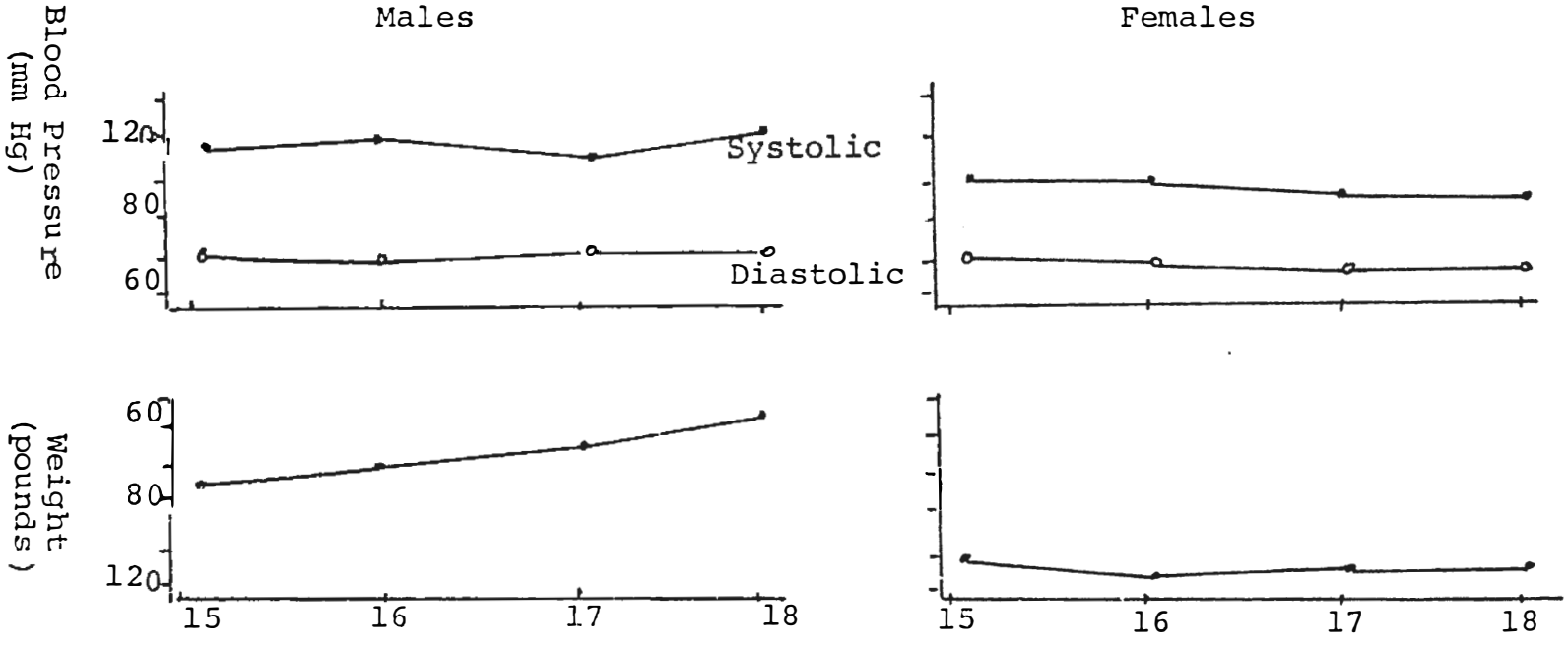


Fig. 8. Mean systolic and diastolic blood pressure by age and sex, and weight by age and sex.

Source: Swartz & Leitch, 1975, p. 79.

TABLE 9

MEAN VALUES OF BLOOD PRESSURES FOR MALES AND FEMALES AGE 15 TO 19 YEARS OLD

	Males				
	Age 15	Age 16	Age 17	Age 18	Age 19
Systolic Mean	117.86 ±13.90	120.18 ±14.55	117.92 ±15.17	123.71 ± 9.98	126.00 ±19.32
Diastolic Mean	72.45 ± 8.97	71.59 ± 8.59	73.68 ±10.39	75.65 ±10.60	72.50 ± 9.85
	N = 53	N = 88	N = 74	N = 34	N = 4
	Females				
	Age 15	Age 16	Age 17	Age 18	Age 19
Systolic Mean	112.19 ±10.67	113.16 ±12.69	112.42 ±11.93	111.36 ±14.49	112.00 ±10.58
	72.62 ± 9.23	71.70 ± 9.51	71.70 ± 9.43	69.36 ±11.18	74.67 ± 5.03
	N = 42	N = 79	N = 91	N = 28	N = 3

N = 243

Source: Swartz & Leitch, 1975, p. 79.

with mean standard deviation for the 15-through 19-year-olds. This study showed a significant difference between systolic blood pressure by race with the highest blood pressure being the white race, and systolic blood pressure by obesity with

higher blood pressure in the obese. It was also found in this population that there was a 10 percent prevalence of elevated blood pressure values equal to or exceeding 140 mm Hg systolic and 90 mm Hg diastolic.

Loggie and Rauh (1975) presented a table compiling several studies on the incidence of hypertension in adolescents and adults. It will be noted that there is some difference of opinion in the definition of hypertension among the various authors. Also, it will be noted that the authors are using standard adult criteria for their definition of hypertension (see table 10).

In 1975 Londe et al., investigated the relationship of blood pressure to sexual maturity in 229 boys and 189 girls aged 10 to 14 years. These authors found no significant correlation between the systolic and diastolic blood pressures and the level of FSH (follicle stimulating hormone) and LH (luteinizing hormone). They also found no correlation between the development of secondary sex characteristics and blood pressure.

Greenfield et al., (1976) and Pazdral et al., (1976) noted that blood pressure is infrequently recorded in children and, if it is recorded, it is done often with an inappropriately sized cuff. Greenfield et al., (1976) presented a table from Mitchell et al. illustrating the

TABLE 10

INCIDENCE OF HYPERTENSION IN ADOLESCENTS AND YOUNG ADULTS

Author, Country (State if USA)	Age of Subjects (Years)	Number Screened	Race	Definition of Hypertension (mm Hg)	Position in Which BP Was Measured	Incidence of Hypertension
Masland et al. US (Maryland) 1956	12-21	1795	Not stated	140/90	Not stated	1.4%
Boe et al. Norway 1957	15-19	3833	Caucasian	150-160/90-95	Sitting	Males 3.01% Females 1.04%
Heyden et al. US (Georgia) 1961	15-25	435	186 Black	Average of 3 readings: Systolic > 140 Diastolic > 90	Sitting	11.5%
Wilber et al. US (Georgia) 1972	15-25	799	All Black	Systolic > 160 Diastolic > 95	Sitting	First reading: Systolic 1.0% Diastolic 1.5% Avg.of 3 readings: Systolic 0.4% Diastolic 1.4%
Kotchen, J., et al. US (Washington, D.C.) 1973	17-20 (mean 18.9)	797	±584 Black ±213 White	Systolic > 140	Sitting	Black males 10% Black females 1% Whites--None
Kilcoyne et al. US (New York) 1974	14-19	First screen: 3537 Rescreen of "hypertensives" 215 of 277 from 1st screen	2193 Black 124 White 1220 Latin	Systolic ≥ 140 Diastolic ≥ 90 Systolic ≥ 140 Diastolic ≥ 90	Sitting Sitting	Systolic 5.4% Diastolic 7.8% Systolic 1.2% Diastolic 2.4%
Lauer et al. US (Iowa) 1975	14-18	1301	4829 subjects 6-18 yrs. screened once. 96.4% White 0.6% Black 2.8% Spanish-American 0.1% Oriental 0.1% American Indian	Systolic ≥ 140 Diastolic ≥ 90	Sitting	Systolic 8.9% Diastolic 12.2% Both systolic and diastolic 4.4%

Source: Loggie and Rauh, 1975, pp. 1374-1375.

percentile values for blood pressure by age. They make recommendations for the definition of hypertension in children 6 months to 15 years (see table 11).

TABLE 11

PERCENTILE VALUES FOR BLOOD PRESSURE BY AGE

Age	Systolic Pressure		Diastolic Pressure	
	50%	95%	50%	95%
0 to 6 months	80	110	45	60
3 years	95	112	64	80
5 years	97	115	65	84
10 years	110	130	70	92
15 years	116	138	70	95

Source: Mitchell et al., cited in Greenfield et al., 1976, p. 771.

Pazdral et al., (1976) presented surveys of patients at three pediatric teaching hospitals. The authors suggested some operational guidelines for upper levels of blood pressure for children by sex and age (see table 12) which again illustrates the variability of standards used to define hypertension in children.

In a study on screening for hypertension in a high school population done by Silverberg et al., (1975), 15,594 students ages 15 to 20 years had their blood pressures

TABLE 12

OPERATIONAL GUIDELINES FOR UPPER LIMITS OF NORMAL BLOOD PRESSURE

Sex, Age in Years	Blood Pressure (mm Hg)	
	Systolic	Diastolic
Male and Female		
0-3	≤110	≤65
3-7	≤120	≤70
7-10	≤130	≤75
Male		
10-15	≤140	≤80
Female		
10-13	≤140	≤80
Female		
13-15	≤140	≤85

Source: Pazdral et al., 1976, p. 2321.

measured. This study used the standard of 150 mm Hg for systolic and/or 95 mm Hg for diastolic blood pressure as a definition for hypertension and referred 2.2 percent of the students for further studies. Again this demonstrated the lack of standardization for norms for hypertension in adolescents and the rather startling incidence of hypertension even by these standards.

Since obesity has influence on blood pressure and most of the previously cited authors considered this of importance, table 13 illustrates obesity standards based on

TABLE 13

TABLE OF OBESITY STANDARDS (CAUCASIAN NORTH AMERICANS)

Age (Years)	Initial Level of Triceps Skinfold Thickness Indicating Obesity	
	Males (mm)	Females (mm)
5	12	14
6	12	15
7	13	16
8	14	17
9	15	18
10	16	20
11	17	21
12	18	22
13	18	23
14	17	23
15	16	24
16	15	25
17	14	26
18	15	27
19	15	27
20	16	28
21	17	28
22	18	28
23	18	28
24	19	28
25	20	29
26	20	29
27	21	29
28	22	29
29	22	29
30-50	23	30

triceps skinfold thickness. These standards are presented in Gallagher et al., (1976) and are taken from studies done by Selzer and Mayer (1965).

At this time it is recognized that there is not a widely accepted definition of juvenile normotension (Korokbin et al., 1976). In fact, there is not even agreement as to whether blood pressure increases progressively to adult levels through adolescence. Thus, it would seem that this area needs to be studied and these studies replicated until definitions of normotension can be agreed upon.

CHAPTER III

PROCEDURE FOR COLLECTION AND TREATMENT OF DATA

Setting

The setting of this study was the only public high school serving a southern, urban community of approximately 50,000 people. The community is relatively non-industralized. Its economy is based upon a military installation, a seafood industry, and tourist trade.

Population

The population of the study consisted of 217 adolescents at the high school who were aged 15, 16, and 17 years. The entire academic section of the student body was given permission forms to be taken home and signed by parent or guardian. The sample population of 217 students are those who returned the signed permission form and were present on the day of data collection. The average daily attendance during the time of data collection was 1,656 students. The 217 students represented 13.1 percent of the total population.

In table 14 the sex distribution of 125 female students and 90 male students is displayed. In the total

TABLE 14

DISTRIBUTION BY SEX OF PARTICIPANTS
IN BLOOD PRESSURE STUDY

	Female	Male
Number of Participants	125	90
Percentage of Participants	58.14	41.86

school population there were 821 females and 835 males. The 125 female students represent 15.2 percent of the total female student population. The 90 male students represent 10.8 percent of the total male student population. The discrepancy between the numbers of students in the daily average attendance versus the numbers of students in subgroups is accounted for by students of other races who were eliminated from this study.

Table 15 illustrates that 29 of the students in the study were black, 182 of them were white, and 2 were of another race. Because these two represented two different races, they were eliminated. The 29 black students represented 11.3 percent of the total black student population. The 182 white students represented 13.0 percent of the total white student population. In the county in which the high school is located, the population is 17.9 percent black, according to the 1970 census.

TABLE 15

DISTRIBUTION BY RACE OF PARTICIPANTS

Race	Number of Participants	Percentage of Participants
Black	29	13.62
White	182	85.45
Other	2	0.94

Table 16 displays the distribution of study participants by age, sex, and race. It may be noted that the largest representation of students was the 15-year-old white female and the smallest representation was the 16-year-old black male. The total of white male student participants was 70. The total population of white males was 703. The 70 students represented 10.0 percent of the total white male population. The total black participants was 7. The total black male population was 132. The 7 students represented 5.3 percent of the total black male population. The total of white female participants was 703. The 98 students represented 14.1 percent of the total white female population. The total black female participants was 18. The total population of black females was 125. The 18 students represented 14.4 percent of the total black

population. The age distribution of this school population is not available.

TABLE 16

DISTRIBUTION BY AGE, SEX, AND RACE OF PARTICIPANTS

Race and Sex	Age in Years					
	15		16		17	
	Number	Percent	Number	Percent	Number	Percent
White, Male	28	14.5	25	13.0	17	3.6
Black, Male	3	1.2	1	0.5	3	1.2
White, Female	41	21.2	33	7.1	24	12.4
Black, Female	4	2.1	6	3.1	8	3.6

Tool

The data flow sheet giving blank spaces for the pertinent information to be filled in by the student and by the principle investigator is presented in appendix B.

The permission slips (appendix A) and the data flow sheets were given corresponding numbers. A note was made on the slip to indicate whether a female student was menstruating at the time of data collection. There was a prepared note on the bottom of the data flow sheet to be returned to the student's parent or guardian if the student's systolic blood pressure was greater than or equal

to 140 mm Hg and/or diastolic blood pressure was greater than or equal to 90 mm Hg.

Data Collection

A meeting was held between the assistant principal of the school and the school nurse. The arrangement was made that the assistant principal would distribute the permission slips to the fifth-period teachers. These teachers distributed the permission slips to the students during the week prior to the arrival of the principal investigator. The students were instructed to have the permission slips filled out and signed by the parent(s) or guardian and returned as early as possible to the fifth-period teacher. On the arrival of the principal investigator to the classroom, the fifth-period teacher distributed the signed permission slips to the respective students. The student aide then distributed the data flow sheets to those students who had appropriately completed the signed permission slips. At that time the student aide gave the permission slips and data flow sheets corresponding numbers. The student aide instructed each student to fill out the sex, age in years and months, and race on the data flow sheet. The student aide then measured and recorded the triceps skinfold in millimeters.

The principal investigator then approached each student, checked that student's data flow sheet for completeness and correctness. The principal investigator took each subject's blood pressure first in the left and then in the right arm according to the American Heart Association's standard technique discussed previously. The first, fourth, and fifth Karotkoff sounds were recorded where all those were audible in the appropriate blanks on the data flow sheet. The fifth sound was recorded as the diastolic.

The student aide was trained to assist the principal investigator. The aide was a grade eleven high school student who was instructed carefully in the collection of this data and was trained to use the skin caliper accurately. She was under the direct observation of the principal investigator throughout the data collection.

The instruments used for this procedure were a new Tycos aneroid syphgmomanometer which had been previously calibrated accurately by the manufacturer. Cuff sizes were varied as indicated by the length and diameter of the subject's arm. The auscultatory instrument used was the Sprague-Rappaport, fitted with the adult diaphragm.

If the blood pressure was found to be elevated according to adult standards, the indicated section at the bottom of the permission slip was filled out accordingly

and given to the student to take home. The recordings were kept confidential between the principal investigator and the individual student.

The data collection period extended from October, 1976, to December 14, 1976. Approximately 19 visits for data collection were made by the principal investigator.

Treatment of the Data

The data were analyzed and basic tabulations were done to bring the data into agreement with the delimitations of the study. The two students of another race were eliminated. The data were then sent to a computer department where it was subjected to intensive statistical analysis. The derived statistics were then tabulated and graphed by the principal investigator and are presented and analyzed in Chapter IV.

Summary

This chapter has reviewed the geographic setting, the involved population, and the precise techniques and instrumentation used on the appropriately and carefully selected students. The techniques of analysis are indicated. The following chapter presents the analysis of the acquired data.

CHAPTER IV

ANALYSIS OF THE DATA

This study presented data accumulated on 217 adolescents who were aged 15, 16, and 17 years. The study also attempted to correlate obesity with blood pressure. However, there was such a small number of obese students (15 out of 200) that further development of this facet was statistically invalid.

Table 17 illustrates the mean, standard deviation, and range of systolic and diastolic blood pressures in the female students comparing those who are and those who are not menstruating. The diastolic means have a very small difference, the systolic slightly larger. However, there is not a significant difference in these two groups.

In graph 1 mean blood pressures are plotted according to age and right arm versus left arm. The average systolic readings for 15-year-olds in the right arm were 102.5 mm Hg and in the left arm were 100.3 mm Hg. In the 16-year-old these readings were 104.2 mm Hg in the right arm and 101.2 mm Hg in the left arm. In the 17-year-old the readings were 108.9 mm Hg in the right arm and 105.3 mm Hg in the left arm. The average diastolic readings for

TABLE 17

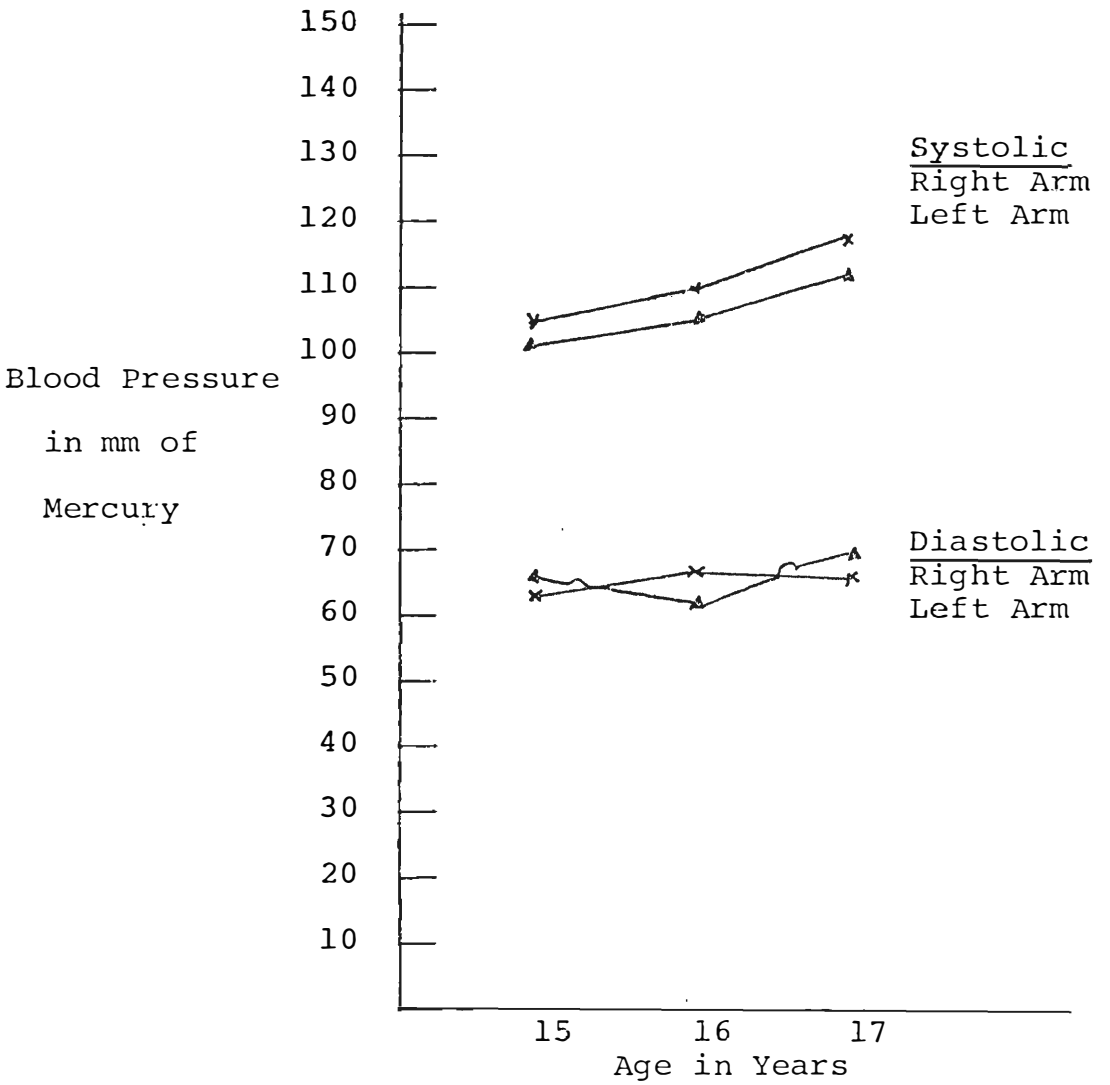
THE MEAN, STANDARD DEVIATION, AND RANGE OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURES IN THE RIGHT ARM OF FEMALE STUDENTS WHO ARE NOT MENSTRUATING

	Menstruating	Yes	No
	Number of Females	29	96
Systolic Blood Pressure	Mean	104.3	100.9
	Standard Deviation	11.2	10.65
	Range	80-124	80-128
Diastolic Blood Pressure	Mean	63.4	63.0
	Standard Deviation	9.46	8.69
	Range	42-84	38-84

N = 125.

the 15-year-old in the right arm were 63.1 mm Hg and in the left arm were 63.3 mm Hg. In the 16-year-old these readings were 64.0 mm Hg, and 63.7 mm Hg in the right arm. In the 17-year-old these readings were 64.7 mm Hg in the right arm and 65.9 mm Hg in the left arm. Since four of the six readings, including all systolic readings, were higher in the right arm than in the left arm, the blood pressures taken in the right arm were used for this study.

Mean, standard deviation, and range of systolic and diastolic blood pressures in the right arm by age are shown in table 18. There is a progressive rise both in systolic



Graph 1. Mean distribution of systolic and diastolic blood pressures in right arms and left arms according to age.

and in diastolic blood pressure from 15 years through 17 years of age. The systolic increase is greater than the diastolic. Nevertheless, both do rise progressively.

TABLE 18

THE MEAN, STANDARD DEVIATION, AND RANGE OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURES IN THE RIGHT ARM, BY AGE

	Age in Years	15	16	17
	Number of Subjects	77	66	54
Systolic Blood Pressure	Mean	102.5	104.2	108.9
	Standard Deviation	12.26	13.60	12.07
	Range	80-136	82-142	80-128
Diastolic Blood Pressure	Mean	63.1	64.0	64.7
	Standard Deviation	8.56	9.79	9.84
	Range	46-86	42-84	38-84

N = 197.

This is further illustrated in table 19, which is an analysis of the mean, standard deviation, and range of systolic and diastolic blood pressures in the right arm of white males by age. The systolic blood pressure readings are highest in the 17-year-old white males. Diastolic blood pressures are highest in 17-year-old black males. This may be explained by the small number of subjects (n = 17).

Table 20 illustrates the mean, standard deviation, and range of systolic and diastolic blood pressures in the right arm of black males by age. There are only seven subjects in this group, a number too small to be statistically valid.

TABLE 19

THE MEAN, STANDARD DEVIATION, AND RANGE OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURES IN THE RIGHT ARM OF WHITE MALES BY AGE

	Age in Years	15	16	17
	Number of Subjects	28	25	17
Systolic Blood Pressure	Mean	106.5	109.8	116.0
	Standard Deviation	13.55	17.11	8.86
	Range	82-136	82-142	98-128
Diastolic Blood Pressure	Mean	64.1	66.4	62.7
	Standard Deviation	8.87	10.00	10.56
	Range	48-86	52-84	

N = 70.

TABLE 20

THE MEAN, STANDARD DEVIATION, AND RANGE OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURES IN THE RIGHT ARM OF BLACK MALES BY AGE

	Age in Years	15	16	17
	Number of Subjects	3	1	3
Systolic Blood Pressure	Mean	104.7	120.0	108.0
	Standard Deviation	15.01	*	14.22
	Range	90-120	*	96-124
Diastolic Blood Pressure	Mean	58.0	60.0	72.0
	Standard Deviation	4.00	*	3.46
	Range	54-62	*	68-74

N = 7.

*These values cannot be calcualted on the basis of only one student.

Table 21 illustrates the mean, standard deviation, and range of systolic and diastolic blood pressure in the right arm of white females by age. In this group the blood pressure changed very little as the ages of the subjects increased.

TABLE 21

THE MEAN, STANDARD DEVIATION, AND RANGE OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURES IN THE RIGHT ARM OF WHITE FEMALES BY AGE

	Age in Years	15	16	17
	Number of Subjects	41	33	24
Systolic Blood Pressures	Mean	99.1	99.9	103.8
	Standard Deviation	11.02	9.50	11.84
	Range	80-122	86-122	80-126
Diastolic Blood Pressure	Mean	62.6	62.3	63.6
	Standard Deviation	8.2	9.75	10.32
	Range	46-84	42-78	38-80

N = 98.

Table 22 illustrates the mean, standard deviation, and range of systolic and diastolic blood pressure in the right arm of black females by age. Again there is a small number of subjects and the statistical significance is questionable.

Graph 2 displays the mean distribution of systolic and diastolic blood pressure in black and white females by

TABLE 22

THE MEAN, STANDARD DEVIATION, AND RANGE OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURES IN THE RIGHT ARM OF BLACK FEMALES BY AGE

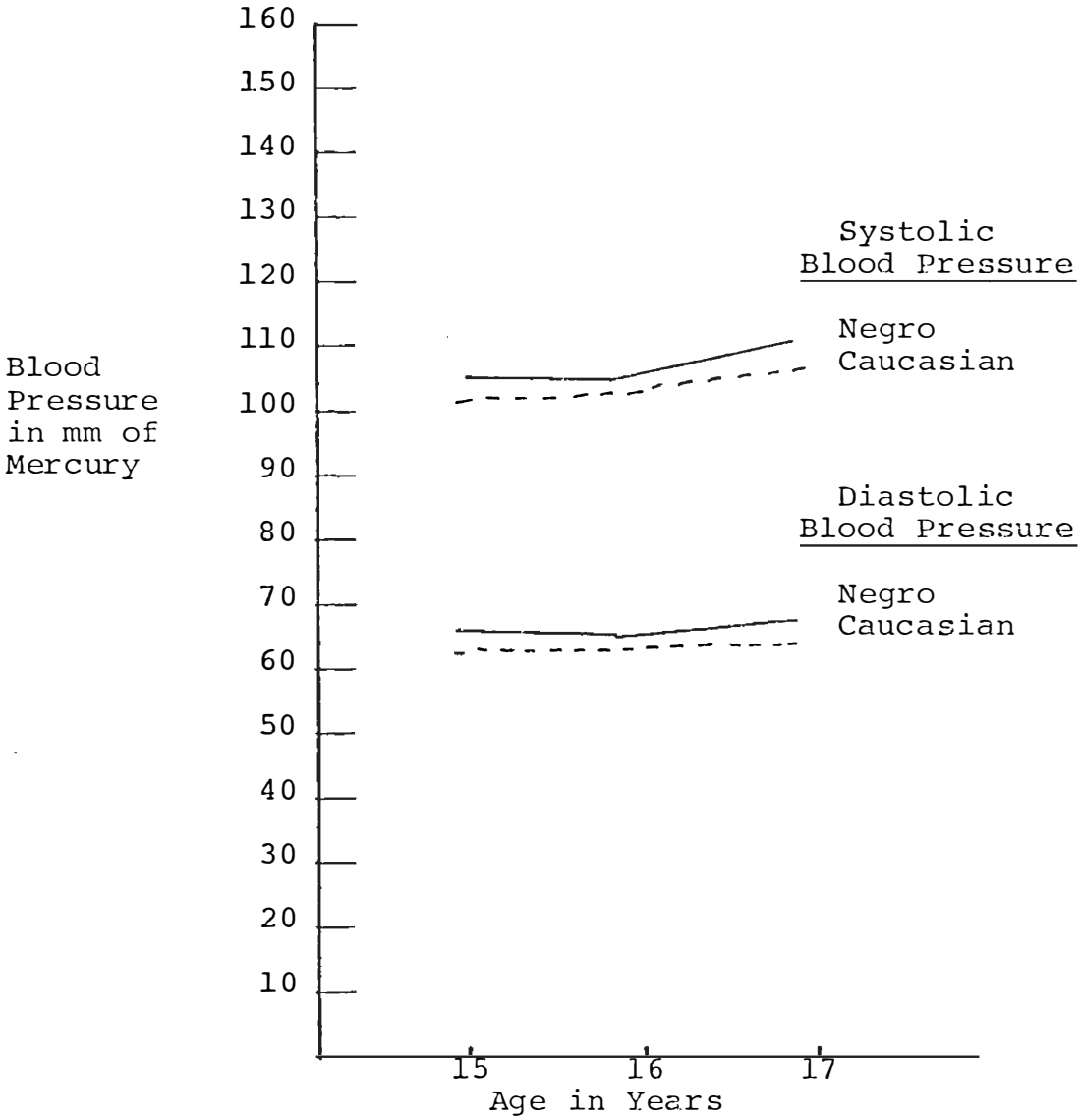
	Age in Years	15	16	17
	Number of Subjects	4	6	8
Systolic Blood Pressure	Mean	106.5	123.3	108.5
	Standard Deviation	7.55	8.82	11.94
	Range	98-116	94-112	92-128
Diastolic Blood Pressure	Mean	60.5	63.3	67.5
	Standard Deviation	8.54	10.33	7.31
	Range	48-66	56-84	60-84

N = 18.

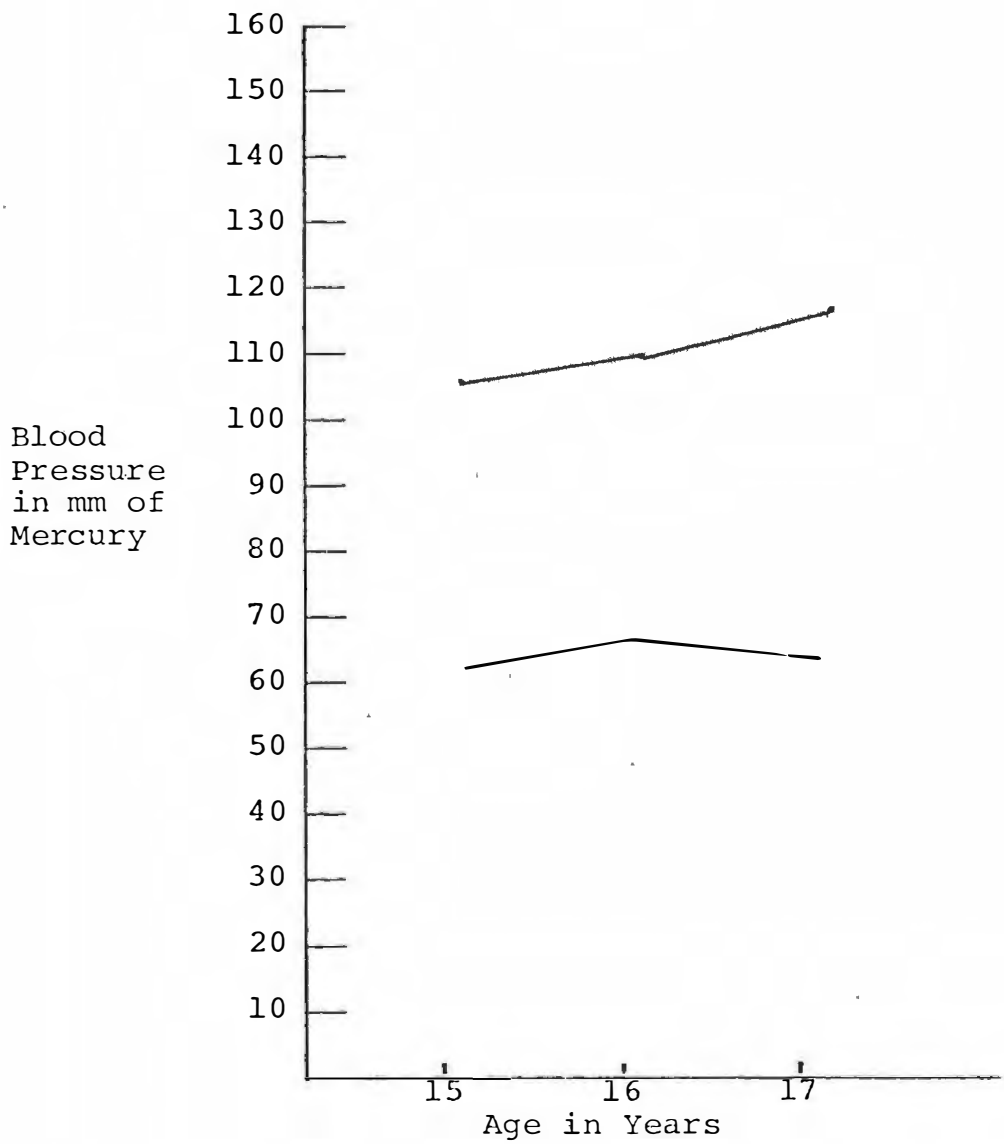
age. It will be noted that the black females' systolic blood pressures are slightly higher than the white females and the diastolic blood pressures in both groups are remarkably similar.

Graph 3 displays the progressive rise of the systolic blood pressure in the white male by age. Diastolic blood pressure in this group remained approximately level.

The data accumulated demonstrates a small but progressive rise in the blood pressure in all of these age groups. The mean standard deviations are not as large as most other quoted studies. Again statistics indicate that the blacks have higher blood pressures when matched by age and sex. The following chapter will discuss these findings.



Graph 2. Mean distribution of systolic and diastolic blood pressure in right arms in the white male according to age.



Note: The number of black males (total of seven) is insufficient to use in this graph.

Graph 3. Mean distribution of systolic and diastolic blood pressure in right arms in the white male according to age.

CHAPTER V

SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

Summary

Hypertension is a very serious health problem in the United States today. Diastolic hypertension reduces life span on an average of 20 years. The incidence of stroke, myocardial infarct, and cerebrovascular accidents are greater in the hypertensive than in the normotensive individual. Because hypertension in adults may have its roots in childhood and adolescence, it is desirable to have well-documented norms in these age groups. It has been stated previously that essential hypertension is fundamentally hereditary. Hennekins et al. (1976) pointed out that there is a tendency to sibling aggregation toward hypertension.

The literature presents varying standards of blood pressure in adolescence and several of the accepted standards are extrapolated from small groups. Several of the tables end at age 15 years, assuming normal adult blood pressures are attained by this age. Several of the standards do not separate the subjects by sex. Some of the standards ignore race and obesity while other literature

stated that both race and obesity affect blood pressure levels. The adult blood pressure studies by age and sex are also questionable in that they do not take into consideration, statistically, those hypertensives who have expired from their disease. This may explain the drop in blood pressure in the 60- and 70-year-old age groups which may not be real but rather an indication of the mortality related to this disease.

The data collected here is from a small number of adolescents representing two races, black and white. The data were collected under carefully controlled conditions and from apparently healthy adolescents.

The data indicate that males do have higher average blood pressures than females and that blacks do have higher average blood pressures than whites. Menstruation apparently does not affect blood pressure. Both the systolic and diastolic blood pressures tend to rise progressively with age through the age groups studied. The average readings and the average standard deviations are not as great as the studies reviewed in the literature.

There is a decrease in the diastolic blood pressure of the right arm of the 17-year-old as compared to the diastolic blood pressure of the 16-year-old. This occurs in

white males in the 17-year-old group and in the white females in the 16-year-old group. This is an area which needs further validation by a study of larger numbers involving just these two subgroups. These studies indicated that these adolescents had not reached defined normal adult blood pressure readings at the time their blood pressures were taken.

The study indicated that further statistical data must be accumulated in order to establish accurate norms of blood pressure in these age groups, since adolescents apparently do not have normal blood pressure by adult standards. It has been demonstrated that even in adolescence the blacks tend to have higher blood pressure readings. Male adolescents have higher blood pressure readings than female adolescents.

Implications

This study has raised the question of the effects of hereditary, race, sex, sexual maturity, obesity, and age on blood pressure. It suggested that adult levels of blood pressure are not reached even by the late adolescence (by 17 years of age). Blacks and/or males have higher blood pressure readings than white and/or females.

Recommendations

Further studies of blood pressure in adolescents should be considered. Notes should be taken of cultural differences. Studies should be carried out in other regions. This study was unable to document blood pressures in significant number of obese adolescents. Studies of obese adolescents should be carried out carefully. The effects of sexual maturity on blood pressure levels should be studied. Blood pressures in adolescents may be correlated with serum lipid levels. The drop in the diastolic blood pressure in the 17-year-old white male and the 16-year-old white female should be investigated more specifically. Blood pressure studies on adolescent black males specifically should be done carefully since this is a high risk group that is difficult to contact medically.

With genetic pedigree and accurately established norms throughout childhood and adolescence, it should be possible to identify the hypertensive early and to control his disease adequately.

APPENDIX A

LETTER OF INTRODUCTION

Dear Parent,

I am a registered nurse who teaches nursing at the Jefferson Davis Campus. I am also doing graduate nursing study at Texas Woman's University.

In an effort to determine what is normal blood pressure in teen-agers, I am conducting a study. I will be taking the blood pressure of teen-agers in your child's high school. Also, I will be measuring the skinfold thickness on the upper inside of the arm to find out if your child is overweight. I am asking your permission to study your child in this way. Please read the consent form below and, if you are willing, please sign it. If you have any questions, please contact me evenings at 374-1914.

Thank you very much,

Patricia B. Howorth, R.N.

CONSENT FORM

I, _____, hereby grant permission to Patricia B. Howorth, R.N. to take the blood pressure of my childn, _____, in each arm and to measure the skinfold thickness of the upper arm. I understand that all information will be treated confidentially and that my child's name will not be used in any way. I also understand that if my child's blood pressure is elevated, I will be notified.

Date_____Signed_____

Witness_____ _____
Relation to child

I would be most grateful if you will check either yes or no, as indicated, to the questions below.

Has your child ever had anything wrong with his/her:

	Yes	No
Kidneys	___	___
Heart	___	___
Blood	___	___
Other serious illness If yes, please specify.	___	___

APPENDIX B

INFORMATION SHEET

Blood Pressure L.A. _____/ _____/ _____
1st 4th 5th

R.A. _____/ _____/ _____
1st 4th 5th

Sex _____ _____
Male Female

Age _____ _____
Years Months

Race _____ _____ _____ _____
Black White Other (Specify)

Triceps skinfold _____mm

Obesity _____ _____
Yes No

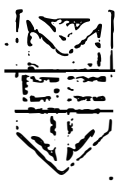
Notification of blood pressure sent to parent or legal guardian.

_____ _____
Yes No

Your child, _____, has a blood pressure of _____ (LA) and _____ (RA). This is considered to be above normal. I would suggest that your child's doctor be consulted.

Thank you.

APPENDIX C



MISSISSIPPI
GULF COAST JUNIOR COLLEGE
JEFFERSON DAVIS CAMPUS

September 7, 1976

Dr. Olon Ray
City of Biloxi City Schools
P. O. Box 168
Biloxi, MS 39533

Dear Dr. Ray:

I am an instructor in the Associate Degree Nursing Program on the Jefferson Davis Campus. I am also a graduate student at Texas Woman's University, Dallas Campus, in Maternal-Child Health Nursing. I have completed my course work and have my Thesis left to do. The topic of my thesis is: "Blood Pressure Distribution among Adolescents By Age, Race, Sex, and Absence or Presence of Obesity". This topic is presently under-researched.

I am writing to ask your permission to come into Biloxi High School for the purpose of measuring blood pressures, and triceps skin-fold thickness as an indication of obesity. Each student measured will have permission from parent or legal guardian prior to measurements.

I would be most grateful for your early reply as I am returning to Dallas to defend the Proposal on September 27th and the signed permissions are a part of the preparation.

Thank you very much.

Sincerely.

Patricia B. Howorth, Instructor
Jefferson Davis Campus
Gulfport, MS 39501

cc: Dr. G. Cannon
Ms. Julia Longino

enc: 4

MISSISSIPPI
GULF COAST JUNIOR COLLEGE
JEFFERSON DAVIS CAMPUS

September 7, 1976

Dr. G. Cannon
Biloxi High School
Father Ryan Ave.
Biloxi, MS 39530

Dear Dr. Cannon:

I am an instructor in the Associate Degree Nursing Program on the Jefferson Davis Campus. I am also a graduate student at Texas Woman's University, Dallas Campus, in Maternal-Child Health Nursing. I have completed my course work and have my Thesis left to do. The topic of my thesis is: "Blood Pressure Distribution among Adolescents By Age, Race, Sex, and Absence or Presence of Obesity". This topic is, presently, under-researched.

I am writing to ask your permission to come into Biloxi High School for the purpose of measuring blood pressures, and triceps skin-fold thickness as an indication of obesity. Each student measured will have permission from parent or legal guardian prior to measurements.

I would be most grateful for your early reply as I am returning to Dallas to the defend the Proposal on September 27th and the signed permissions are a part of the preparation.

Thank you very much.

Sincerely,

Patricia B. Howorth, Instructor
Jefferson Davis Campus
Gulfport, MS 39501

cc: Dr. Olon Ray
Ms. Julia Longino

enc: 4

MISSISSIPPI
GULF COAST JUNIOR COLLEGE
JEFFERSON DAVIS CAMPUS

September 7, 1976

Ms. Julia Longino, R.N.
P. O. Box 168
Biloxi, MS 39533

Dear Ms. Longino:

I am an instructor in the Associate Degree Nursing Program on the Jefferson Davis Campus. I am also a graduate student at Texas Woman's University, Dallas Campus, in Maternal-Child Health Nursing. I have completed my course work and have my Thesis left to do. The topic of my thesis is: "Blood Pressure Distribution among Adolescents by Age, Race, Sex, and Absence or Presence of Obesity." This topic is presently under-researched.

I have obtained permission from Dr. Olan Ray and Dr. G. Cannon to do research study at Biloxi High School. Since you are the school nurse I would be most grateful for your assistance in this endeavor. I will be taking all blood pressure in order to eliminate the variables, and measuring the skin fold thickness. It will be necessary to notify parents or legal guardians if I find elevated blood pressures. Probably the majority of, if not all, the measurements will be done on Wednesday afternoons as this best fits my class schedule.

I look forward to working with you with many thanks.

Sincerely,

Patricia B. Howorth

cc: Dr. O. Ray
Dr. G. Cannon

enc: 4

APPENDIX D

BILOXI MUNICIPAL SEPARATE SCHOOL DISTRICT
P. O. BOX 168 BILOXI, MISSISSIPPI 39533
TELEPHONE 374-1810 SUPERINTENDENT - OLON E. RAY

September 14, 1976

Ms. Patricia Howorth, Instructor
Jefferson Davis Campus
Gulfport, MS 39501

Dear Ms. Howorth:

The Biloxi Public Schools are happy to cooperate with your thesis study "Blood Pressure Distribution Among Adolescents by Age, Race, Sex and Absence or Presence of Obesity" after permission from parents or guardians is obtained for Biloxi High School students.

We understand that student involvement will consist of (1) questions, (2) blood pressure measurement and (3) triceps skin-fold thickness measurement.

Dr. Olon Ray, Superintendent

Dr. George Cannon, Principal

Julia T. Longino, B.S., R.N.
Coordinator Health Services

APPENDIX E

TEXAS WOMAN'S UNIVERSITY
COLLEGE OF NURSING
DENTON, TEXAS

75

DALLAS CENTER
1810 Inwood Road
Dallas, Texas

HOUSTON CENTER
1130 M.D. Anderson Blvd.
Houston, Texas 77025

AGENCY PERMISSION FOR CONDUCTING STUDY*

THE Biloxi Municipal Separate School District

GRANTS TO Patricia B. Howorth

a student enrolled in a program of nursing leading to a Master's Degree at Texas Woman's University, the privilege of its facilities in order to study the following problem:

Blood Pressure Distribution in Apparently Healthy Adolescents

The conditions mutually agreed upon are as follows:

1. The agency (may) (may not) be identified in the final report.
2. The names of consultative or administrative personnel in the agency (may) (may not) be identified in the final report.
3. The agency (wants) (does not want) a conference with the student when the report is completed.
4. The agency is (willing) (unwilling) to allow the completed report to be circulated through interlibrary loan.
5. Other: _____

Date. 10 – 15 – 76

Signature of Agency Personnel
Dr. George D. Cannon

Signature of student

Signature of Faculty Advisor

*Fill out and sign three copies to be distributed as follows: Original - Student; first copy — agency; second copy -- T.W.U. College of Nursing.

GNIS - 110

REFERENCES CITED

Alexander, M. M., & Brown, M. S. Pediatric physical diagnosis for nurses. New York: McGraw-Hill Book Co., 1974.

Armitage, P. & Rose, G. A. The variability of measurement of casual blood pressure: I. a laboratory study. Clinical Science, 1966, 237, 325-335.

Corns, R. H. Maintenance of blood pressure equipment. American Journal of Nursing, 1976, 76, 776-777.

Dollery, C. T. Normal and raised arterial pressure: what is hypertension. In G. Onesti, K. E. Kim & J. H. Meyer (Eds.), Hypertension: mechanisms and management. New York: Grune & Stratton, 1973.

Greenfield, D., Grant, R., & Lieberman, E. Children can have high blood pressure, too. American Journal of Nursing, 1976, 76, 770-772.

Guyton, A. C. Textbook of medical physiology (4th ed.) Philadelphia: W. B. Saunders Co., 1971.

Guyton, A. C., et al. Part II. Hemodynamics of essential hypertension. In G. Onesti, K. E. Kim, & J. H. Meyer (Eds.), Hypertension: mechanics and management. New York: Grune & Stratton, 1973.

Haggerty, R. J., Maroney, M. W., & Nadas, A. S. Essential hypertension in infancy and childhood. A.M.A. Journal of Diseases of Children, 1956, 92, 535-549.

Hennekins, C. H., et al. Sibling aggregation of blood pressure: nature or nurture? Preventive Medicine 1976, 5, 60-62.

Heyden, S., Bartel, A. G., Hames, C. G., & McDonough, J. R. Elevated blood pressure levels in adolescents, Evans County, Georgia. Journal of the American Medical Association, 1969, 209, 1683-1689.

Kilcoyne, M. M. Adolescent hypertension. The American Journal of Medicine, 1975, 58, 735-738.

Kilcoyne, M. M., Richter, R. W., & Alsup, P. A. Adolescent hypertension. Circulation, 1974, 50, 758-764.

Kirkendall, W. M., Burton, A. C., Epstein, F. H., & Freis, E. D. Recommendations for human blood pressure determination by sphygmomanometers. American Heart Association, 1967.

Labarthe, D. P., Hawkins, C. M., & Remington, R. D. Evaluation of performance of selected devices for measuring blood pressure. American Journal of Cardiology, 1973, 32, 546-553.

Loggie, J. M. H., & Rauh, L. W. Persistent systemic hypertension in the adolescent. The Medical Clinics of North America, 1975, 59, 1371-1383.

Londe, S., Boirgorgnie, J. J., Robson, A. M., & Goldnig, D. Hypertension in apparently normal children. Journal of Pediatrics, 1971, 78, 569-577.

Londe, S., et al. Blood pressure and puberty. The Journal of Pediatrics, 1975, 87, 896-900.

Mendlowitz, M. Vascular reactivity is systemic arterial hypertension. In G. Onesti, K. E. Kim, & J. H. Meyer (Eds.), Hypertension: mechanisms and management. New York: Grune & Stratton, 1973.

Moss, A. J. Measurement of arterial blood pressure. In A. J. Moss & F. H. Adams (Eds.), Heart disease in infants, children, and adolescents. Baltimore: The Williams & Wilkins Co., 1968.

National High Blood Pressure Education Program. Analysis of the high blood pressure treatment problem. Washington, D.C.: Department of Health, Education, and Welfare, 1973.

Pazdral, P. T., et al. Awareness of pediatric hypertension. Journal of the American Medical Association, 1976, 235, 2320-2322.

Rowland, C. V., Jr. Anorexia and obesity. Boston: Little, Brown & Co., 1970.

Silverberg, D. S., et al. Screening for hypertension in a high school population. Canadian Medical Association Journal, 1975, 113, 103-108.

Smirk, F. H. Casual, basal, and supplemental blood pressures. In G. Onesti, K. E. Kim, & J. H. Meyer Eds.), Hypertension: mechanisms and management. New York: Grune & Stratton, 1973.

Swartz, H., & Leitch, C. J. Differences in mean adolescent blood pre-sure by age, sex, ethnic origin, obesity and familial tendency. The Journal of School Health, 1975, 45, 76-82.

U.S. National Center for Health Statistics. Blood pressure of adults by age and sex. Washington, D.C.: U.S. Department of Health, Education, and Welfare, 1964.

Vaughan, V. C. III, & McKay, R. J. (Eds.). Nelson Textbook of Pediatrics. Philadelphia: W. B. Saunders Co., 1975.

Voors, A. W., et al. Studies of blood pressures in children, ages 5-14 years, in a total biracial community. Circulation, 1976, 54, 319-327.

Wolf, J. L. Adolescent hypertension and cardiovascular disease prevention. The Journal of the American College Health Association, 1973, 22, 113-119.

Ziai, M., Janeway, C. A., & Cooke, R. E. Pediatrics. Boston: Little Brown & Co., 1969.

SELECTED BIBLIOGRAPHY

Books

Barness, L. A. Manual of pediatric physical diagnosis (4th ed.). Chicago: Year Book Medical Publishers, Inc., 1972.

Benson, H. Methods of blood pressure recording. In G. Onesti, K. E. Kim & J. H. Meyer (Eds.), Hypertension: mechanisms and management. New York: Grune & Stratton, 1973.

Berne, R. M. & Levy, M. N. Cardiovascular physiology (3rd ed.). St. Louis: The C. V. Mosby Co., 1977.

Chinn, P. L. Child health maintenance. St. Louis: The C. V. Mosby Co., 1974.

Gallagher, J. R., Heald, F. P., & Garell, D. C. Medical care of the adolescent (3rd ed.). New York: Appleton-Century-Crofts, 1976.

Illingworth, R. S. The development of the infant and young child (5th ed.). Baltimore: Williams & Wilkins Co., 1972.

Marlow, D. R. Textbook of pediatric nursing (4th ed.). Philadelphia: W. B. Saunders Co., 1973.

Peery, R. M. & Miller, F. N. Pathology (2nd ed.). Boston: Little, Brown & Co., 1971.

Silver, H. K., Kempe, C. H., & Bruyn, H. B. Handbook of pediatrics (8th ed.). Los Altos, Ca.: Lange Medical Publications, 1969.

Vernier, R. L. & Urizar, R. Systemic hypertension. In A. J. Moss & F. H. Adams (Eds.) Heart disease in infants, children and adolescents. Baltimore: The Williams & Wilkin Co., 1968.

Wasserman, E., & Slobody, L. B. Survey of clinical pediatrics (6th ed.). New York: McGraw-Hill Book Co., 1974.

Articles

Bennett, D. L. Hypertension in adolescents. The Alabama Journal of Medical Sciences, 1974, 11, 198-205.

Comstock, G. W. An epidemiologic study of blood pressure levels in a biracial community in the southern United States. American Journal of Hygiene, 1957, 65, 271-315.

de Castro, F. J., et al. Hypertension in adolescents. Clinical Pediatrics, 1976, 15, 24-26.

Korobkin, M., Perloff, D. L., & Palubinskas, A. J. Renal arteriography in the evaluation of unexplained hypertension in children and adolescents. The Journal of Pediatrics, 1976, 88, 388-393.

Kotchen, J. M., et al. Blood pressure distributions of urban adolescents. Journal of Epidemiology, 1974, 99, 316-324.

Lancour, J. How to avoid pitfalls in measuring blood pressure. American Journal of Nursing, 1976, 76 773-774.

Lieberman, E. Essential hypertension in children and youth: a pediatric perspective. Journal of Pediatrics, 1974, 85, 1-11.

Voors, A. W. Cuff bladder size in a blood pressure survey of children. American Journal of Epidemiology, 1975, 101, 489-494.