A STUDY OF BLOOD PRESSURE VALUES IN CHILDREN AND THEIR RELATIONSHIP TO WEIGHT, HEIGHT, AND FAMILY HISTORY OF HEART DISEASE

by
Mary Ellen Shick, B.S.

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APPROVED:

[redacted]

Wilma Peterson, Ph.D., Associate Professor, Thesis Advisor

[redacted]

M. Katherine Crabtree, M.N., Associate Professor, First Reader

[redacted]

Sharon Clark, M.N., Associate Professor, Second Reader

[redacted]

Carol Lindeman, Ph.D., Dean, School of Nursing

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INTRODUCTION

Hypertension, often called "the silent killer," is one of the most common diseases of American adults and has been labeled by Londe and Goldring (1976) as the greatest health threat facing our nation today. It is estimated that 23 million adults, ages 18 to 74 years, can be classified as hypertensive. Cardiovascular disease, which may occur as a result of persistent hypertension, is a leading cause of mortality and mobidity in adults (Chenoweth, 1973). In only about 10% of the cases of adult hypertension can a definite cause be established. In the reamining 90%, where no direct disease process can be identified, the condition is labeled primary hypertension (Lieberman, 1974).

The etiology of primary hypertension is not clear, but until recently has been considered an adult disease. Most of the research has been done on adults and screening programs performed in the United States and elsewhere have been directed toward the population over 20 years of age. Before 1970 elevated blood pressures in childhood and adolescence were generally considered a distinct disease process, usually secondary to renal disease (Londe & Goldring, 1976). In 1952 McCrory and Nash wrote "The isolated finding in children of persistent elevation of diastolic and systolic blood pressure without apparent cause is extremely rare." As recently as 1974 the Textbook of Pediatrics (Nelson) stated that although hypertension did occur in both children and adolescents, ". . . in most instances hypertension in

childhood is a secondary manifestation of an underlying disease . . ." (p. 1098). Most practicing health care providers believe this to be the case and as a result, blood pressure measurements in children under 20 years of age are still infrequently included as part of routine physical examinations (Lieberman, 1976).

Loggie (1971) states that each year four or five children are admitted to her adolescent hypertension clinic at the University of Cincinnati with severely elevated blood pressures for which no secondary cause can be found. These children are very ill and require intensive therapy. In trying to determine the age of onset of such advanced disease, she is unable to find any record of past blood pressure readings, presumably because this important facet of the physical examination was not routinely included.

Recently health professionals have begun to consider that a primary hypertensive state does in fact exist in the pediatric population, both as a distinct entity and as a precursor to the hypertensive state in the adult. The limited research done on children demonstrates a definite possibility that hypertension and the ensuing damage to the cardiovascular system begins in the hypertensive, asymptomatic child (Buck, 1973). Only after years of persistently elevated pressures does the individual become symptomatic and seek treatment. By then extensive damage may have occurred. Blood pressure values in children need to be monitored over time in order to provide longitudinal data to validate present suggestive findings. When the hypertensive child is identified and evaluated over time, the etiology and course of the disease may be understood. When the etiology is more fully understood

this knowledge may help prevent or control hyptertension.

Purpose of the Study

The primary purpose of the study is to identify the incidence of elevated blood pressures in a selected group of 10 to 13-year-old children.

A second purpose is to attempt to correlate the child's weight and height with levels of blood pressure. A task force appointed in 1974 by the National Heart, Lung, and Blood Institute to formulate blood pressure standards for children considered only age as a determining factor in blood pressure levels. Recent evidence indicates that weight and height may be more closely correlated with blood pressure levels than age (Blumenthal & Lauer, 1981; Gruskin, 1979; Lieberman, 1977; Prineas, Gillum, Horibe & Hannan, 1980). More data is needed to substantiate this relationship.

A third purpose is to investigate the familial and genetic influences on levels of blood pressure. Studies have demonstrated that a familial tendency toward blood pressure levels exists and that children at risk can be identified at an early age (Biron, Mongeau & Bertrand, 1976; Buck, 1973; Zinner, Levy & Kass, 1971).

Review of the Literature

The review of the literature focuses on research related to the field of juvenile hypertension, studies directed toward identifying risk factors related to hypertension and attempts to determine the etiology of hypertension.

Longitudinal studies of the course of juvenile hypertension are

scarce. Before the early 1970's, measurements of blood pressure levels in children were not routinely taken therefore baseline information is lacking. In addition, elevated blood values in children were considered rare and thought to be due to secondary causes (Lieberman, 1974). Primary hypertension was thought to exist in only extremely rare cases. Another factor contributing to the lack of quality research related to blood pressure values in children is that adult standards were applied to children (Loggie, 1975; Weidman, 1979). It was not until it was recognized that blood pressure patterns in children were different from adults that separate standards were devised. The upper limits of normal systolic and diastolic pressures were arbitrarily accepted as 130 to 140/85 mm Hg until Londe (1966) recorded blood pressures on 1,850 children 4 to 15 years of age in St. Louis, Missouri and found that 90 out of 100 children under 10 years of age had blood pressure values below 130/85 mm Hg. Although normotensive by adult standards, some children were definitely above the 90th percentile when compared to a peer group. The few research studies (Buck, 1973; Lieberman, 1974) which have been conducted in the area of childhood hypertension indicate that blood pressure patterns may be established early in life. There is suggestive evidence that the hyptertensive child often may grow into the hypertensive adult.

Londe and Goldring (1976) followed 131 children ages 4 to 18 in St. Louis, Missouri who were considered to be hypertensive according to the adult standards set by the World Health Organization, that is 140-160/90-95 mm Hg. No secondary cause for the hypertension could be found. These children were followed for an average of 3½ years.

Twenty-nine of the children were diagnosed before 6 years of age. Of the 80 children who were followed until they were 9 years of age, 65% continued to have blood pressures above the normal range.

One of the few longitudinal studies was conducted in Boston on a group of 88 children who were followed for four years (Zinner, Martin, Sacks, Rosner & Kass, 1975). Blood pressure values were adjusted for age and sex, and expressed as mean, range and standard deviation units. Sixty-five percent of the children whose initial blood pressure values were greater than one standard deviation above the mean continue to have values elevated within this range when reevaluated four years later.

Buck (1973) in Ontario, Canada observed 28 children with elevated systolic and diastolic blood pressures over a period of six years. Elevated pressures were defined as values which were above one standard deviation from the mean within each sex and weight group. At the end of the six year period when these children were compared with their control group who had been matched for age and sex, the 28 subjects continued to have elevated systolic and diastolic pressures.

The few research studies investigating primary hypertension in children indicate that it does exist and often persists into adulthood (Buck, 1973; Londe & Goldring, 1976). A third study, in which 3,537 high school students in Harlem participated in a blood pressure screening program, it was found that an overall prevalance rate of 5.4% systolic hypertension and 7.8% diastolic hypertension was evident on the initial screening (Kilcoyne, Richter & Alsup, 1974).

Not only can the hypertensive state be found in childhood, but

insults to the cardiovascular system may occur at an early age. A group of 30 adolescents in Evans County, Georgia, whose blood pressure values exceeded 140/90 mm Hg were followed for 7 years. When they were reevaluated after this time it was found that two of the group had died from cerebral hemorrhage. Four had symptoms of cardiovascular or cerebrovascular disease and five more had sustained hypertension. Only 12 had become normotensive in the interim (Heyden, Bartel, Hames & McDonough, 1969).

Much of the lack of data concerning normal and abnormal blood pressure values in children results from the standards used. Before 1974 it was known that blood pressure increased with age, but there was very little documentation regarding progression. It was not known if the increase was uniform over time or if the increase paralleled the physical growth velocity of the individual. In 1974 the National Heart, Lung, and Blood Institute appointed a Task Force to establish specific standards for blood pressure levels in children. One of the objectives of the group was to prepare charts of the distributional curves of arterial pressure by age, sex and race, and to recommend an upper limit of normal values in order to help identify potentially hypertensive children. The charts were constructed from recordings of blood pressure in children 2 to 17 years of age, collected at three research centers: Muscatine, Iowa; Rochester, Minnesota; and Miami, Florida (National Heart, Lung and Blood Institute, Pediatrics, 1977). Critics of the standards developed by the task force question whether the design of the study and the interpretation of the data accurately represent all children. They point out the following

limitations; all children in the study who were beyond the age of 5 years were caucasian and living in a rural or a semi-rural setting; only one blood pressure reading was taken on each child, and height and weight were not considered. In spite of the limitations, these charts are the only standardized values available for children (Lieberman, 1980).

The final recommendation of the task force was that blood pressure screening be incorporated into the total health care program for children. Children 3 years of age and older should have their blood pressures measured annually as part of the routine physical examination. Sustained pressures above the 95th percentile measured on three separate occasions, should be considered abnormal and warrant further examination to determine a possible cause (National Heart, Blood and Lung Institute, Pediatrics, 1977).

Although the Task Force pointed out that the school setting meets the criteria for a successful screening program, few schools presently measure blood pressures on students. In a survey of 15 elementary schools in the Multnomah County School District in 1979 (Shick) it was found that blood pressure measurements were not taken as part of the routine screen procedures. However, many school administrators gave high priority to hypertensive screening for the faculty. Since the mechanism exists in schools, hypertension screening programs for the pupils could be added if the need for the program could be demonstrated. Kilcoyne (1975) suggests that routine blood pressure screening within the school system would appear to be the most effective way to detect early hypertension. Two recent studies

by nurse researchers from the Pacific Northwest were conducted in schools (Clark, 1976; Spratlen, 1980), one in a public school district and the other in a private school. Both demonstrated the need and effectiveness of screening programs in schools.

Risk Factors Associated with Hypertension

Although the etiology of primary hypertension in children, as in adults, is unknown the influence of certain factors is believed to play a major role. These factors include race, obesity, sodium intake, genetic and environmental influences, chronic stresses and smoking. However, in this study only the factors of race, weight and genetic and environmental influence on the etiology of hypertension will be considered because it is in these areas that the nursing profession can be most influential in case finding and health teaching. While nurses are unable to change the genetic make-up or race of an individual, they are in an excellent position to identify risk factors which may be present in a child and his family and through health education help the individual minimize the risk in these areas.

Race. It has been demonstrated that black adults, especially males, have an increased incidence of hypertension and the condition is frequently more severe (Finnerty, 1971; Freis, 1974). Not only are blacks more likely to be hypertensive but because of lower socioeconomic standards they are less likely to be under medical surveillance (Kolata, 1979).

The following two studies indicate that this difference in prevalance rates between blacks and whites begins in childhood.

Blood pressure measurements of 3,527 black, latin and white high

school students in Harlem revealed a prevalance rate of 5.4% systolic and 7.8% diastolic hypertension during the initial screening (Kilcoyne, et al., 1974). Standards of 140/90 mm Hg were used as upper limits of normal. No racial difference in values were noted during the initial recording. However, a followup screening 7 to 10 days later revealed that black males had a higher prevalance rate of diastolic hypertension than both other groups. The researchers also noted a marked increase in the incidence of elevated pressures between 17 and 18 years of age, especially in black males.

In Bogalusa, Alabama 3,524 children 5 to 14 years of age participated in blood pressure screening. Nine readings were taken on each child during the 1973-1974 school year. The researchers found that black children had blood pressures much higher than caucasian children and the difference in values started before the age of 10 years (Voors, Foster, Frerichs & Berenson, 1976).

Blood pressure levels of three major ethnic groups, white, black and children with Spanish surnames, were studied in a primary care center in Houston, Texas. The study group consisted of 2,810 children 3-17 years of age. The researchers found that elevated pressure readings were most common among blacks and least common among whites (Gutgesell, Terrell & Labarthe, 1980).

The blood pressure levels of 100 students 14 to 17 years of age were measured in Chatham County, Georgia (Nauright, Slee, Davis, Easterling, Galloway, Hughes, Laroche, & Whiteman, 1979). The researchers found that 15% of the black students in the study had high normal blood pressures compared to 9% of the white students.

Two studies question whether black children actually have systolic and diastolic pressure levels above that of caucasian children. In Dallas in 1979 blood pressure levels were measured by Task Force Standards recorded on 10,641 eighth grade students, of whom 46% were black (Fixler, Laird, Fitzgerald, Stead, & Adams, 1979). Their findings revealed very little difference in mean systolic and diastolic pressures between black and white children.

Blood pressure measurements were taken on 1,668 black children ranging in age from 4 to 17 years in Brooklyn. The researchers observed no difference in the mean systolic pressure of their all black population and that of white children reported in the literature (Dube, Kapoor, Ratner & Tunick, 1975).

It has been well documented that black adults exhibit a tendency toward higher blood pressures when compared to a white population of similar age and sex (Fries, 1974; Kaplan, 1978). Large studies need to be conducted on black children to determine if younger aged blacks exhibit this tendency.

Obesity. The relationship between obesity and hypertension has been well documented (Chiang, Perlman & Epstein, 1969), and appears to be as much a risk factor in children as in adults (Lauer, Filer, Reiter & Clarke, 1976). Hypertension is more common among obese persons, and it has been found that weight reduction can bring about a lowering of blood pressure (National Heart, Lung and Blood Institute, Pediatrics, 1977). Kaplan (1978) observes that obesity is the most frequent abnormal finding in children and adolescents with elevated blood pressure.

Weight and its relationship to levels of blood pressure was

studied by Stamler, Stamler, Riedlinger, Algera and Roberts (1978). They screened the blood pressures of one million adults in Chicago and had each person classify themselves as overweight, underweight or normal weight. The group that classified themselves as overweight had prevalance rates of hypertension which were 50 to 300% higher than the other two groups screened. Prineas, et al. (1980) found that weight was the best measure of body size for predicting blood pressure. The bigger and heavier the children were in this study, the higher their blood pressure.

Lauer, et al. (1976) attempted to relate wight and salt preference to levels of blood pressures in three groups of school children in Iowa. The size of the groups were not stated but they were chosen from 4,800 school children on the basis of blood pressure levels. Their results showed no relationship between salt preference and blood pressure levels but they found that the most obese children in the group had the highest pressure levels.

In a study in Muscatine, Iowa, risk factors known to be associated with coronary artery disease in adults were assessed in children. Over a 14 month period 4,829 school children ages 6 to 18 participated in the study which examined blood pressure, weight, serum cholesterol and triglycerides. The researchers reported that hypertension in the children was more common than previously supposed. It was found that 16.7% of the children in the study had pressures greater than 140/90 mm Hg. When only children above the 90th percentile in weight were included the figure rose to 27.3%. The researchers concluded that the correlation between obesity and blood pressure elevation begins in childhood (Lauer,

Connor, Leaverton, Reiter & Clarke, 1975).

Nurses have the opportunity to intervene in this area of childhood obesity by means of health education to children and families. Individuals can be made aware of the risks involved in becoming overweight and that hypertension and cardiovascular complications are more prevalent in obese persons. This will enable the child to actively participate in his or her own health maintenance.

Genetic and Environmental Influences. It has been recognized for many years that elevated blood pressures tend to aggregate in families. It is not known whether this is due to the genes its members share or to the definable environmental influences in the family setting such as diet or stressful living conditions. Page (1976) states that while a genetic predisposition may be necessary for the development of primary hypertension, environmental factors are also necessary for the condition to express itself. (Zinner, et al. (1971) found in their study of 190 families in Boston that a familial tendency for higher blood pressures is established early in life, but no attempt was made to identify specific environmental or genetic factors that may have contributed to this finding.

To test the theory that genetic factors are the primary determinants of similar blood pressure levels in families, Biron, et al. (1972) compared the parent-child correlation of blood pressures of natural children and adopted children. Blood pressure was measured in each member of 398 French-Canadian families in Montreal who had at least one adopted child of the same ethnic origin. They reported significant correlation ($p < .001$) in the natural parent-child relationship, but

no significant correlation in the parent-adopted child combination. They concluded that heredity explains most of the familial resemblance of blood pressures among family members.

Similarity of blood pressure levels in siblings was the subject of a study attempting to determine the earliest age at which a similarity occurs (Henekens, Jesse, Klein, Gourley & Blumenthal, 1976). No data concerning the number of families in the study was given. In the families that contained full and half-siblings, infants, even at one month of age, demonstrated a higher correlation of blood pressure levels with their full siblings than with their half-siblings. They believe these findings are strong support for genetic influence as the determinant of blood pressure levels. Thus if future studies attempting to establish the etiology of hypertension confirm that heredity plays a major role, identification, intervention and surveillance of blood pressure of children in the high risk group may reduce the prevalence of the disease in adults.

The concept that environmental influence is the major determining factor in blood pressure levels has gained support from studies of populations outside the major western culture. These populations are generally free from hypertension and do not exhibit the tendency found in Western cultures for blood pressure levels to increase with age (Page, 1976). These populations are regarded as primitive or pre-industrial societies living in non-urban or rural locations. When individuals from these primitive societies become town dwellers, or are assimilated into a westernized environment, biological changes consistent with Western trends are evident. For instance, blood pressures

begin to rise as age increases, plasma lipids increase, and a weight gain occurs with advancing age that is generally not the rule in a primitive culture. Page (1976) considers these findings as evidence that environmental factors play a major role in the determination of blood pressure levels.

Beaglehole, Eyles and Prior (1979) studied the effect of migration on children from Tokelau, three isolated islands in the South Pacific. The Tokelauan society is insulated from an industrialized culture and the living patterns are relaxed and relatively free from the pressures typical of other Polynesian cultures in that area. In 1966 a major hurricane destroyed the cocunut trees, a primary food source, and during the ensuing years many families migrated to New Zealand. In 1971 White examined all children aged 5 to 14 years while they were still residents on the island. Follow-up examinations were conducted in New Zealand in 1975-1977 on those children who had migrated and their blood pressures compared to those of children who stayed on the islands of Tokelau. The researchers found that the migrant children five to nine years old, had higher blood pressure values and were heavier than the non-migrant children. However, this difference was evident in only the children under 10 years of age. The researchers postulated the higher blood pressures in the younger children may be due to a susceptibility difference in the two age groups to the effects of migration. The change in diet and the exposure to a totally new environment may have its greatest impact in young children. If this is proven to be true, perhaps the long term effects may also be more harmful.

The specific geographic location and its environment may have an

influence on the levels of blood pressure. Researchers have found differences in mean systolic and diastolic pressure between juvenile populations from various regions of the United States (Fixler, Kautz & Dana, 1980).

The relative contributions of heredity and environment to the role of hypertension have yet to be determined by large-scale and well controlled research.

Summary

The natural history of primary hypertension is not known. It was thought to be a disease of adults and the majority of research has been directed toward this age group. The few available longitudinal studies on children indicate the possibility that tendencies toward elevated blood pressure may be established in childhood and the pattern may continue into adulthood. The hypertensive child may have a distinctly greater possibility of becoming a hypertensive adult.

Certain risk factors have been implicated in the etiology of hypertension. Among these risk factors, obesity and a familial tendency toward hypertension appear to exert the strongest influence. The factor of race is also strongly correlated with increased blood pressure. Black males exhibit a higher prevalence rate than any other group. The role of genetic and environmental influences have not been established. The limited research in this area indicates an interaction of heredity and environment may result in the hypertensive state.

Nurses can be influential in the identification and control of hypertensive disease in children. Through recognition of risk factors involved and subsequent health education to children and families in

avoiding these risk factors, nurses may be instrumental in helping to prevent the long-term effects of primary hypertension on the cardiovascular and cerebrovascular system.

Theoretical Framework

Health is a highly desirable goal for society. The cost of illness is substantially greater than the cost of prevention. Hypertension is a disease process that affects 15-20% of the adult population in America (Page, 1976), and results in irreversible damage to the cardiovascular and cerebrovascular systems. It has been demonstrated that early identification and treatment of the hypertensive adult significantly reduces the deleterious effects of sustained elevated blood pressure on the organs of the human body (Hypertension Detection and Follow-up Program, 1979; Veterans Administration Cooperative Study, 1967). The age at which onset of the disease process is most likely to occur has not been established. It is known that high blood pressure in adults occurs long before the person becomes symptomatic and seeks treatment. Identifying the child who is hypertensive or is at risk for hypertension in the future may be accomplished by routine blood pressure screening in the schools. Early identification and early intervention may further reduce the morbidity and mortality which are the result of sustained, elevated blood pressures. The model of the theoretical framework for identification and intervention of the child with hypertension (Figure 1) illustrates the importance of blood pressure screening programs.

FIGURE 1: The theoretical framework for the control of hypertension includes a) identifying the child at risk for hypertension by identifying the family at risk, b) instituting nursing intervention by annual screening programs and health education and c) identifying the hypertensive child and referring for diagnosis and treatment. Identification and intervention may result in a healthy adult; lack of identification and intervention may result in a hypertensive adult with cerebrovascular complications.

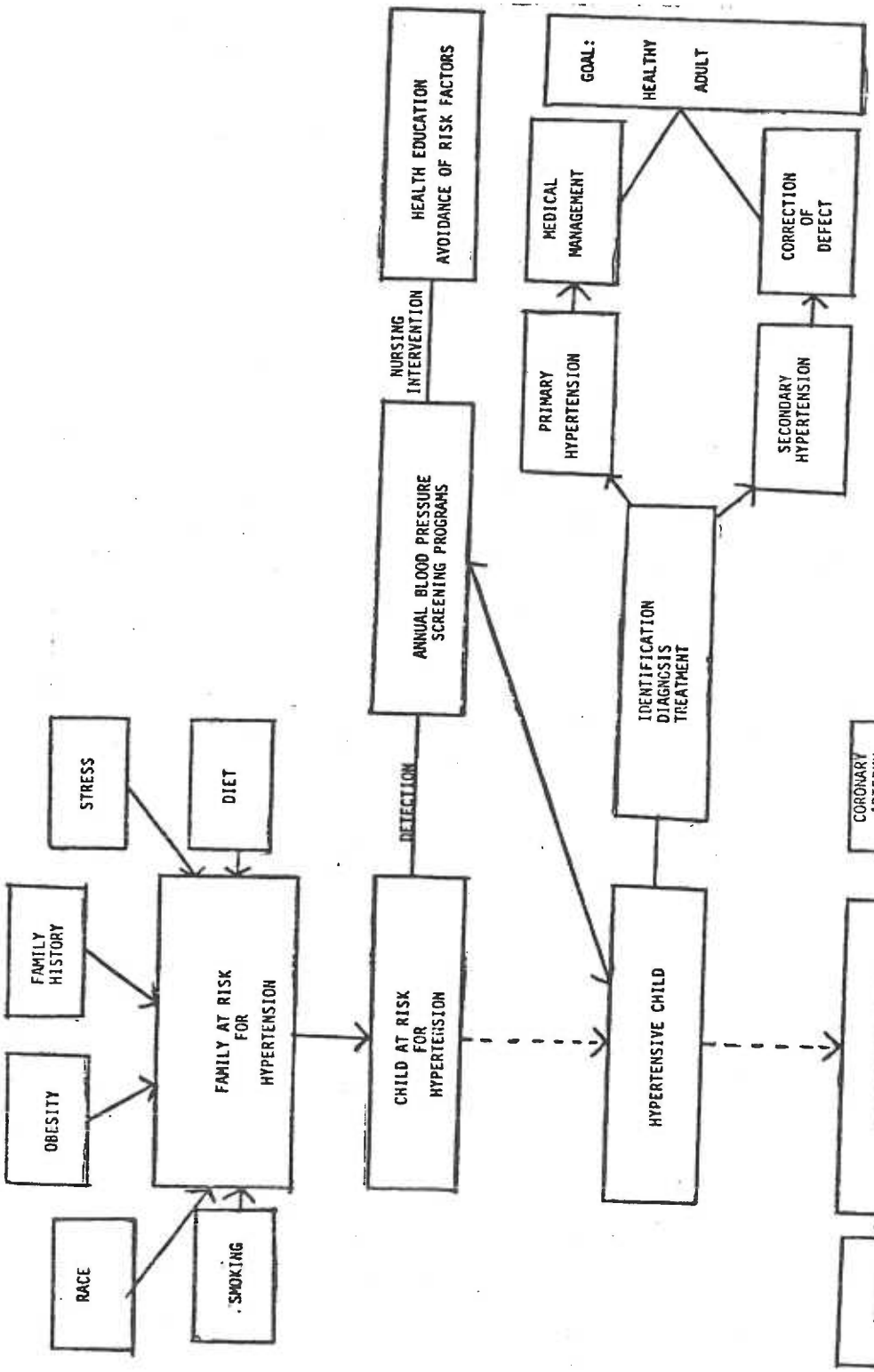


Figure 1. Theoretical framework for the identification of child at risk for hypertension and intervention measures to influence the outcome of the hypertensive process.

Hypotheses

As a result of the literature review the following hypotheses will be tested:

1. Two percent of children aged 10 to 13 years of age will have blood pressure values above the 90th percentile by national standards when screened in a school setting.
2. Of the children aged 10 to 13 yeas of age who are found through a school screening program to have blood pressure values above the 90th percentile by national standards, at least 10% will continue to have elevated blood pressure values when rescreened two weeks later as compared to a control group of normotensive children.
3. Children aged 10-13 who are classified as overweight by the national standards for weight will have a higher incidence of elevated blood pressures based on established national standards for blood pressure than will children of the same age group whose weight is within the normal range.
4. Children aged 10-13 whose blood pressure is at or above the 90th percentile based on national standards will have a higher incidence of heart disease in the family history than children of the same age whose blood pressures are below the 50th percentile.

CHAPTER II

METHODS

Design

The study is descriptive in nature and exploratory in design. The results describe the levels of systolic and diastolic blood pressures in 10 to 13-year-olds and the correlation of levels of blood pressure, the dependent variable, with the independent variables of height, weight and a family history of heart disease.

Subjects and Setting

The sample chosen for the study consisted of elementary school children 10 to 13 years of age from four schools in the Portland Public School District. The age group was selected because a majority of the research in juvenile hypertension focuses on the adolescent population. If the attempt is made to establish the age of onset of hypertension younger populations should also be included in research studies. The specific schools were selected to provide a sample in which both black and caucasian students were represented. The four schools were also chosen to represent a range of socioeconomic status. A map constructed by Dr. William Morton, Professor and Head of the Division of Environmental Medicine, University of Oregon Health Sciences Center, was used in the selection of schools (Appendix A). The division of socioeconomic areas was based on four criteria: median family income, percent of families with income below the poverty level, the percent

of high school graduates among persons aged 25 and older, and the percent of occupied housing units with 1.01 or more persons per room. A total sample of 206 students were screened.

Procedure for Collection of Data

The investigator set up an appointment with the office of the Assistant Superintendent for Curriculum for the Portland Public Schools to explain the purpose of the study and to seek permission to conduct the research. Subsequently written permission was obtained from Dr. Edwin Schneider (Appendix B). In addition permission was sought from the principal or faculty coordinator in each school through a personal interview before beginning the data collection. Appointments were made to discuss the purposes of the study and to determine the most effective way to accomplish the screening. A copy of the letter of permission from Dr. Schneider, a copy of permission to procede with the study from the Committee on Human Research, University of Oregon Health Sciences Center, an abstract of the study to be done and the procedure for data collection were all given to each coordinator to share with the teachers. In order to make the experience an educational one, the investigator offered additional information on blood pressure and hypertension which could be discussed with the students before the consent forms were sent home to the parents. A film on the dynamics of blood pressure and the significance of hypertension in adults was obtained from the Oregon Heart Association and shown to potential study subjects in two schools. In the third school a written explanation of blood pressure and the procedure for measuring blood pressure was

prepared by the investigator and given to the home room teachers for presentation to their classes (Appendix C). The remaining school requested no instructional material.

Obtaining Parental and Student Consent

1. Consent forms were sent to all parents of 5th 6th and 7th grade stduents in the selected schools. A space was also provided for the child to sign his or her consent (Appendix D). Parents were informed that a few students might be recalled two weeks after the initial screening to double check the accuracy of the measurements. Parental permission was requested for their child to be included.

2. A questionnaire was included with the consent form asking the parents if they have been diagnosed by a doctor or a nurse as having high blood pressure or heart disease (Appendix D). They were also questioned about any known incidence of high blood pressure or heart disease on either the maternal or paternal side of the family. Parents were informed that only children who returned the questionnaire would be included in the study.

Establishing Inter-Rater Reliability

Inter-rater reliability of the data collectors was established by having each collector, graduate nursing students, pair with another collector and each using a stethescope over the same brachial artery on eight subjects to determine the systolic and diastolic pressure. A variation of 2 mm Hg among data collectors was considered acceptable. Inter-rater reliability was established between collectors at a level of .8%.

Data Collection Process

1. The signed consent forms were collected from the schools three days prior to the day selected for the screening program. Identification numbers were assigned to each subject.

2. Upon arrival in the room designated by the school coordinator for screening each subject was given a data collection sheet with his or her identifying number and spaces for the birthdate, sex, blood pressure readings, height and weight to be recorded. Race was determined by observation by the data collectors. To maintain confidentiality for the student the list of names which matched the identifying number was given to the school principal or faculty coordinator.

3. All students were advised prior to data collection that it was expected a small number would be recalled in two weeks to check the accuracy of the measurements. This was done to minimize anxiety levels in subjects found to have elevated pressures and who would be rescreened in two weeks.

4. Blood pressure measurements were done in the school setting during regular school hours. Four children were called to the screening room at one time. When the fourth subject's last blood pressure measurement was being taken, the first subject returned to the classroom and asked the next four subjects to come to the screening area.

   a. The child was placed in a comfortable sitting position with the right upper arm exposed and resting on a supportive surface. Sufficient time was allowed to recover from recent activity.

   b. A cuff was chosen for each subject which completely encircled

the upper arm. It was found in this study that the majority of subjects required an adult size cuff to accommodate for the length of the upper arm. The systolic pressure was recorded as the first sound heard and the diastolic pressure corresponded to the disappearance of sound. Three pressure recordings were taken five minutes apart.

5. In between the three pressure readings the height and weight of each subject was taken in stocking feet. The height was measured with the subject's back, heels, and head against a wall marked in inches. A small board was held flat against the child's head to obtain accurate measurement. The weight was taken using the school's balance scales and was recorded in pounds.
6. Subjects found to be at or above the 90th percentile for blood pressure levels were rescreened two weeks from the initial screening. An equal number of normotensive subjects were rescreened at this time as a comparison group.
7. Subjects found to have a sustained elevated blood pressure on the second screening were referred to the school nurse for follow-up.

Analysis of Data

The mean of the two pressure readings nearest in value on each subject was used in the statistical analysis. Measures of central tendency were computed for systolic and diastolic blood pressure,

height, and weight within each age group and sex in order to examine the data and to compare the findings to nationally accepted values.

A correlation matrix was designed to ascertain the relative contribution of height, weight, and a positive family history of heart disease to the levels of blood pressure. Correlation coefficients can indicate not only the magnitude of the relationship but also the direction of the relationship. If the two variables are positively related they will increase or decrease together.

Before the correlation was attempted, scatterplots were constructed to determine any correlation between the dependent variable, blood pressure levels, and the independent variables of height, weight, and a positive family history of heart disease. The significance of Pearson's product-moment coefficient was determined by use of a Z test set at a P of $< .001$.

CHAPTER III

RESULTS AND DISCUSSION

A review of the literature reveals that hypertension may have its beginnings in childhood. Early identification is essential if irreversible damage to the body organs is to be prevented. Blood pressure screening is not a part of the overall health maintenance program in the Portland Public Schools. The purpose of this study was to determine levels of blood pressures in a 10 to 13-year-old student population and to identify the incidence of sustained elevated systolic and/or diastolic pressures. The study also attempted to correlate the child's weight, height and a postive family history of heart disease with blood pressure levels.

The theoretical framework relating to the detection and intervention of the child with hypertension was used to generate the following hypotheses:

1. Two percent of children aged 10 to 13 years of age will have blood pressure values above the 90th percentile by national standards when screened in a school setting.
2. Of the children aged 10 to 13 years of age who are found through a school screening program to have blood pressure values above the 90th percentile by national standards, at least 10% will continue to have elevated blood pressure values when rescreened two weeks later as compared to a

control group of normotensive children.

3. Children aged 10 to 13 who are classifed as overweight by national standards of weight will have a higher incidence of elevated blood pressures based on established national standards than children of the same age and sex whose weight is within the normal range.
4. Children aged 10 to 13 whose blood pressures are at or above the 90th percentile based on national standards will have a higher incidence of heart disease in the family history than children of the same age whose blood pressures are below the 50th percentile.

The results of the study will be presented and discussed in the following order. First, the sample will be described according to age, sex and the socioeconomic area in which the school appears. Next the findings of blood pressure levels, height and weight in each age group will be presented as the mean and standard deviation and compared to the means reported as national standards. The findings in regard to the incidence of high normal blood pressure in this study and the correlations between blood pressure levels and height, weight and a positive history of family heart disease will follow, as well as additional related findings.

Description of the Sample

The 206 subjects, 108 boys and 98 girls, who participated in the study were students at four elementary schools in the Portland Public School District. The schools were chosen to represent a variety

of socioeconomic areas. The status of each area chosen was determined by consulting a map of Portland constructed by D. William Morton, University of Oregon Health Sciences Center. The map is based on median family income, percent of families with income below the poverty level, the percent of high school graduates among persons aged 25 and older, and the percent of occupied housing units with 1.01 or more persons per room (Appendix A). The limitation of the map is the fact that it has not been revised to reflect the 1980 census findings.

Data collected included three measurements of systolic and diastolic pressure, and one measurement of height and weight on each subject. In addition a questionnaire indicating the presence or absence of heart disease or hypertension on either side of the family was requested for return with the parental consent form.

The distribution of the study subjects according to socioeconomic area, age and sex is shown in Table 1.

An attempt was made to include subjects in schools from neighborhoods which were primarily low income areas and from sections which contained a black population. However, school authorities refused permission stating that other research projects had been carried out in the schools recently and parents were objecting to research that was race related and unrelated to education.

The sample consisted of 108 boys ages 10, 11, 12 and 13 and 98 girls ages 11, 12 and 13. Data for the 10-year-old girl is lacking from the sample. There is no apparent explanation for the lack except that parents had not returned the signed consent form, therefore the students could not participate in the study.

Table 1

Distribution of Study Subjects According to Socioeconomic Area, Age and Sex

Socioeconomic Area	Age	Boys	Girls	N
Low*	10	16	0	16
	11	23	14	37
	12	5	1	6
			subtotal =	59
Middle**	11	6	12	18
	12	21	33	54
	13	9	6	15
			subtotal =	87
Upper Middle ***	11	4	5	9
	12	13	13	26
	13	11	14	25
			subtotal =	60
			N =	206

* Areas #33.01, 7.01 (Appendix A)

** Area #75

*** Area #69

Systolic and Diastolic Blood Pressure Findings

The means and standard deviations of systolic and diastolic blood pressure were computed and compared by age and sex with the norms reported by the National Task Force and the National Health Survey. These values can be found in Tables 2 and 3.

Blood pressure levels, both systolic and diastolic, in boys of all age groups were more than one standard deviation below those reported in the Iowa-Mayo pool unpon which the National Task Force based the norms. In girls, only the diastolic pressure in the 12-year-olds was below one standard deviation from standards. Thus in the present sample blood pressure values for boys is consistently and considerably lower than national standards. The values for both boys and girls in this study are lower than the means reported in other studies and is shown in Table 4. The values found in this study are compared to the national standards in Figure 2.

Similar findings are reported by Spratlen (1981), Fixler, et al. (1979), and Dube, et al. (1975). It has been suggested by Fixler, et al. (1980) that the discrepancies between the Task Force norms and the findings in other studies may be attributed to actual differences among the populations. Geographic location, racial composition and sample size can significantly alter the results of blood pressure screening programs. Other influencing factors may be the methods of data collection, the type of instrument used for measuring pressure or the definition of diastolic pressure (muffling or disappearance of sound). According to one research group (Prineas, et al., 1980) room temperature and the time of day have a significant effect on blood

Table 2

Means, Standard Deviations and Ranges of Systolic and Diastolic Pressure, Height and Weight by Age and Sex for Sample and Compared to National Standards

BOYS

Age		Systolic	Diastolic	Height (Inches)	Weight (Pounds)
10 (N=16)	$\bar{x}$	96.75	63.75	54.70	76.70
	SD	10.26	5.20	2.83	28.85
		110.8*	72.5*	54.96**	71.04**
	Range	84-119	54-74	50.5-62	53.5-181
11 (N=35)		101.66	59.53	56.95	87.20
		10.81	9.14	2.78	22.57
		113.8*	74.6*	57.20**	79.46**
	Range	80-124	38-75	52-64	44.5-147.5
12 (N=42)		104.74	60.59	59.15	91.90
		10.81	8.32	2.54	12.28
		115.4*	73.6*	60.80**	93.35**
	Range	86-126	40-78	53.25-66.5	64.25-125
13 (N=15)		109.76	61.93	61.21	102.64
		7.68	10.02	3.31	20.36
		118.6*	73.4*	63.88**	99.99**
	Range	97-125	40-81	57-69	81-160

* Iowa-Mayo Pool - National Task Force Standards
** National Health Survey - Series 11 #165

Table 3

Means, Standard Deviations and Ranges of Systolic and Diastolic Pressure, Height and Weight by Age and Sex for Sample and Compared to National Standards

GIRLS					
Age		Systolic	Diastolic	Height (Inches)	Weight (Pounds)
11 (N=32)	$\bar{x}$	104.77	60.33	57.39	95.74
	SD	12.49	10.31	3.30	26.10
		115.2*	73.8*	56.24**	82.79**
	Range	82-130	42-78	50.25-66.5	61-149
12 (N=48)		106.19	59.38	59.51	94.42
		8.91	8.95	3.14	16.96
		117.3*	73.6*	62.36**	102.12**
	Range	89-123	40-79	53.25-66.5	64.5-125
13 (N=18)		107.39	63.56	60.88	98.03
		15.44	12.57	3.94	24.27
		119.1*	75.4*	63.68**	106.83**
	Range	97-125	48-84	57-69	81-160

* Iowa-Mayo Pool - National Task Force Standards
** National Health Survey - Series 11 #165

Table 4

Comparison of Systolic Means of Present Study With Three Studies

Age of subject	Londe, 1966		Iowa-Mayo Pool, 1974		Londe, 1975		Shick, 1981	
	Male	Female	Male	Female	Male	Female	Male	Female
10	114	114	110.8	110.6	110	108	96.8	---
11	114	121	113.8	115.2	109	110	101.6	106.2
12	117	117	115.4	117.3	114	113	104.7	106.2
13	120	120	118.6	119.1	113	112	109.8	107.4

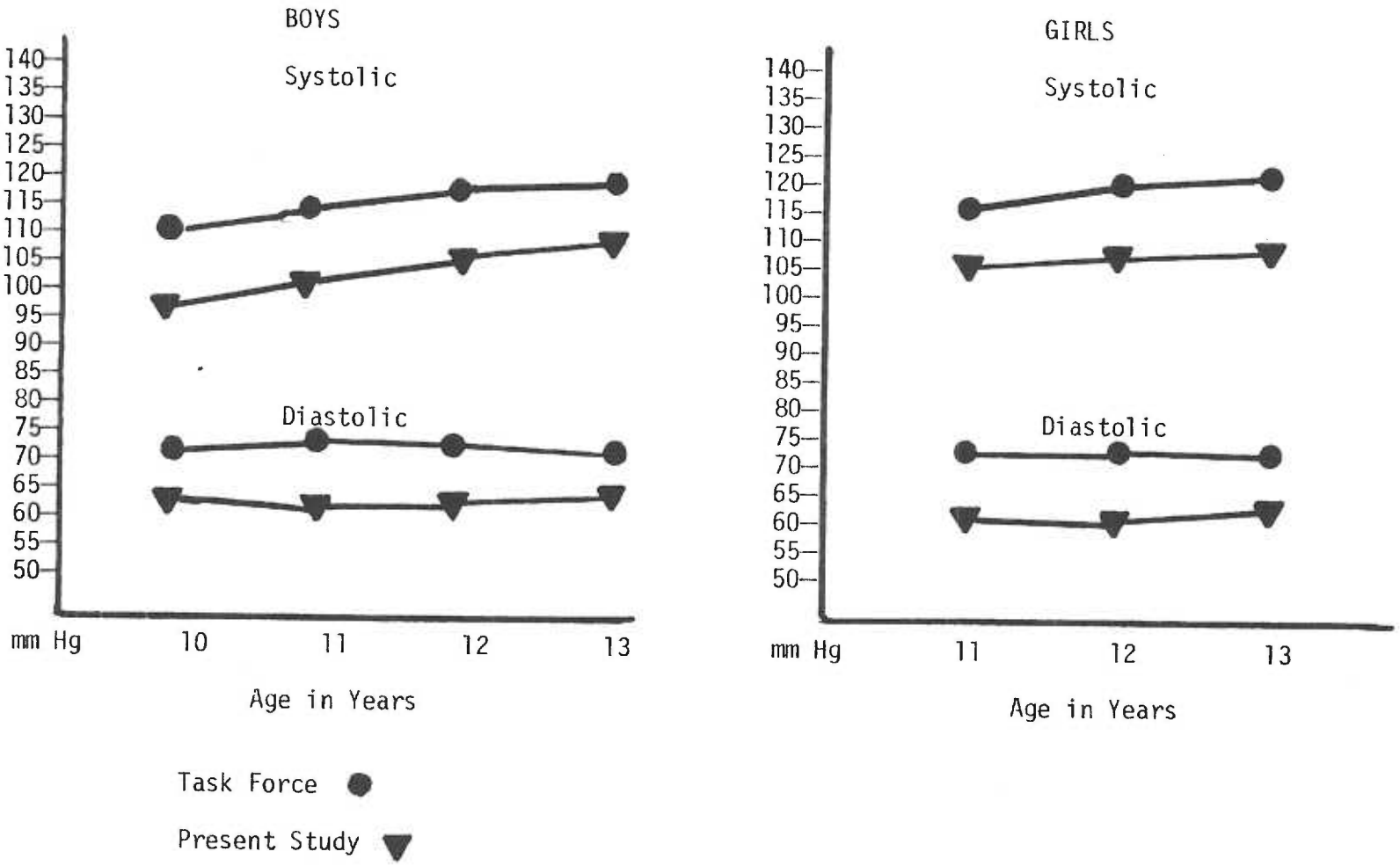


Figure 2: Comparison of systolic and diastolic blood pressues in present study with National Task Force standards

pressure levels.

The difference between blood pressures reported in this study and the Task Force may also be due to the method of gathering data. In the Task Force Standards only one blood pressure reading was taken on each subject and the means of sytolic and diastolic pressure was derived from cross-sectional data for each age and sex. In the present study it was found that the first measurement was usually the highest of the three and was not used in computing the mean. There is no apparent reason to explain why the differences should be more significant in boys than in girls. The small sample size could have influenced the findings.

Incidence of Elevated Pressures

On the initial screening nine (4.5%) of the subjects had systolic pressures which measured above the 90th percentile based on standards set by the National Task Force. Only one diastolic elevation was found and in this subject the systolic pressure was also significantly elevated. Thus the first hypothesis, which stated that two percent of the children who were screened would have blood pressures above the 90th percentile, is supported. The incidence of elevated blood pressures reported in this study is similar to that reported by Kilcoyne (1974) and Dube (1975), but below that found by other researchers. The wide range of reported incidence of elevated blood pressures by other researchers is demonstrated in Table 5.

It is difficult to make comparisons with many of the other studies in regard to the incidence of elevated blood pressures because of the age differences in the populations studied, variety of standards used and because the reported incidence in much of the research is

Table 5

Reported Incidence of Hypertension in Juvenile Populations

Senior Author	Year	Age of Population	Race	Standards Used	Incidence
Heyden	1961	15-25 years	Black White	140/90	11%
Buck	1964	5 years	White	*	5.8%
Lauer	1974	14-18 years	White	140/90	16.7%
Kilcoyne	1974	14-19 years	Black White	140/90	1.2% systolic 2.4% diastolic
Dube	1975	4-17 years	Black	**	1.8 systolic-boys 2.5% systolic-girls
Nauright	1979	14-17 years	Black White	Task Force	10%
de Castro	1976	15-19 years	White Black	140/95	9.3%

* Elevated is one standard deviation from mean of sex and weight group.

** Elevated = two standard deviations or more above the mean for age group.

based on only one blood pressure measurement (deCastro, et al., 1976; Dube, et al., 1975). This investigator found that almost without exception the first pressure reading was the highest. Fixler, et al. (1979) reported the incidence of hypertension among the subjects in their Dallas study to be 8.9% on the initial screening. After a third examination, allowing at least a four-week period between measurements, only 1.2% continued to have elevated pressures.

In addition to differences in ages to subjects and the technique of blood pressure measurement, often other procedures accompanying the screening act as intervening variables. In the Muscatine study (Lauer, et al., 1975), in which they reported the incidence of hypertension to be 16.7%, the measurements of blood pressure were preceded by a venipuncture on each child. In the Bogalusa Heart Study (Voors, et al., 1976) blood pressures were recorded as the last procedure in a 1½ to 2 hour physical screening which included venipuncture, height and weight measurements, skinfold thickness and a complete physical examination.

Until procedures for blood pressure screening in children are standardized and systematically implemented the reported incidence of hypertension in children will continue to vary considerably.

Rescreening the Subjects With Elevated Blood Pressures

Nine subjects (4.5%) were found to have elevated systolic pressures on initial screening. The nine subjects were rescreened two or more weeks later along with an equal number of normotensive subjects who functioned as a comparison group. Three blood pressures were again taken on each subject requiring rescreening. The systolic and diastolic

pressures of six (3%) of the nine subjects originally found to be elevated returned within a normal range. Three subjects (1.5%), all girls, continued to have elevated pressures and were referred to the school nurse. Two of these girls were 11 years old, black, and both were in the 95th percentile in weight. The third subject was caucasian, 13-years-old, in the 75th percentile for hight, but under the 50th percentile for weight. The outcome of the screening program is shown in Figure 3.

Based on these findings the second hypothesis, which states that 10% of subjects found to have elevated pressures on the initial screening will continue to have elevated pressures, was supported. In this population three of the original nine subjects (33%) continued to exhibit elevated blood pressure levels.

Correlation Matrix

Pearson's product-moment correlation computed on the data revealed a significant ($P < .001$) relationship between blood pressure levels and both weight and height. The correlation of blood pressure levels with a positive family history of heart disease indicated no significance. The correlation matrix is shown in Table 6.

Correlation of Systolic Pressure with Weight and Height

The findings in the present study support the third hypothesis which states that children who are classified as overweight will have higher blood pressure values. Weight has been positively correlated with elevated blood pressures in both adults and children (Chiang, et al., 1969; Kaplan, 1978; Lauer, et al., 1976). Children who are heavier and

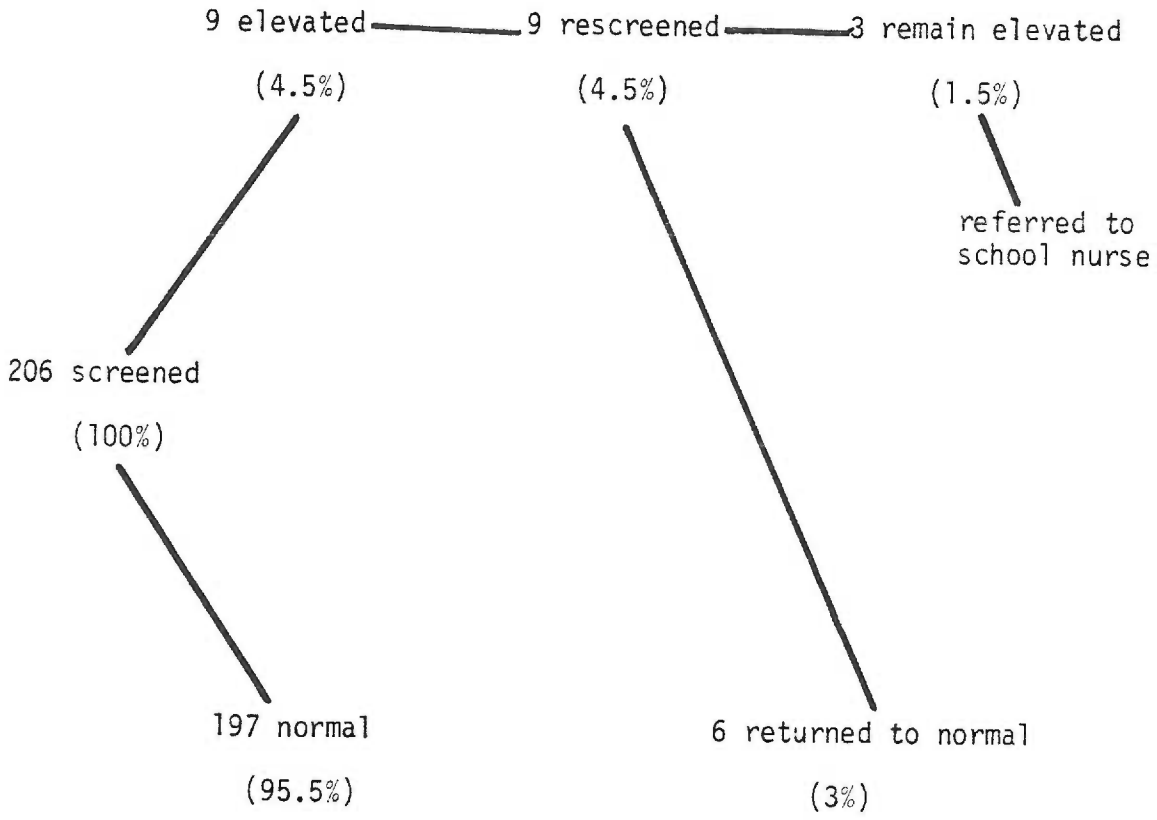


Figure 3: Outcome of screening program

Table 6

Correlation of Systolic Blood Pressure with Height, Weight, and a Positive Family History of Heart Disease

Variable	Correlation with Systolic Pressure (r)
Height	0.43*
Weight	0.48*
Family History	0.09

*P < .001

taller usually have blood pressure levels higher than their peers. This finding is supported by other researchers (Dube, et al., 1975; Londe, 1966). They found blood pressures and body weight were positively correlated in children and adolescents. Lauer, et al. (1976) reported that the most obese children in their groups also had the highest blood pressures; the least obese children were in the group with the lowest blood pressures.

A profile of children in the present study who are over the 90th percentile in weight is presented in Table 7. Aside from the two subjects who were above the 90th percentile in both weight and systolic blood pressure, no consistent profile emerged.

The corrleation of height with levels of blood pressures found in this study has been reported by Blumenthal & Lauer (1981) who found most of the variation in blood pressure levels in their population correlated with height. Prineas, et al. (1980) suggest that tables of

Table 7

Profile of Study Subjects Above 90th Percentile in Weight

Subject	Systolic	≥50th	≥75th	≥90th	Height*	≥50th	≥75th	90th
1	120		X		64			X
2	102	X			66.67			X
3	122		X		62.67			X
4	107	X			66.5			X
5	115		X		63.15		X	
6	101	X			59	X		
7	111	X			64			X
8	100	X			61		X	
9	121		X		63.87			X
10	123		X		67.87			X
11	120		X		64.75			X
12	108	X			61.87		X	
13	110	X			61.87		X	
14	128				60.25		X	
15	125				57.25	X		

* Height in inches

blood pressure levels by height are more suitable for establishing norms for blood pressure than is age.

In this study both height and weight contributed significantly to the levels of blood pressure. This finding supports researchers who believe that height, weight or a height/weight index may constitute a more suitable determinant for blood pressure levels than age alone.

Correlation of Systolic Pressure with a Positive Family History

A correlation coefficient of .09 indicated no significance between levels of systolic blood pressure and a positive family history of heart disease. Thus the fourth hypothesis, which stated that children with higher blood pressure levels would have a higher incidence of heart disease in their family, is not supported. This finding is contrary to the results of other researchers. Londe (1971) reported that parental hypertension was significantly higher in his group of hypertensive children than in normotensive control subjects. Zinner, et al. (1971) found a definite tendency in preschool children toward higher pressures in families with one or two hypertensive parents.

However, the finding in this study is similar to that of Nauright, et al. (1979) who found no correlation between the presence of hypertension in the adolescent and a family history of cardiovascular disease. In that study population only 8% of the subjects who had a positive family history had a high blood pressure level, while 16% of those reporting no positive history had elevated blood pressures.

One possible explanation for the finding of no correlation between blood pressure levels and family history in this study may be that

in many cases parents were not under any medical supervision and did not know if they had heart disease or hypertension and answered the question as "don't know." In the low income area there were many one parent households where the one parent did not know the medical history of the spouse. There were other children who lived with grandparents or relatives who did not respond to questions about the parents. Complete family histories were returned in less than 100 of the subjects.

Additional Related Findings

In the initial screening process it was found that 13 of the subjects screened had systolic pressures over the 75th percentile. The Task Force recommendations include monitoring children whose blood pressures are consistently above the 95th percentile but no recommendation is made for those children who have an occasional blood pressure above the norm for age and sex. Lieberman (1976) mentions the tendency toward lability of blood pressure which charactierzes children. Londe (1976) found that over half of his patients with elevated readings have an occasional normal reading. Not much is known about the course of lability of blood pressure in children. Studies of adults indicate that those with transient blood pressure elevations are more likely to develop fixed hypertension in later life (Blumenthal & Lauer, 1981). In order to examine the subjects whose blood pressure values were above the 75th percentile on the initial screening a profile of the values was constructed and appears in Table 8. Four children with systolic blood pressures above the 75th percentile also had height and weight measures greater than the 90th percentile. While no consistent

Table 8

Raw Scores of Systolic Blood Pressure, Height and Weight of Subjects Above the 75th Percentile in Systolic Pressure

Subject	Age	Sex	Systolic	≥75th	≥90th	Height	≥75th	≥90th	Weight	≥75th	≥90th
1	10	M	119	X		62		X	181		X
2	11	F	121	X		63.87		X	112		X
3	11	M	120	X		64		X	128.5		X
4	11	M	119	X		61.5		X	147.5		X
5	11	M	124	X		56.5	0		85	0	
6	11	F	122	X		60	X		107	X	
7	11	F	128		X	60.25	X		149		X
8	11	F	126		X	57.25	0		146		X
9	12	M	122	X		62.38	X		125		X
10	12	M	124	X		58.5	0		98	0	
11	12	F	122	X		64		X	111	X	
12	13	F	151		X	63.75	X		108	0	
13	13	F	124	X		57.5	0		70	X	

0 = Below 50th Percentile

pattern emerges for the three subjects with systolic blood pressures greater than the 90th percentile, the presence of a relationship is suggested.

Children who present with one blood pressure reading above the 75th percentile may need to be monitored annually.

CHAPTER IV

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This investigative study documented blood pressure levels in 206 children ages 10, 11, 12 and 13 years. The study determined if any correlation existed between height, weight and a positive family history of heart disease with blood pressure levels. The study also examined the relative contribution of each of the independent variables to the dependent variable, blood pressure levels.

The subjects who participated in the study were students at four elementary schools in the Portland Public School District and represented three socioeconomic areas, an upper middle, a middle and a low socioeconomic area. The sample consisted of 98 girls and 108 boys.

Upon the initial screening nine (4.5%) of the subjects were found to have systolic blood pressures above the 90th percentile when compared to the standards set by the National Task Force. Five of these subjects were from the highest socioeconomic area in the study, none from the middle, and two from the lowest socioeconomic agea. When the nine subjects were rescreened two or more weeks later six subjects' pressure levels had returned to normal. The remaining three subjects continued to have elevated pressures and were referred to the school nurse. Two of the subjects were from the low socioeconomic

area and were both above the 95th percentile in weight (Table 8). The third subject was from the upper middle income area, was above the 75th percentile for height but below the 50th percentile in weight.

The results in this study support three of the four hypotheses proposed. The first, that two percent of the children screened would have elevated blood pressures, was supported by the finding that 4.5% of the children screened had elevated systolic blood pressures on the initial screening.

The second hypothesis, that 10% of the children who were found to have elevated blood pressures will continue to have elevated pressures, when rescreened was also supported. Of nine subjects who had elevated systolic pressures on initial screening, 33% continued to have elevated levels.

The third hypothesis, that children who are classified as overweight will have a higher incidence of elevated blood pressure, was supported. Analysis of data indicated a significant correlation ($P < .001$) of weight with levels of blood pressure. A slightly less correlation is that of blood pressure levels with height which is still significant at the $P < .001$ level.

The fourth hypothesis, that children with elevated pressures will have a higher incidence of heart disease in the family history was not substantiated. Although this finding is contrary to the findings of others (Londe, 1971; Zinner, et al., 1971), the correlation coefficient computed was .09 indicating no significance. A reason for this negative finding may be the lack of complete data in the family history of many of the study subjects.

Conclusions

Blood pressure screening in the schools could be a highly effective method to identify the child whose blood pressure is above the norm on several occasions. The family history could then be explored for further evidence of hypertension. School nurses are in an excellent position to identify the child at risk and consequently the family at risk. Intervention in the form of health teaching, blood pressure monitoring or referral for medical supervision may prevent much of the organ damage that occurs before symptoms of the disease appear. Nurses can monitor the children of hypertensive patients and add to the much needed knowledge about the etiology and early course of hypertension. Nurses can be the ones to discover and use this very simple procedure of blood pressure screening in the school age population to enhance health by early detection and intervention.

Recommendations for Further Study

Based upon the results of this study, the following recommendations are made for further research:

1. A longitudinal study of subjects found at or above the 75th percentile based on national standards should be undertaken to determine if they remain in the 75th percentile as they increase in age.

2. Replication of the study with a larger sample size and including other age groups to determine if blood pressure levels continue to rise at a steady rate or if there are periods during growth when blood pressure levels change more rapidly than at other times.

3. A large scale screening of various ethnic groups present in

this area should be undertaken to determine if there are definite ethnic and regional differences which could be documented.

4. A family questionnaire should be administered in conjunction with a screening program in which the parents are asked specifically if they do or do not have hypertension and their blood pressure levels to correlate the incidence of elevated blood pressure among parents with their child's level.

5. Follow-up of the children of hypertensive patients who are seen in the hypertensive clinics at the University of Oregon Health Sciences Center to learn more about the family aggregation of elevated blood pressures.

Blood pressure measurements in children are, as a rule, neglected by schools, physicians' offices and clinics. A large number of screening programs in various areas of the country would aid in the generation of accurate standards for measuring blood pressure in juveniles and in the identification of the child who has hypertension or the potential for becoming a hypertensive adult. The school appears to offer the most effective setting to accomplish this early detection of high risk individuals and appropriate setting for preventive intervention and long term follow-up.

REFERENCES

Beaglehole, R., Eyles, E., & Prior, I. Blood pressure and migration in children. International Journal of Epidemiology, 1979, 8, 5.

Biron, P., Mongeau, J., & Bertrand, D. Familial aggregation of blood pressure in 558 adopted children. Canadian Medical Association Journal, 1976, 115, 773.

Blumenthal, S., & Lauer, R. Where are children's blood pressures headed. Hypertension, 1981, 3, 46.

Buck, C. The persistence of elevated blood pressure first observed at age five. Journal of Chronic Diseases, 1973, 26, 101.

Chenoweth, A. High blood pressure; a national concern. The Journal of School Health, 1973, 43, 307.

Chiang, B., Perlman, L., & Epstein, F. Overweight and hypertension. Circulation, 1969, 39, 403.

Clark, S. Adolescent hypertension. Unpublished Masters Thesis, 1979.

deCastro, F., Biesbroeck, R., Erikson, C., Farrell, P., Leong, W., Murphy, D., & Green, R. Hypertension in adolescents. Clinical Pediatrics, 1976, 15, 24.

Dube, S., Kapoor, S., Ratner, H., & Tunick, F. Blood pressure studies in black children. American Journal of the Diseases of Children, 1975, 129, 1177.

Finnerty, F. Hypertension is different in blacks. Journal of the American Medical Association, 1971, 216, 1634.

Fixler, D., Kautz, J., & Dana, K. Systolic blood pressure differences among pediatric epidemiological studies. Hypertension 2 (Suppl I) 1980, I-3 I-7.

Fixler, D., Laird, W., Fitzgerald, V., Stead, S., & Adams, R. Hypertension screening in schools: Results of the Dallas study. Pediatrics, 1979, 63, 32.

Fries, E. The clinical spectrum of essential hypertension. Archives of Internal Medicine, 1974, 133, 982.

Gruskin, A. Pediatric Grand Rounds, UOHSC, November 8, 1979.

Gutgesell, M., Terrell, G., & Labarthe, D. Pediatric blood pressures: Ethnic comparisons in a primary care center. Hypertension, 1981, 3, 39.

Henekens, C., Jesse, M., Klein, B., Gourley, J., & Blumenthal, S. Sibling aggregation of blood pressure: Nature or nurture? Preventive Medicine, 1976, 5, 60.

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

Hypertension Detection and Follow-up Program (HDFP). Journal of the American Medical Association, 1979, 242, 2562.

Kaplan, N. Clinical hypertension. Baltimore: The Williams and Wilkins Company, 1978.

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

Kilcoyne, M., Richter, R., & Alsup, P. Adolescent hypertension. Circulation, 1974, 50, 758.

Kolata, G. Treatment reduces deaths from hypertension. Science, 1979, 206, 1386.

Lauer, R., Connor, W., Leaverton, P., Reiter, M., & Clarke, W. Coronary heart disease risk factors in children: The Muscatine study. The Journal of Pediatrics, 1975, 86, 597.

Lauer, R., Filer, L., Reiter, M., & Clarke, W. Blood pressure, salt preference, salt threshhold, and relative weight. American Journal of the Diseases of Children, 1976, 130, 493.

Lieberman, E. Essential hypertension in children and youth: A pediatric perspective. The Journal of Pediatrics, 1974, 85, 3.

Lieberman, E. Childhood hypertension: Evaluation and management. Cardiovascular Medicine, 1976, 1, 124.

Lieberman, E. Pediatric Grand Rounds, UOHSC, December 1, 1977.

Lieberman, E. Blood pressure and primary hypertension in childhood and adolescence. Current Problems in Pediatrics, 1980, 10, 4.

Loggie, J. Systemic hypertension in children and adolescents. Pediatric Clinics of North America, 1971, 18, 1273.

Loggie, J. Hypertension in children and adolescents. Hospital Practice, June, 1975, 81.

Londe, S. Blood pressure in children as determined under office conditions. Clinical Pediatrics, 1966, 5, 71.

Londe, S., & Goldring, D. High blood pressure in children: Problems and guidelines for evaluation and treatment. The American Journal of Cardiology, 1976, 37, 650.

McCrory, W., & Nash, F. Hypertension in children: A review. American Journal of Medical Science, 1952, 223, 671.

Nauright, L., Slee, N., Davis, S., Easterling, J., Galloway, M., Hughes, M., Laroche, M., & Whitman, S. Identifying hypertensive adolescents. Pediatric Nursing, 1979, 5, 34.

Nelson, W. (Ed.). The Textbook of Pediatrics. Philadelphia: W. B. Saunders Company, 1974.

Page, L. Epidemiologic evidence on the etiology of human hypertension and its possible prevention. American Heart Journal, 1976, 91, 527.

Prineas, R., Gillum, R., Horibe, F., & Hannan, P. The Minneapolis children's blood pressure study. Hypertension 2 (Suppl I), 1980, I-18 I-24.

Report of the Task Force on Blood Pressure Control in Children. Pediatrics, 59 (Suppl), 1977, 797.

Shick, M. A survey of elementary school health services in Portland Public Schools. Unpublished manuscript, 1979.

Spratlen, L. Blood pressures among inner city adolescents. Unpublished manuscript, 1981.

Stamler, R., Stamler, J., Riedlinger, W., Algera, G., & Roberts, R. Weight and blood pressure. Journal of the American Medical Association, 1978, 240, 1607.

Veterans Administration Cooperative Study Group on Antihypertensive Agents. Journal of the American Medical Association, 1970, 213, 1143.

Voors, A., Foster, T., Frerichs, R., Weber, L., & Berenson, G. Studies of blood pressures in children, ages 5-14 years, in a total biracial community. Circulation, 1976, 54, 319.

Weidman, W. High blood pressure (hypertension) and the school-age child. Journal of School Health, 1979, 49, 213.

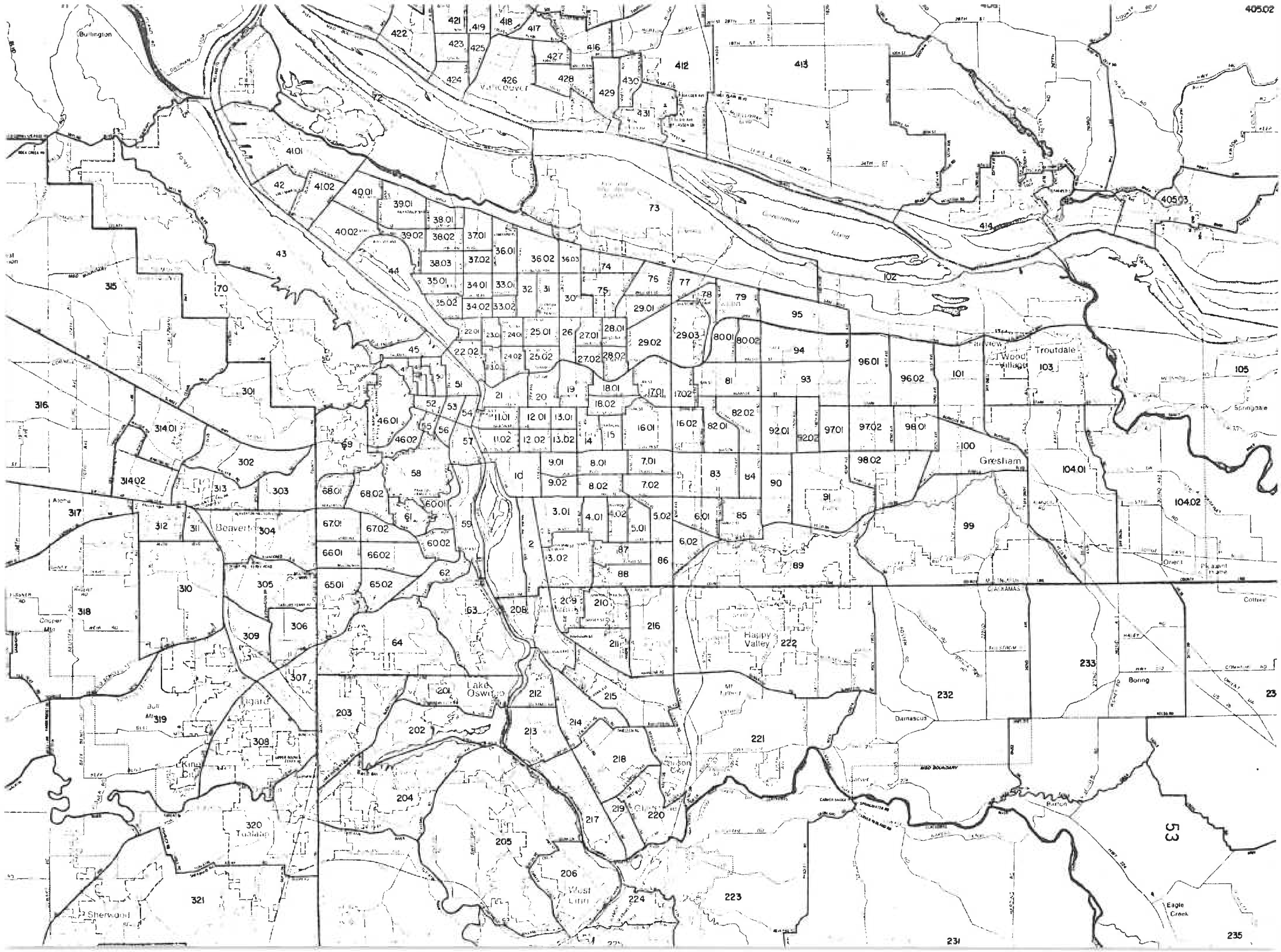
Zinner, S., Levy, P., & Kass, E. Familial aggregation of blood pressure in childhood. The New England Journal of Medicine, 1971, 284, 401.

Zinner, S., Martin, L., Sacks, F., Rosner, B., & Kass, E. A longitudinal study of blood pressure in childhood. American Journal of Epidemiology, 1975, 100, 437.

APPENDIX A

Map and Score Code showing Socioeconomic Areas

for Multnomah County


405.02
Burlington
Vancouver
Forest
Government Island
Troutdale
Wood Village
Gresham
Beaverton
Tigard
Lake Oswego
Happy Valley
Damascus
Boring
Tualatin
Sherwood
West Linn
Eagle Creek
Multnomah
Clackamas

Ethnic Socioeconomic Distribution in Multnomah County, Oregon

Socioeconomic Score *	1970 Population	Blacks #	Blacks %	Spanish Language #	Spanish Language %
High 20 - 29	9,092	14	0.2	114	1.3
30 - 39	30,073	163	0.5	312	1.0
40 - 49	97,805	425	0.4	1,113	1.1
50 - 59	171,572	2,668	1.6	2,477	1.4
60 - 69	143,106	4,587	3.2	2,106	1.5
70 - 79	72,076	2,919	4.0	1,634	2.3
80 - 89	22,190	4,816	21.7	280	1.3
90 - 109	9,297	5,935	63.8	196	2.1
Low 110 - 129	1,234	612	49.6	100	8.1
Intermediate	222	16	7.2	24	10.8
Total	556,667	22,155	8.0	8,356	1.5

* Sum of scores for census tract characteristics:

a. median family income
b. % families with income below poverty level
c. % high school graduates among persons aged 25 or older
d. % occupied housing units with 1.01 or more persons/room

Socioeconomic strata contain these census tracts:

20 - 29: 46.01, 46.02, 61, 69
30 - 39: 3.02, 58, 60.01, 60.02, 63, 68.01, 68.02, 95
40 - 49: 3.01, 16.01, 19, 25.01, 25.02, 26, 27.01, 27.02, 28.01, 28.02, 29.03, 55, 62, 64, 65.01, 65.02, 66.01, 66.02, 67.01, 67.02, 70, 78, 80.01, 82.01, 94, 98.02
50 - 59: 2, 4.01, 8.01, 9.01, 9.02, 12.02, 14, 15, 17.02, 18.01, 18.02, 24.01, 24.02, 29.01, 29.02, 30, 31, 36.03, 39.02, 40.02, 47, 52, 54, 57, 79, 80.02, 81, 82.02, 91, 92.01, 92.02, 93, 96.01, 96.02, 97.01, 97.02, 100, 101, 102, 104.01, 105
60 - 69: 4.02, 5.01, 5.02, 6.01, 8.02, 12.01, 13.02, 16.02, 17.01, 20, 32, 35.02, 36.02, 37.01, 37.02, 38.02, 38.03, 39.01, 41.02, 44, 45, 53, 56, 59, 71, 72, 73, 74, 75, 76, 77, 83, 84, 89, 98.01, 99, 103, 104.02
70 - 79: 1, 6.02, 10, 11.02, 13.01, 23.02, 35.01, 36.01, 38.01, 41.01, 42, 43, 48, 49, 50, 85, 86, 87, 88, 90
80 - 89: 7.01, 11.01, 21, 22.02, 33.01, 34.01, 40.01
90 - 109: 23.01, 33.02, 34.02, 51
110+ : 22.1
Indeterminate: 40.99, 41.99, 44.99

APPENDIX B

Permission to Conduct the Study in the Portland Public Schools

PORTLAND PUBLIC SCHOOLS
501 North Dixon Street / Portland, Oregon 97227
Mailing Address: P.O. Box 3107 (97208)
Phone (503) 249-2000
EVALUATION DEPARTMENT
Victor W. Doherty
Assistant Superintendent

November 26, 1980

Ms. Mary Shick
University of Oregon
Health Sciences Center
School of Nursing
Sam Jackson Park Rd.
Portland, Oregon 97201

Dear Ms. Shick:

This is to confirm the approval of the conduct of a study of blood pressure in children that you propose to make in grades 5, 6, and 7 of selected elementary schools in the Portland district. This study appears to meet criteria for conducting such studies. We see in it some potential value to the District in determining the need or lack of need for testing children for blood pressure at an early age.

Sincerely,

Victor W. Doherty

Victor W. Doherty
Assistant Superintendent
Evaluation

VWD/ams

APPENDIX C

Explanation of Blood Pressure Prepared for 5th Grade Classes

The heart is a big muscle which fills with blood, then pushes it out into the body through tubes or vessels that are called arteries. The arteries then carry this blood, which has oxygen and other things the body needs, around to all of the body parts. Each time your heart beats it is putting blood into these arteries. The walls of the arteries stretch each time the blood is pumped into them so it can flow smoothly. In some people, for reasons no one knows, the arteries don't stretch as they are supposed to and the heart has to work harder and harder to push the blood through. When the arties lose their stretchiness we call this condition hypertension or high blood pressure. People who have hypertension or high blood pressure don't usually know they have it because it doesn't make you hurt any place or doesn't cause any sickness that makes you feel bad. But all this time the heart is working too hard, the arteries in all parts of the body have too much pressure put on them, and the high pressure finally affects your brain, your kidneys, and your heart. By the time you do get sick and know something is wrong with you, the damage has been done and can't be fixed.

We can tell whether or not a person has high blood pressure by wrapping a cuff around the upper arm, then pumping it up with air. While we listen with an instrument called a stethescope placed over the artery, we slowly let the air out of the cuff until we can hear the heart beat again pushing the blood into the artery. The one good things about hypertension or high blood pressure is that the person who has it can take medicine to make his blood pressure normal again.

APPENDIX D

Parental Consent Form

Family History Questionnaire

UNIVERSITY OF OREGON HEALTH SCIENCES CENTER
SCHOOL OF NURSING

Consent for Human Research

Dear Parent,

I, Mary Shick, will be conducting a blood pressure screening program in _____School as a research project entitled, "A Study of Blood Pressures in Children and its Relationship to Height, Weight, and Family History of Heart Disease." This research is under the supervision of Dr. Wilma Peterson, Professor of Nursing and is part of the requirements for a Master's Degree at the University of Oregon School of Nursing. All children in the 6th, 7th and 8th grades are invited to participate.

Three pressure readings will be taken 5 minutes apart. Between the readings, the height and weight of the student will be measured. To obtain the pressure reading a cuff is wrapped around the upper arm and the cuff inflacted. There is a feeling of slight pressure in the arm until the cuff is deflated. There is no risk in the procedure. The benefits of the screening may be to identify any children who have blood pressures above normal. A few students will be rescreened in two weeks time from the initial screening to double check the accuracy of our measurements. Any elevations of pressures found will be reported to the school nurse for followup. All data collected will be recorded using code numbers for each student. The school nurse will be in possession of the list of student names to match the code numbers and only she will have access to it. The total time required of your child should be about 15 minutes. Any parent or child can refuse to participate without penalty. If the parent refuses permission, the child will not be allowed to participate.

Because recent research has demonstrated that blood pressure levels in children tend to run a similar course to that of their parents and grandparents, may I ask you to supply the information requested in the accompanying questionnaire? The total time requried to complete the questionnaire should be no more than 5 minutes. Code numbers will be used to identify all information.

It is not the policy of the Department of Health, Education and Welfare, or any other agency funding the research project in which you are participating to compensate or provide medical treatment for human subjects in the event the research results in physical injury. The University of Oregon Health Sciences Center, as an agency of the State, is covered by the State Liability Fund. If you suffer any injury from the research project, compensation would be available to you only if you establish that the injury occurred through the fault of the Center, its officers or employees. If you have further questions, please call Dr. Michael Baird, M.D., at (503) 225-8014.

May I have your permission for your child to take part in the screening? I will be happy to answer any questions concerning this study and may be contacted at 245-2138 after 3:00 p.m.

Please return both pages to school with your child.

Thank you for your cooperation.

Mary Shick, R.N.

I agree to allow my child _____
First Name Last Name

to participate in a blood pressure screening program conducted by Mary Shick in _____ School.

Signed _____
Parent or Guardian

_____
Student

Date _____

UNIVERSITY OF OREGON HEALTH SCIENCES CENTER
SCHOOL OF NURSING

Dear Parent,

The following information will remain confidential and will not become part of the your child's school record. Anonymity will be insured by the use of code numbers to be used in the data analysis.

The following questions apply to blood relatives of the child.

Please check appropriate space.

Mother: Has a physician or nurse ever told you that you have high blood pressure or heart disease?

yes_____ no_____ don't know_____

Do you know of any heart disease or high blood pressure in either of your parents?

Mother's Mother - yes_____ no_____ don't know_____

Mother's Father - yes_____ no_____ don't know_____

Father: Has a physician or nurse ever told you that you have high blood pressure or heart disease?

yes_____ no_____ don't know_____

Do you know of any heart disease or high blood pressure in either of your parents?

Father's Mother - yes_____ no_____ don't know_____

Father's Father - yes_____ no_____ don't know_____

Only children whose parents return this sheet will be included in the study.

APPENDIX E

Height, Weight, and Blood Pressure Standards

NATIONAL CENTER FOR HEALTH STATISTICS

Figure IX. Stature by age percentiles for girls aged 2 to 18 years.

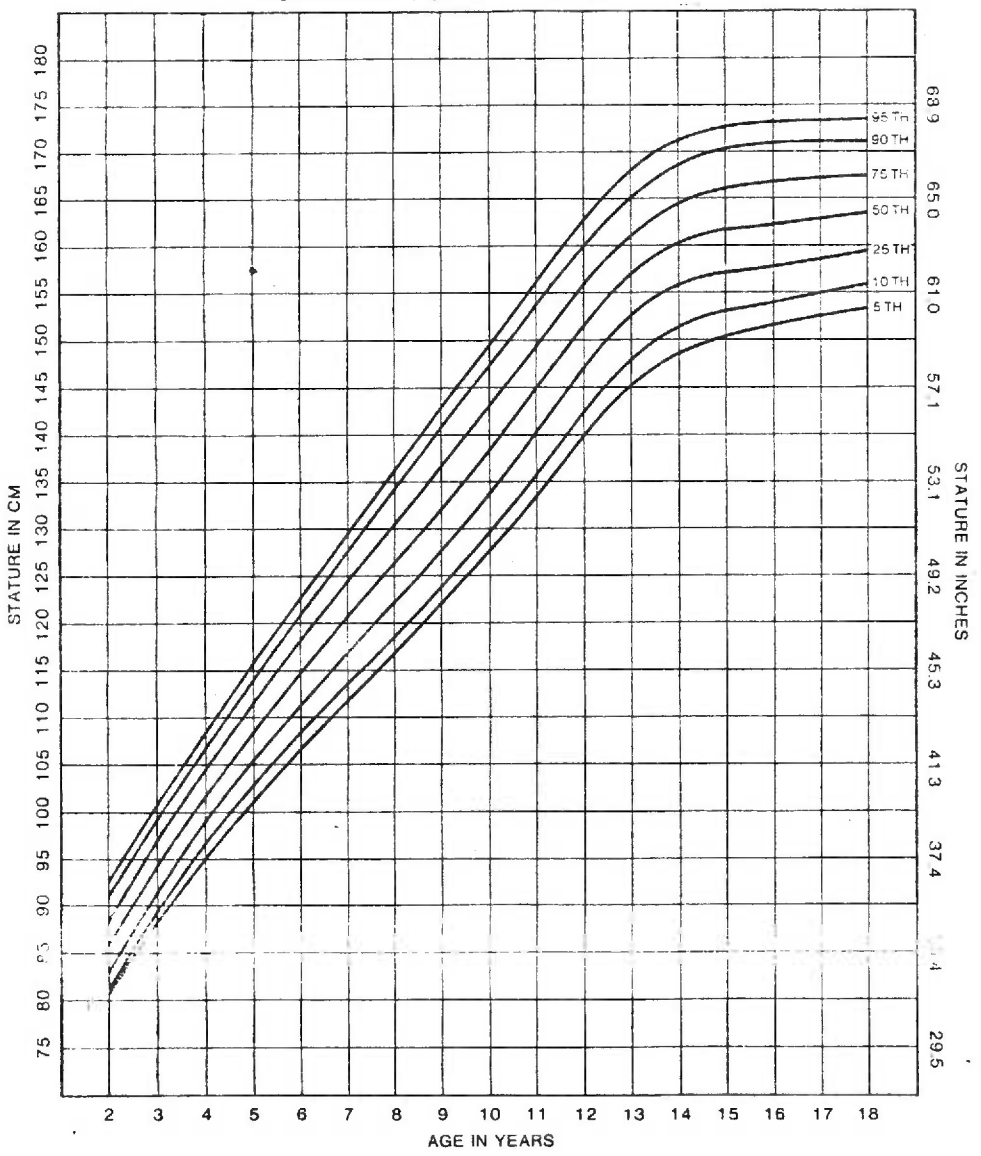
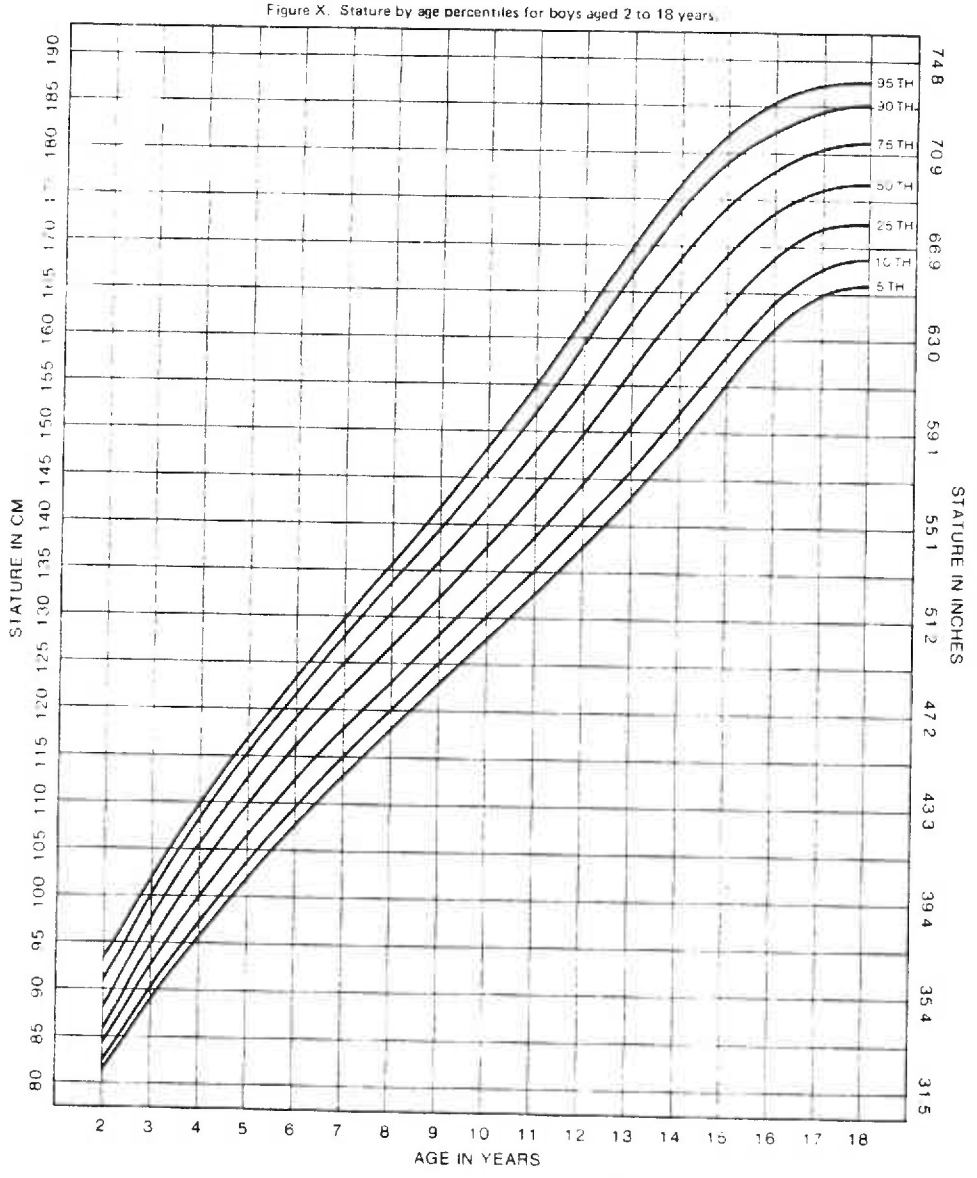


Figure X. Stature by age percentiles for boys aged 2 to 18 years



NATIONAL CENTER FOR HEALTH STATISTICS

Figure XI. Weight by age percentiles for girls aged 2 to 18 years.

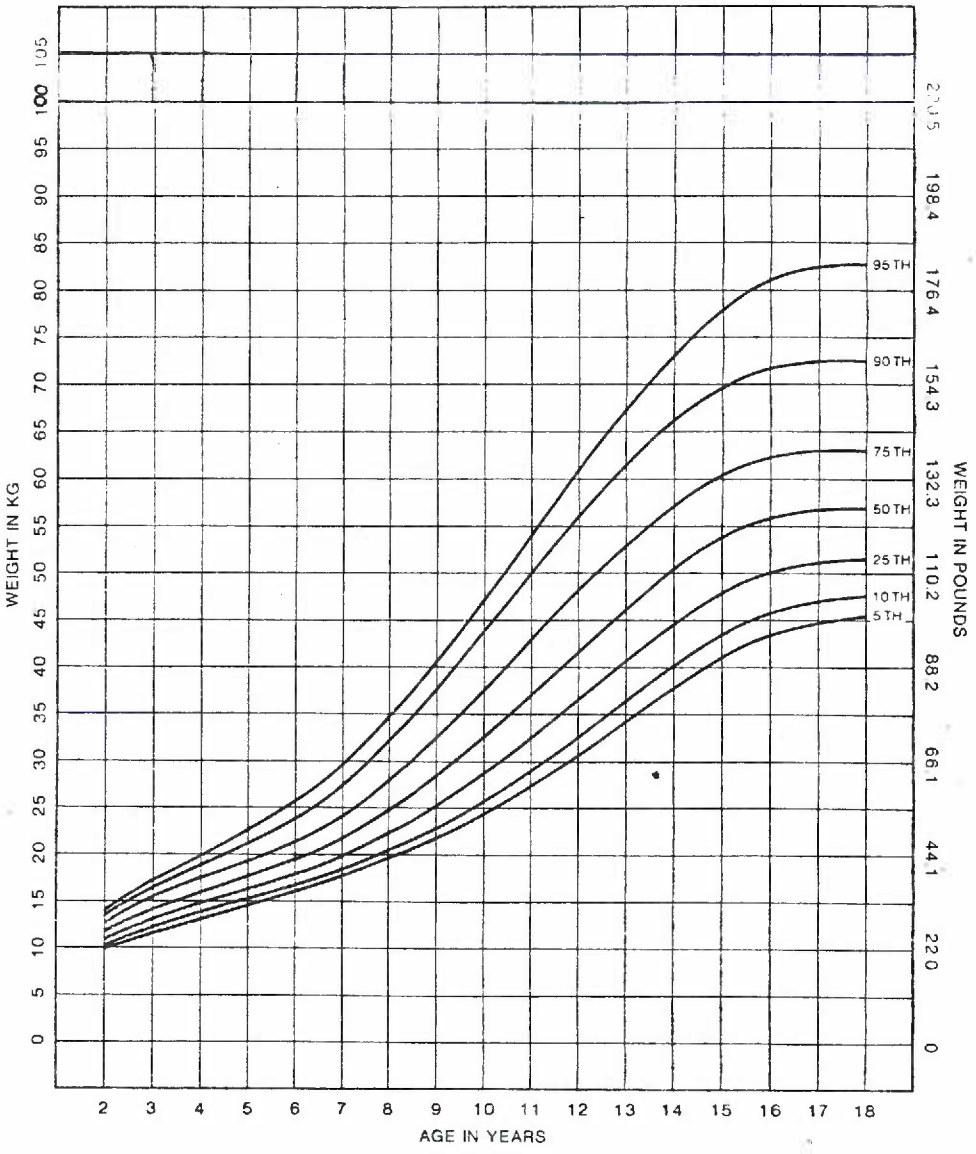
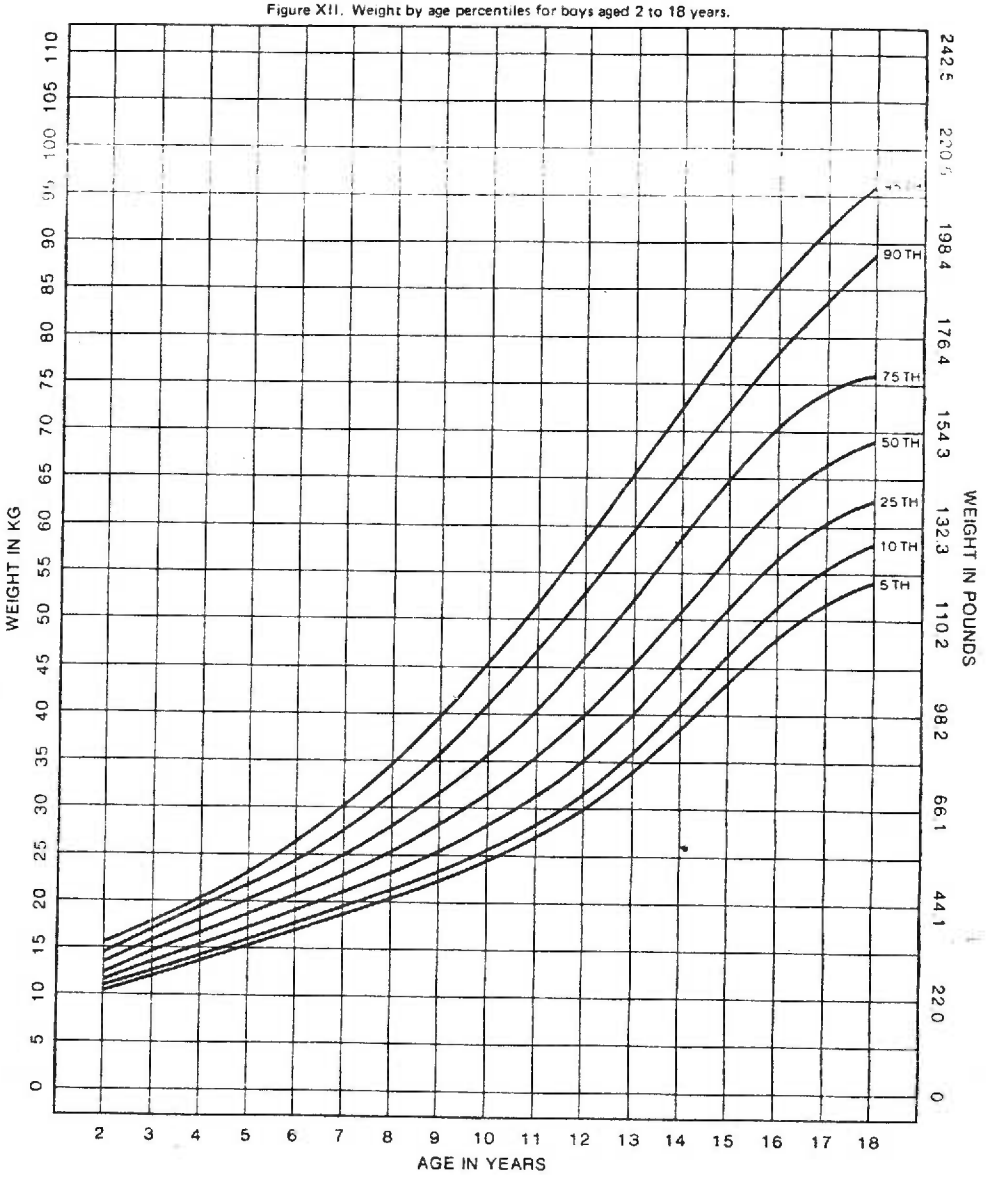
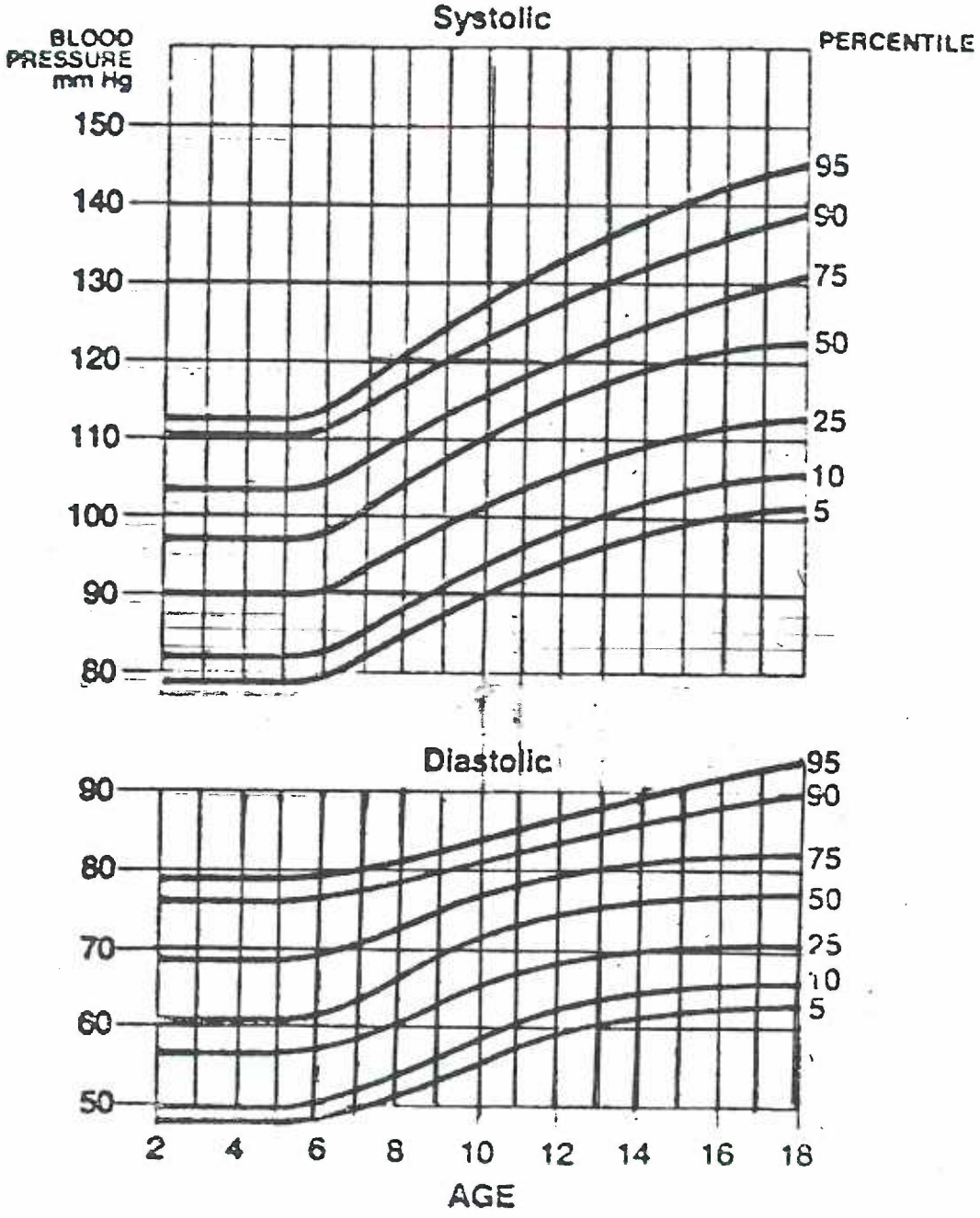


Figure XII. Weight by age percentiles for boys aged 2 to 18 years.

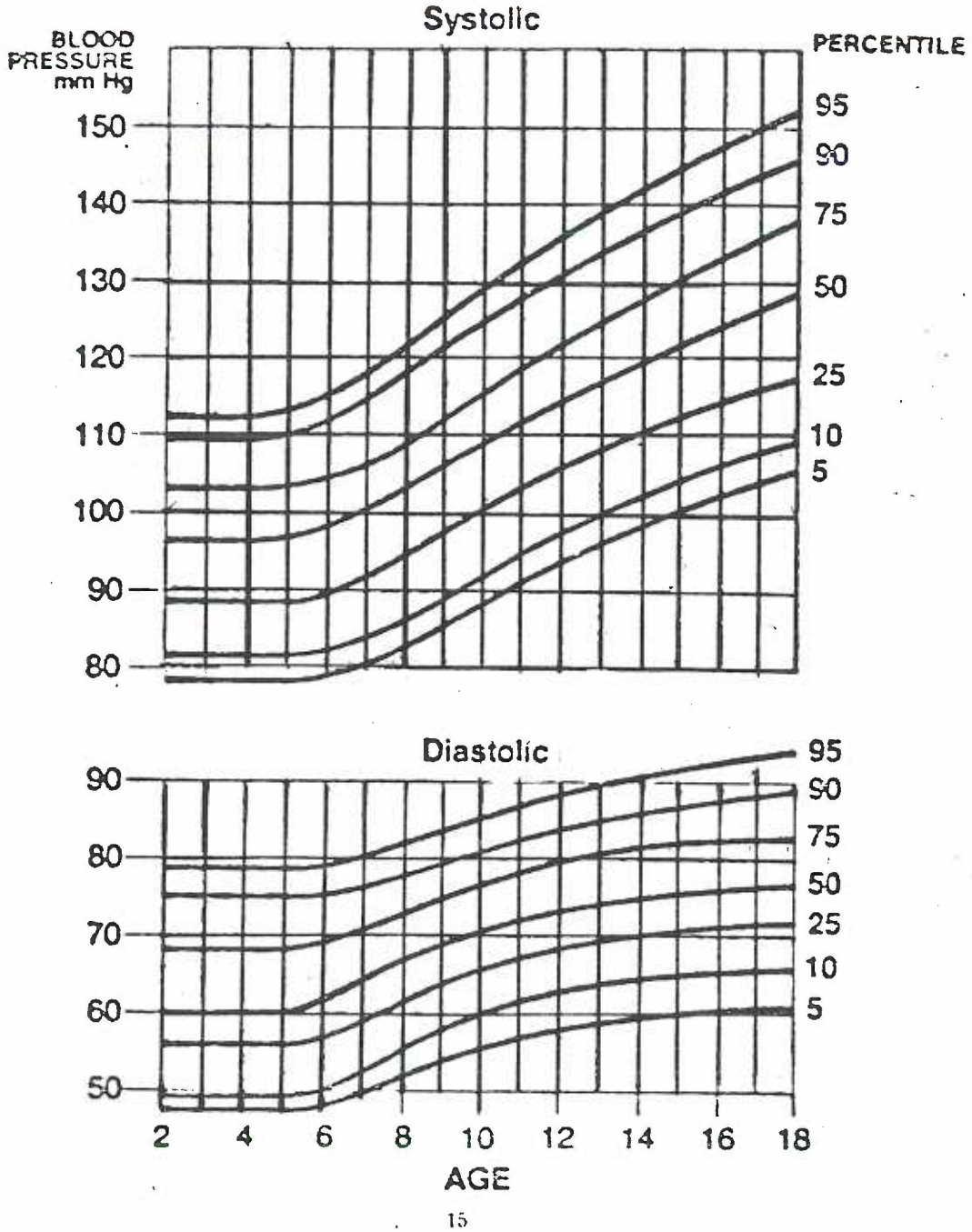


Percentiles of blood pressure measurement in girls (right arm, seated). 68



Percentiles of blood pressure measurement in boys (right arm, seated).

69



15

AN ABSTRACT OF THE CLINICAL INVESTIGATION OF

MARY ELLEN SHICK

For the MASTER OF NURSING

Date of Receiving this Degree: June 12, 1981

TITLE: A Study of Blood Pressure Values in Children and Their Relationship to Weight, Height and Family History of Heart Disease

Approved: Wilma Peterson
Wilma Peterson, R.N., Ph.D., Associate Professor

The purpose of this clinical investigation was to document blood pressure levels in children 10, 11, 12, and 13 years of age and to identify the incidence of elevated systolic and/or diastolic blood pressures in this group. The study examined the correlation between weight, height, and a positive family history of heart disease and blood pressure levels.

The sample consisted of 108 boys and 98 girls from four elementary schools in the Portland Public School District.

Upon initial screening nine subjects (4.5%) had blood pressure values above the 90th percentile by national standards. The nine subjects were rescreened two weeks later, as well as an equal number of normotensive subjects, matched for age and sex, as a comparison group. The systolic and diastolic pressures of six subjects (3%) had returned within normal range. Three subjects (1.5%) continued to have elevated pressures and were referred to the school nurse.

A correlation matrix revealed a significant ($P < .001$) relationship between weight and blood pressure levels, and height and blood pressure levels; the most significant correlation was with weight.

The findings indicated there is no correlation between a positive family history of heart disease and levels of blood pressure.

Blood pressure means in the present study were found to be lower for age and sex than the standards set by the National Task Force. This is in agreement with other research in the area of blood pressure levels in children and may be suggestive of regional or geographic differences.