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Skinfold and other anthropometrical measurements of preadolescent boys from selected ethnic groups

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Dissertation

SKINFOLD AND OTHER ANTHROPOMETRICAL MEASUREMENTS OF
PREADOLESCENT BOYS FROM SELECTED ETHNIC GROUPS

Submitted by

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In Partial Fulfillment of Requirements for
the Degree of Doctor of Education
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Professor of Education
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INTRODUCTION

The study of obesity in relation to disease and physical fitness is of major concern to those interested in child growth and development. Numerous stature and other anthropometrical investigations show quantitative tallness or shortness and weight, however precise data is lacking in the area of soft tissue measurement employing modern spring-loaded skinfold caliper techniques. Moreover, the data available for the United States are not strictly comparable with respect to ethnic origin and socio-economic status both of which influence average heights and weights. Ethnic origin coupled with environmental background influence the physical status of the individual. Ideal weight and height standards in the United States almost all currently used go back to the Medico-Actuarial Investigation of 1912.


Since patterns of dietary intake and economic conditions have changed over the past forty years, it seems that a re-evaluation of the standard tables originating with the 1912 data appear desirable. Measurement of height and weight alone is not an accurate guide to obesity. Some confusion does exist between the terms overweight and obesity. Children of the stocky type may have relatively large skeletal frames and more than the average amount of muscular tissue so that both their weight and appearance exceed that of the average child for their age, but they are not to be considered obese. Obesity is characterized by an excess accumulation of fatty subcutaneous tissue. The skinfold measurement technique provides a precise means of measuring subcutaneous body fat. These measurements in conjunction with accurate and quantitative anthropometric height, weight and girth measurements can furnish a true picture of the individual at a given age.

The data obtained in this research may be helpful when added and compared with similar and future research in the evaluation of the physical status and growth progress of children.
Definitions of terms used.-- The terms in this study are defined as follows:

**Anthropometric.** Relevant to the science of measuring the human body and its parts and functional capacities.

**Bi-iliac.** The width of the pelvic girdle. The greatest distance between the lateral margins of the iliac crests.

**Ethnic groups.** Relating to community of physical and mental traits, or designating groups of mankind discriminated in the basis of common customs and characters. The Italian, Jewish and Negro groups were classified as ethnic samples in this study.


Girth. To measure around the body, the circumference of anything.

Preadolescent. Relating to the pre-puberal developmental period with variability from ages ten to thirteen years. The pre-adolescent age range from ten through twelve years were considered in this study.

Skinfold. Represents the skin plus subcutaneous tissue. Fat thicknesses, or the thickness of the skin plus the fat containing tissue.

Subcutaneous fat. Adipose or fatty tissue between the skin layer and muscle. The weight of subcutaneous tissue (skin plus fat) constitutes about seventeen per cent of body weight in adult man. Six per cent is skin and eleven per cent is fat.


3/Keys and Brozek, op. cit., p. 256.


5/Keys and Brozek, op. cit., p. 256-257.
Justification of the problem.-- Skinfold measurement of children both boys and girls is largely an untouched area. This technique has been widely used to give an estimate of body fat by those concerned with nutrition, fat distribution, child growth and anthropometrical surveys, however until recently, much of the skinfold measurements were taken with instruments requiring subjective reading. Various types of calipers have been used (Franzen type and C shaped scissors). Each recorded different results because of the variability in instruments. Therefore, a lack of standardization in the recording was evident among interested investigators.

Edwards conducted a skinfold and anthropometric survey of adolescent boys in the Boston area (1957) utilizing a newer type constant tension Vernier caliper.

The caliper used in the present study is the newest and most modern device available which accurately measures the subcutaneous tissue. The Harpenden caliper is superior to previous instruments used since it is a precision made gauge


2/Randolph Edwards, op. cit., p. 4.
which gives a constant squeeze pressure and reads accurately to 0.1 millimeter. This precise and minute reading is not possible with older machines. This type of instrument is recommended by leading researchers of body fat and skinfold measurement. Keys and Brozek (leading researchers of body fat techniques in the United States) state that it is preferable to use an instrument in which the pressure is built within the caliper themselves. The Harpenden caliper meets this requirement. Caliper methods of estimating body fat are inexpensive and measurements are quickly made. Keys and Brozek further state that skinfold measurements provide an effective and practical method for rating an individual's fatness. Several studies have shown a high correlation between spring-loaded caliper methods of estimating body fat and roentgenograms. Brozek and Mori reported a correlation of 0.82 between x-ray and skinfold measurement among adult men. Similar high


2/Ancel Keys and Josef Brozek, *op. cit.*, p. 258.

3/Ibid., p. 256.

Correlations (.88) have also been found by other researchers. Correlations ranging between 0.8 and 0.9 were obtained by W. D. Hammond (British researcher) for boys and girls of an unspecified age. These studies further confirm the validity of caliper methods in estimating body fat.

Height and weight tables commonly used for children are based upon data from twenty to fifty years ago. Significant changes in the rate and amount of growth in children has occurred in this period. This study constitutes up-to-date data for Boston area children of three ethnic groups. To the writer's knowledge, it is the first of its kind measuring preadolescent male children of Italian, Jewish, and Negro descent.

Statement of the problem.-- It is the purpose of this study to establish percentile norms for skinfolds of subcutaneous fat and other anthropometrical measurements of preadolescent American-Italian, American-Jewish and American-Negro boys, (ages 10, 11, and 12 years). The specific intentions are


2/Ibid.
1. To make skinfold measurement at the following body sites: abdomen, chest, lateral arm, posterior arm, and scapula

2. To make anthropometrical measurement of height, weight, girth of arm, chest, thigh and bi-iliac crests

3. To establish percentile norms (10th, 25th, 50th, 75th, and 90th) on a half year basis (10, 10½, 11, 11½ and 12 years) for body fat, height, weight, girth of arm, chest, thigh, and bi-iliac crests of each ethnic group

4. To make a comparison of height, weight and body fat between each ethnic group

5. To make a comparison of body fat as determined by skinfold measurements with the Wetzel Grid physique (body build) types

6. To make a comparison of height and weight of each group with other similar studies.

Scope of the study.-- Six hundred and forty-seven (647) male subjects have been measured from three selected ethnic groups. Age levels 10, 11 and 12 years were chosen and classified in Table 1, page 9.
Table 1. Age and Selected Ethnic Groups of Preadolescent Boys

<table>
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<th>Age</th>
<th>Ethnic Groups</th>
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<tr>
<td></td>
<td>Italian</td>
<td>Jewish</td>
</tr>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>10 yrs.</td>
<td>54</td>
<td>46</td>
</tr>
<tr>
<td>10½ yrs</td>
<td>36</td>
<td>45</td>
</tr>
<tr>
<td>11 yrs.</td>
<td>44</td>
<td>42</td>
</tr>
<tr>
<td>11½ yrs</td>
<td>41</td>
<td>37</td>
</tr>
<tr>
<td>12 yrs.</td>
<td>51</td>
<td>42</td>
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<tr>
<td>Total</td>
<td>226</td>
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Ethnic groups were established on the basis of parental descent:

1. **American-Italian**. -- Child was considered American-Italian if both parents were of Italian descent.

2. **American-Jewish**. -- Child was considered American-Jewish if both parents were of Jewish descent.

3. **American-Negro**. -- Child was considered American-Negro if both parents were of the Negro race.

All male subjects were selected from the Boston, Massachusetts area with the exception of thirty-four subjects measured in the city of Plymouth, Massachusetts. The organizations, schools and clubs listed served as sources for the
Sources for American-Italian subjects.-- (1) Assumption School, Boston; (2) Cold Springs School, Plymouth; (3) Goodwill House, East Boston; (4) Hedge School, Plymouth; (5) Liberty School, Revere; (6) Mt. Carmel School, East Boston; (7) Norfolk House, Roxbury; (8) North End Swimming Pool, Boston; (9) North End Union, Boston; (10) Paul Revere School, Revere; (11) Saint Rose School, East Boston; (12) Shurtleff School, Chelsea; (13) Trinity House, East Boston.

Sources for American-Jewish subjects.-- (1) Beth El Hebrew School, Dorchester; (2) Chelsea Y.M.C.A., Chelsea; (3) Garfield School, Revere; (4) Liberty School, Revere; (5) Paul Revere School, Revere; (6) Roosevelt School, Revere; (7) Shurtleff School, Chelsea; (8) Wolcott School, Revere.

Sources for American-Negro subjects.-- (1) Huntington Avenue Y.M.C.A., Boston; (2) Norfolk House, Roxbury; (3) Roxbury Boys Club.

Need for research.-- Measurement of skinfold thickness is of value in the appraisal of the quantitative relative leanness-fatness in handling problems of overweight and under-
weight, and for the evaluation of the nutritional state. The National Research Council, Food and Nutrition Board state that the evaluation of nutritional status of man with regards to emaciation, obesity, growth, skeletal and muscular development is a major neglected area. Such evaluations must depend primarily on physical measurements of the body and comparisons with suitable standards for selected items of measurements.

The growth, weight and composition of the body depend, in part on the supply of nutrients and may serve as a useful criterion of one aspect of nutritional status. In order to properly interpret the biological significance of body weight, data should be obtained for approximate analysis of body weight in terms of body composition. Measurement of the thickness of subcutaneous fat provide a valuable measure of leanness-fatness.

The National Research Council states that height, weight and a measurement of subcutaneous fat are the irreducible data of body measurement. Harvard researchers, Stuart and Meredith affirm that the quantity of subcutaneous tissue is an extremely

1/Ancel Keys, op. cit., p. 111.

2/Ibid.

3/Ibid., p. 115.

important attribute of nutritional status. The amounts of subcutaneous tissue depends to a considerable extent upon dietary habits and health occurrences, and hence change in this amount may be an important indication of changes in nutritional state or in the storage and loss of fat or water in the tissues.

Various investigators advise the establishment of new norms for total body fat for all age levels using the recommended techniques for skinfold measurement. It is the intent of this study to obtain data and formulate norms through use of currently recommended anthropometric procedures. The subsequent data should prove useful to professional workers interested in the growth and development of preadolescent boys.


2/Harold C. Stuart and Howard Meredith, op. cit., p. 1369.

CHAPTER II

REVIEW OF THE LITERATURE AND RESEARCH

The practical implication of obesity as a health problem has received increased attention in recent years. Mayer cites the Metropolitan Life Insurance statistics which show that the mortality between ages twenty and sixty-four is fifty per cent greater among overweight men and women in their insured population. In this era of prosperity and abundance, researchers view with alarm the increased frequency of obesity among school children. Johnson and others found a substantial prevalence of excess fat within the ranks of elementary and secondary school children. Obesity ranks high as a national health problem. Few studies attempt to analyze this condition precisely both in terms of body bulk and of the amount of adipose tissue. Concepts of "overweight" and


"obesity" have been loosely referred as a similar condition. Overweight does not necessarily imply "fatness." It is entirely possible for individuals to gain weight with fat loss. In certain cases, individuals may compensate for loss of fat by increased muscular density. It appears that mere "overweight" is not the same as "fatness," and that height and weight alone do not clearly indicate the prevalence of adipose tissue.

The skinfold technique provides an indirect method of evaluating leanness-fatness in man. Measurement of the skinfolds, which vary in thickness roughly in proportion to the subcutaneous adipose tissue are being used with increasing frequency as a criterion of fatness. A recent study on changes in body fat estimated from skinfold measurements demonstrates the application of this technique by physical education research workers.


Much of the early work in the area of skinfold caliper measurement was done in Europe. Reynolds reports the work by Richer (1890) of France as the first to measure directly the fat folds. The use of a spreading circular caliper for this purpose is mentioned without any attention to standardization in tension or specification of the contact points in the work of Oeder and Bedkin (1915). Measurements were made on eight locations and sex differences in fatness relating to children were indicated by these professional anthropometrists. German researchers, Numan (1912), Peiser, (1921), and Kading (1922) worked with Zurich, Berlin and Bonn children and laid the groundwork for more intensive studies in relation to soft tissue and body build. The early German work further contributed to the development of the skinfold technique and the study in patterns of distribution of superficial adipose tissue.

An early American study of Czech anthropologist Matiekga


2/Ancel Keys and Josef Brozek, op. cit., p. 258.


4/Ibid.
(1921) paved the road for further research in the approach of comprehensive analysis of human physique incorporating the measurement of skinfolds. Matiegka developed a method for estimating the amount of principal body tissues -- bone, fat and muscles. The volume of the skin and subcutaneous fat was estimated on the basis of six skinfold measurements and body surfaces.

Contemporary body fat researcher, Brozek cites:

"Anthropometrically, the correct road to a quantitative analysis of human physique has been clearly outlined by Czech anthropologist, Matiegka."

Most of the early caliper models were unsatisfactory because tension was very low. Matiegka's dimensions were secured by a sliding compass with blunt points and the exertion of a mild pressure just to enable the skinfold to slip out of the branches when the fingers are released from position. Matiegka measured the skinfold on: (1) the front of the upper arm above the biceps, (2) on the palmar


side of the forearm at the level of the maximal breadth, (3) on the thigh halfway between the inguinal fold and the knee, above the quadriceps muscle, (4) on the calf of the leg, (5) on the thorax halfway between the nipples and the umbilicus, and (6) on the abdomen halfway between the navel and the anterior superior iliac spine. These measurements were made with a pressure that had not been standardized, and the size of the fold was not stated. Although Matiegka's instrument represented subjective caliper readings, this study attempted to evaluate the amounts of the various elements concerned in the make-up of the body.

A pioneer study by Franzen in 1929 introduced a new spring-equipped type of fat caliper which has been widely used. Franzen studied fat folds in relation to nutritional condition and showed that amount of fat is a better indicator of nutritional status than mere weight. Franzen proposed three measurements of the skin and subcutaneous fat; (1) front of upper arm, (2) back of upper arm, and (3) over

1/J. Matiegka, op. cit., p. 226.
the calf. Standards were established for the ages ten, eleven, and twelve for these fat measurements. Franzen made a very real contribution in the technique of measuring subcutaneous fat, and in devising calipers for the purpose with springs of constant tension, and in proposing a standard technique. Considerable training in the operation of this type caliper was essential for accurate measurement and the instrument did not record to the nearest 0.1 millimeter. These two factors affected considerable discrepancy in the use of the caliper.

McCloy and a group at the Iowa Child Welfare Station, State University of Iowa used five skinfold measurements to determine fatness in children. The Franzen caliper was employed for measurement of these sites, (upper chest, chest back, abdomen, suprailiac, and arm). The technique for these measurements is described as follows:

"The observer grasps a double layer of skin and subcutaneous tissue with the thumb and forefinger of the left hand, with the thumb and forefinger pointing toward each other. The fold of skin and fat is held


3/"Appraising Physical Status: The Selection of Measurements," op. cit., p. 121.
somewhat loosely while the calipers are applied in such a way as to be about two millimeters above the ends of the thumb fingers. The spring is then released and the calipers held against the fold of skin to prevent its slipping away, and the measurement recorded."

McCloy established norms for boys and girls on a yearly basis from four to eighteen years. "Average" and "minimum" fat tissue measurements were calculated and tabulated utilizing the Franzen instrument. Precise measurement was lacking in terms of establishing points. McCloy's work was set up on the basis of ranges describing "means" and "minimum." Percentages were calculated in terms of the departure from the mean. It is relevant to note that the caliper employed in these studies was calibrated at the Iowa Station and that the instrument sent out by the manufacturer varied considerably in tension. Absolute standards of pressure were not established in the period of the McCloy studies. The variability of pressure between the jaw faces of the instrument and the tedious technic required affected the accuracy of fat fold reading. The Iowa norms for breadth of skin and subcutaneous tissue although restricted in accuracy by the older Franzen caliper, showed in general a marked sex difference beginning in early adolescence, with means for girls increasing and means for boys tending to
Physical education researcher, Cureton (1944), utilized the Franzen caliper in evaluating physique. Cureton measured six body areas: (1) chest fold, (2) abdominal fold, (3) hip fold, (4) front thigh fold, (5) gluteal fold, and (6) rear thigh fold. Rating tables were established and based upon direct measurements of superficial fat taken on three hundred thirty-two male college students. The classification range of very low, low, trained, average, fat, obese, very obese was indicated. A seven point scale from very low, to very obese was used in the Illinois study. Cureton described the ideal physique as good muscular development with a moderate amount of fat, and a proportionately developed body.

Stuart and Meredith (1946-1947), determined a list of


4/Ibid., p. 103.

recommended body measurements which include height, weight, hip width, chest circumference, leg girth, and a subjective rating of the skin and subcutaneous fat tissue. They recognized skinfolds and subcutaneous body fat to be an essential factor in body measurements. These researchers proposed a subjective rating scheme employing a five category scale and using symbols (+), (+ +), (+ + +), (+ + + +), and (+ + + + +) of appraising fat folds. A spring caliper (Franzen) was used to measure the thickness of the folds. Use of this instrument assumed considerable clinical experience in making judgments of subcutaneous tissue. The assignment of measurement values to rating categories were made as follows: the lowest ten per cent of the values for a given age and sex were assigned to the category (+), the next twenty per cent to the category (+ +), the middle forty per cent (+ + +), the next twenty per cent to category (+ + + +), and the highest ten per cent to category (+ + + + +). Norms were set up on one half year basis and age calculated to the nearest half year birthday. Percentile tables on a 10th, 25th, 50th, 75th, and 90th series

2/Ibid., p. 1438.
were established with the intent of readily determining in what portion of the distribution a child falls with respect to each measurement. The data utilized in constructing the tables were collected between 1930-1945 on Iowa City children of Northwest European ancestry.

Stuart and Meredith regarded the quantity of subcutaneous tissue as an extremely important physical attribute and recommended the measurement of these fat folds as a very helpful aid in determining growth progress and physical status. It is interesting to note the appreciation and general interest for quantitative data in the appraisal of physique during this period by pediatricians.

Studies since the Stuart and Meredith tables have indicated an increasing utilization of caliper methods in determining body fat. Reynolds and Asakawa established, in an investigation of one hundred sixty-seven children from the Fels Research Institute, a "ranking" with reference to


the degree of obesity employing an unspecified skinfold caliper. Five categories of obesity were established: (1) obese, (2) mixed obese, (3) relative obese, (4) relative mixed obese, and (5) not obese. This analysis points out the importance of weight/height measurements in determining stature however relates .... "Weight and weight/height pick out most of the obese and mixed obese, but unfortunately also select children who are not obese."

Cureton augmented the interest in subcutaneous fat in relation to physical fitness of champion athletes. Measurements were made by this physical educator with a Franzen caliper which was approximated in millimeters. Cureton made a comparison of the 1936 and 1948 United States Olympic swimming teams and concluded that the 1948 team had about two millimeters less external fat per measurement. The adipose tissue measurements were taken on the cheeks, abdomen, hips, gluteals, front thigh and rear thigh together with the sum of the adipose measurements. Cureton's

1/Earle L. Reynolds and Toshiko Asakawa, op. cit., p. 486.


findings advanced the premise that strenuous physical conditioning tends to reduce external fat pads.

The reliability of caliper methods in terms of correlation between repeated measurements by the same observer are high. The coefficient of consistency determined in one study was 0.955 and 0.982 for upper arm front and back, 0.968 for the subscapular and 0.975 for the suprailiac measurements. Reliability values obtained for young children in a series of measurements by two different observers produced coefficients of correlation from 0.84 to 0.93. Other studies consistently show a high degree of accuracy in determining the quantity of subcutaneous fat. Garn measured the thickness of fat-plus-skin layer at the level of the lowest rib at the midaxillary line in males employing two techniques: (1) spring-loaded pinch calipers and (2) roentgenogrammetric measurements. Agreement between the two methods was high ($r=0.88$). Caliper methods in evaluating leanness-fatness were recently evaluated by Brozek and Mori. Skinfold thickness was measured at the back of


2/Ibid.


the right upper arm over the triceps with a caliper pressure of 10 \( \text{gm/mm}^2 \). The "r" between the thickness of the dorsal skinfold measured on the upper arm and corresponding roentgenographic readings was 0.824. Hammond obtained correlations of 0.82 for the thigh, 0.83 for biceps, and 0.89 for the triceps in a sample of one hundred fifty boys employing a similar type spring-loaded caliper. Accuracy with which skinfolds can be measured varies from site to site, however substantial evidence is available to validate skinfold techniques as a measure of subcutaneous fat wherever reliable instruments and procedures are employed.

A number of individuals and research groups have been working to improve calipers which would permit more accurate, reliable, and valid skinfold measurements.

Further studies have found that the measured skinfold thickness is highly dependent upon caliper pressure until at least 10 \( \text{gm/mm}^2 \) has been reached. The technique of measuring with the caliper the folds of the skin plus

1/ Ibid., p. 323.
2/ Ibid.
3/ Ancel Keys and Josef Brozek, op. cit., p. 258.
subcutaneous tissue has been used much, but the reading obtained varied and depended upon the characteristics of the instrument employed. Most of the early models were unsatisfactory because tension was very low at small openings but increased rapidly as the jaws of the calipers expanded. As a result of the variety in instruments used by researchers, Edwards and others conducted a series of experiments to determine the optimum design of skinfold calipers. The Harpenden Caliper was devised and recommended for standard use by these investigators. Using trained and untrained observers, slight, but consistent differences in readings on any one subject were made and their differences varied to a small extent from one subject to another. Piscopo and Thompson obtained a correlation of 0.94 in results obtained by two different observers measuring Boston University students. Similar results were further obtained by Piscopo and Thompson with correlations ranging from 0.769 to 0.917 on a group of children ages ten, eleven and twelve


3/Ibid.

4/Unpublished Data by Piscopo, J., February 11, 1959, Boston University, Boston, Massachusetts.
Several studies have been made since the development of the Harpenden caliper, and the modified Vernier caliper currently used by researchers at the University of Minnesota. The pattern of fat distribution in relation to measuring the thickness of fat folds over the whole body in a number of age and sex groups was remarkably constant within each group according to British researcher Edwards. Edwards further asserts that one or more fat folds can estimate the quantity of fat in the body by measuring the thickness of the subcutaneous tissue with caliper methods.

Caliper methods have been employed by researchers studying subcutaneous tissue changes, weight loss and gain. Garn's investigation on eighty-one male subjects showed that relative fat pattern is an individual characteristic

1/ Unpublished Data by Piscopo, J., June 16, 1959, Boston University, Boston, Massachusetts.


having some permanence and resistance to change under nutritional stress. Fat changes during weight loss in relation to diet was further examined by Garn and Brozek. These scientists found that fat is withdrawn in proportion to the initial amount of fat present and that relative fat patterns before and after weight reduction are preserved. Studies relative to college basketball and hockey players by Thompson and others has demonstrated that body weight was not altered during a season, although a redistribution of weight was evident from skinfold findings. A recent study further amplified skinfold research in relation to body fat changes and athletic training. Thirty-four members of the Boston University football squad served as subjects in a skinfold investigation by Thompson. Height, weight and skinfold measurements were made at the beginning of the season and the last week of training. The results indicated consistent mean loss of body fat of all sites measured with


2/"Changes in Body Fat Estimated From Skinfold Measurements of College Basketball and Hockey Players During A Season," op. cit., p. 418.

3/"Changes in Body Fat Estimated From Skinfold Measurements of Varsity College Football Players During A Season," op. cit., p. 87.
an increase in body density. Thompson's studies disclosed a practical way to study changes in body composition, especially body fat, by use of the skinfolds associated with conditioning and training.

The literature reveals several studies of skinfold and related research among British and Canadian investigators. Hammond used the Harpenden caliper to determine measurements in a group of British adult factory workers and girls aged two to fifteen. This study showed that fat measurements at different sites were in such close agreement, that almost any one measurement could be substituted for the rest without great loss. Although the best measurements vary somewhat according to the total battery, and according to the individual, the results of this investigation revealed that the subscapula and abdominal measurements followed by biceps and either subcostal or suprailiac measurements give the best indication of total fat. All the skinfold measurements were found

1/ Ibid., p. 93.
4/Ibid., p. 204.
to be highly representative of total body fat in terms of calculated regression equations for the actual thickness of body surface fat measured from x-ray plates.

In a later survey, Hammond and Gillett studied a group of boys and girls aged seven to fifteen relevant to nutritional debility. All children were measured annually in some twenty measurements including six subcutaneous fat measurements over a period of three years. This investigation compared the physique and growth of debilitated children at an open air school with their brothers and sisters attending ordinary schools.

A precise and quantitative set of measurements employing the skinfold technique provided a pattern of growth and nutrition in a selected group of British children by D. A. W. Edwards. In addition to finding a marked consistency of fat patterns within each age and sex groups, Edwards found


that an observer can measure a fold with such accuracy that
if his average reading is ten millimeters, he will not be
more than half a millimeter different from this in nineteen
out of twenty measurements. The Harpenden caliper was
employed in this study with readings to 0.1 millimeter.

Pett made a random sample of the Canadian population
male and female representing fifteen million people. Height,
weight, and skinfold measurements were averaged. The skin-
fold measurements were taken at the back of the upper arm
and were included in this study for the purpose of evaluating
leanness-fatness. The anthropometric data compiled by Pett
provides in Canada, tables that are available of average
weights, so that a Canadian's weight may be compared with
the average weight of all other Canadians in the same height
and age group. This is the first representative table of
its kind which sampled the entire population of Canada

1/Ibid.

2/Lionel Bradley Pett, "A Canadian Table of Average Weights
for Height, Age and Sex," American Journal of Public Health
(July, 1955), 45:862.

involving almost twenty-two thousand individuals. In addition to furnishing descriptive anthropometric measurements of Canadians, the Pett data provides a suitable basis for comparing measurements with similar tables developed in other countries.

Some criticism has been established relating to the accuracy of height and weight tables currently in use. Pett points out that many people use tables dating back to those of Baldwin-Wood and other studies of forty years ago. Origins of some of the figures are unknown. Brozek states that the Medico-Actuarial Mortality Investigation of 1912 study of height, weight tables which form the basis of standards currently used are of questionable accuracy. Health textbooks frequently cite the Metropolitan Life Insurance height-weight tables as acceptable standards for height and weight. Contemporary health educators, Diehl, Rue and

1/Ibid., p. 862.

2/Ibid.

3/Ancel Keys and Josef Brozek, op. cit., p. 252.

rein report the metropolitan tables in their standard health textbooks. brozek points out the limitation of these tables as follows: (1) means of classifying skeletal frame in men and women are not indicated and (2) the ideal weights are given not as points but as ranges. the large scale canadian study establishing a canadian table of average weights for height, age and sex include skinfold measurement as a criterion of fatness as well as weight and height.

the Boyd tables of 1952 include smoothed percentiles of height and weights of Colorado boys and girls from two to eighteen. these tables represent both height and weight of about one hundred seventy-five children measured over a period of years in a certain geographic area. up-to-date norms of height, weight and skinfolds have been established by canadian and british researchers, however, this area of study has been largely neglected in the United States.

1/ thurman B. rue and fred v. rein, living, scott foresman and company, Chicago, 1954, p. 78.

2/ Ancel keys and josef brozek, op. cit., p. 255.

A survey-testing study was made by Randolph Edwards employing the modified Vernier caliper. Edwards determined skinfold and other anthropometrical measurements of five hundred adolescent boys, ages thirteen to seventeen. Percentile norms were established for each level on a one and a half year basis. Some consideration was given to three ethnic classifications; (1) Northern European, (2) Southern European and (3) Jewish. Edwards found the Jewish group heaviest and possessed more subcutaneous tissue than the other groups studied. Edwards' study represents a pioneer survey of subcutaneous body fat on adolescent American boys using a modern constant tension skinfold caliper.

A survey study in skinfold measurements of approximately twenty-four hundred young men measured shortly after induction into the United States Army was conducted by R.W. Newman. The samples used consisted of two thousand seventeen American born white males and three hundred sixty-one American Negro males. A racial contrast emphasized the leanness of the

2/Ibid., p. 98.
Negro and a distinctive deficiency of subcutaneous fat over the pectoral and triceps regions. The causes of these differences in body fat were not analyzed by these researchers, however their significance to human nutrition is apparent. Although this study demonstrated the striking difference of certain racial groups, it is confined to the limited number of Negroes considered as compared to the larger number of white males measured.

Although the measurement of skinfolds dates back to Richer (1890), efforts toward the standardization of instruments, caliper pressures and sites of measurement are relatively recent. Baker and others found skinfold measurements of: (1) right arm, midway from acromion to olecranon, (2) right forearm, lateral to the cubital fossa, (3) left waist, about five centimeters lateral to the umbilicus, (4) right back, immediately below the inferior angle of the scapula, and (5) right calf lateral, efficiently predict

1/Russell W. Newman, op. cit., p. 163.
radiographic thickness of skin plus subcutaneous tissue.  

A recent study by Lewis and others employed the caliper technique considering thirty-six sites. These sites were reduced to six: (1) outer arm, (2) outer thigh, (3) anterior axillary line opposite nipple, (4) back paramedian at the inferior tip of the scapula, (5) front mid-clavicular between the costal ridge and iliac crest, and (6) back paramedian between the scapula and the iliac crest. Means of the six were in good agreement with the means of the original thirty-six points.

There is lack of agreement on the number and location at which the skinfolds should be measured. Matiegka reported measurements of skinfolds at seven sites. Edwards mentions the ease with which a fold of skin may be raised and

1/P. T. Baker and Others, op. cit., p. 54.


the accuracy with which a site can be located. 1/ Keys and Brozek 2/ suggest, as a minimum number, the skinfolds measured on the upper arm (in the midway on the posterior line), below the scapula, and above the iliac crest. These sites are readily accessible to measurement in individuals of both sexes. Thompson recommends abdomen, chest, and upper arm skinfold measurements since interrelation between skinfolds at various sites are high (0.7 - 0.95). 3/ The new Harpenden caliper employed in the present study measures skinfolds with precise accuracy when properly used and objectively quantifies the thickness of folds to the nearest 0.1 millimeter. It is significant to note that one of the main purposes of the study is to provide data on skinfold measurements relating to American preadolescent boys of selected ethnic groups, heretofore unavailable.

Recent skinfold research has found applicable facets


2/Ancel Keys and Josef Brozek, op. cit., p. 260.

3/"Changes In Body Fat, Estimated From Skinfold Measurements of Varsity College Football Players During A Season," op. cit., p. 88.
for measurement in relation to chronic hemiplegia. Lee investigated eight skinfold thickness dimensions using the new Harpenden caliper. This researcher reports 21.5 to 45.0 per cent greater thickness on the diseased limbs than the corresponding region of the normal limbs.

The technique of determining body fat changes from skinfold measurements has several possible applications in the field of health and physical education. Thompson briefly cites the following feasible projects for further study:

"(1) Changes in body fat determined from skinfold measurements in relation to participation in various interscholastic and intercollegiate sports

(2) Physical fitness tests and their relationship to excess fat

(3) Establishment of new norms for total body fat for all age levels using the recommended techniques for skinfold measurement and the established regression equations for predicting body fat from skinfolds

(4) Physical educators, school physicians, school nurses, and health educators are frequently called upon to help a child solve an overweight problem. Skinfold measurements would be quickly made and interpreted to the child.


2/ Op. cit., p. 188.

A change in 'pinch' thickness would be meaningful to him.

(5) Accurate estimation of body fat change in relation to adult physical fitness."

A recent study employed the skinfold technique in the field of geriatrics.

At least five groups are currently working with skinfold and other body composition techniques in the United States in an effort to further present knowledge in this field. These groups include: Laboratory of Physiological Hygiene, University of Minnesota, Minneapolis; Environmental Protection Division, Quartermaster Research and Development Command Laboratory, Natick, Massachusetts; Medical Nutrition Laboratory, Fitzsimmons Army Hospital, Denver, Colorado; Fels Research Institute, Antioch College, Yellow Springs, Ohio; and Bone Density Research and Evaluation Center, University Park, Pennsylvania. These organizations periodically release pertinent data of population characteristics and sample statistics relevant to skinfold and other anthropometric measurements.

CHAPTER III
RESEARCH PROCEDURES AND TECHNIQUES

1. Introduction

The writer exercised considerable practice time in adjusting to the right "feel" of the skinfold and handling of the Harpenden caliper. Practice measurements were made on approximately seventy-five male subjects, under the supervision of an experienced researcher, before gathering the actual data employed in this study. A test, re-test was made on fifty preadolescent subjects. The results disclosed high correlation values extending from .941 to 1/ .997. The technique was further checked on a field trip. Actual measurements of the writer were correlated with the results of an expert. These findings disclosed correlations ranging from 0.77 to 0.92.

Arrangements were made with school authorities and


2/Clem W. Thompson, Associate Professor of Education, Boston University, see appendix for summary data--Appendix A, p. 211.

3/Ibid.
social organizations to use students and club members as subjects. It was necessary to measure the entire male student body of some schools, in order to reach the three ethnic groups needed for the study. The participating authorities were most cooperative in scheduling subjects for measurement. The measuring took place in the physical education office, medical quarters or vacant rooms of the various schools and clubs.

The graduate trained secretarial services of the writer's wife were invaluable in recording the background information and raw scores. Students were generally processed in groups of ten with the secretary notating identification data and recording the measurement scores for each subject. This method facilitated the testing procedure and made it possible to secure the data quickly and accurately.

2. General Procedures

Eleven skinfold and other anthropometrical measurements were objectively measured on each subject. Identification data for each boy measured were recorded as follows:

1. **Name.**— Full name, last name first, followed by first name and middle initial

2. **Age.**— The age bracket included: (1) years; (2) months; (3) days; (4) birthdate.
Age units were classified on a one half year basis
nearest the subject's birthday, e.g., a subject whose age was recorded ten years, nine months through eleven years, two months was classified as an eleven year old. Five age units were established on a half year basis with a range of nine years, nine months through twelve years, two months.

3. **Grade.**-- The current grade level of each subject was recorded. The range of grades included from grade three through grade seven.

4. **Ethnic classification of the subject.**-- Each ethnic classification, (American-Italian, American-Jewish, or American-Negro) was recorded. The ethnic of each subject was established on the basis of ethnic descent of the parents, e.g., a child was considered American-Italian if both parents were of Italian origin. Identical criteria were applied to the Jewish and Negro groups.

5. **Occupation of mother.**-- The type of employment presently engaged by the mother was recorded. Non-working mothers were listed as "housewife."

6. **Occupation of father.**-- The type of employment presently engaged by the father was recorded. Professional working fathers were listed by
professional pursuit. Individuals self-employed in business were listed accordingly.

7. **Residence.**-- The present residence of each subject was listed as follows: (1) street; (2) number of house; (3) city; (4) state.

Table 2 illustrates the nature and form of the general identification data secured on each of the six hundred

**Table 2. General Classification Data**

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</table>

*a/ Age at time of testing

*b/ Months since last birthday

*c/ Days since last birthday

*d/ Birthdate: Year, month, day

*e/ Father

*f/ Mother
- forty-seven (647) subjects measured.

8. Organization or school.-- The testing site, usually a social agency, public or private school was listed on each record form.

3. Measurement Tools

The Harpenden skinfold caliper.-- The caliper is fitted with anvils which are fifteen millimeters long by six millimeters wide and are located to give pressure of ten grams per square millimeter. The scale of the instrument reads to the nearest 0.1 millimeter. The large hand can make two complete revolutions, the first measuring 0.20 millimeters, the second from twenty to forty millimeters. The maximum measurement registerable is fifty millimeters. The caliper as shown in Plate 1 has been tested and approved by the British Medical Research Council. The necessary constant squeeze pressure of ten grams per square millimeter was also checked by the writer and verified by the Toledo Scale Company of Boston.

The Detecto doctor's scale.-- A springless portable


physician's scale was employed in determining weight. The scale shown in Plate 2 registers every one fourth pound up
to three hundred pounds and is of beam balance construction. The platform size measures 11 by 13\(\frac{1}{2}\) inches.

Other anthropometrical tools.-- Other measuring devices are shown in Plate 3. These tools were employed in measuring height, girths, bi-iliac diameter, length of upper arm and

Plate 2. Detecto Doctor's Scale
marking device in locating the proper site for measuring skinfolds.

Plate 3. Other Anthropometrical Tools

1. **Triangular head piece.**—The headpiece is made of three fourths inch plywood with a flat surface of nine inches permitting precise contact with the subject's head and height measuring centimeter stick fastened to the wall. A three fourths inch hole was made approximately near the center of the device for non-slip grasping of the apparatus.
2. **Upper arm marking device.**-- This piece of equipment is constructed of a wood headpiece and a fifteen inch length expressly designed to mark the midpoint of the upper arm between acromial and olecranon process.

3. **Skinfold marking device.**-- This device is designed to mark the chest skinfold with a dermatographic pencil five centimeters (approximately two inches) from the right nipple on a line toward the uppermost point of the axillary fold. The marking device was also used to mark the abdominal skinfold measuring site five centimeters to the right side of the umbilicus.

4. **Steel measuring tape for upper arm and thigh girths.**-- A spring-back steel tape, one meter in length with a constant tension spring to insure that girth measurements were made with invariable tension on the tape was used on each subject.

5. **Tape for measuring chest girth.**-- A special tape for measuring chest girth was devised which insured accuracy of measurement. A non-stretchable, wired

---

tape with an elastic band eight inches long attached at one end, and a series of button fasteners on the opposite end, permitted the tape to remain at the desired position without slippage, after chest movements of inspiration and expiration. This particular type tape is especially recommended for mass measurements.

6. Obstetrical caliper.-- A "Damco" standard physician's obstetrical caliper with measurable readings to the nearest 0.5 millimeter was used to measure the outside diameter of bi-iliac crests. The range of readings measures up to 40 centimeters.

4. Measurement Techniques

Skinfolds.-- Skinfold measurements were made in the standardized way with the Harpenden caliper. Each skinfold was lifted with the thumb and index finger and held while the caliper was applied approximately 1 centimeter away. A firm hold on the skinfold was preferred and the caliper jaws applied in such a way that the critical pressure on the skinfold was exercised by the constant surfaces of the instrument, not by the experimenter's fingers. Each skinfold was measured three times and the average reading recorded to

\[1/\text{Peter V. Karpovitch, op. cit., p. 336.}\]
the nearest 0.1 of a millimeter.

1. **Abdominal skinfold**.— The marking procedure shown in Plate 4 aided materially in selecting the proper site on each subject tested. The subject standing, measurement was made with skinfold orientated laterally as shown in Plates 5a and 5b approximately 5 centimeters to the right of the umbilicus.

![Plate 4. Marking the Abdominal Skinfold](image-url)
The abdominal skinfold proved to be a tedious fold to measure, especially among obese individuals. Therefore, it was particularly important to mark the precise site with the marking device before each fold was measured. The marking procedure assured consistency in "pinching" the skin at the
2. Chest skinfold.-- The subject standing, marking and measurement of the skinfold was made as shown in Plates 6, 7a, and 7b. The measurement was made at the fold parallel to a line from the right nipple and uppermost point of the axillary fold 5 centi-
Plate 7a. Plate 7b.

Plates 7a and 7b. Measuring the Chest Skinfold meters from the right nipple.

3. Upper arm (lateral) skinfold. -- The subject standing, marking and measuring of the skinfold was made as shown in Plates 8, 9a, and 9b. Measurement was made at the fold over the lateral head of the triceps, halfway between the tip of the shoulder (acromion
Plate 8. Marking the Upper Arm (Lateral) Skinfold

process) and the elbow (olecranon process). This measurement proved particularly difficult since the muscular development of upper arm, in some individuals, interfered with lifting of the fold of skin.

4. Upper arm (posterior) skinfold. -- The subject
Plates 9a and 9b. Measuring the Upper Arm (Lateral) Skinfold

standing, measuring of the skinfold was made as shown in Plates 10a and 10b. Measurement was made at the fold parallel to the long axis of the right arm, over the right triceps, halfway between the olecranon and acromial processes. The measurement of this fold was easily determined.

5. Scapula skinfold.-- The subject standing, measuring
Measuring the Upper Arm (Posterior) Skinfold

of the skinfold was made as shown in Plates 11a and 11b. The measurement was made at the fold diagonally from the vertebral column toward the inferior angle of the right scapula, approximately 2 centimeters below the inferior angle and slightly toward the midline of the body. The measurement at this site appeared to be the easiest determined by the writer
Plate 11a. Plate 11b.

Plates 11a and 11b Measuring the Scapula Skinfold

The comparative "looseness" of the skin at this point contributed to ease of measurement.

Other anthropometrical measurements.-- The height, weight, and girth devices were checked for proper operation and accuracy before each testing period.

1. Height measurement.-- Two meter sticks were joined together by an elastic band, attached to a flat wall and employed as a height anthropometer. Each
subject was measured in centimeters and recorded to the nearest millimeter. All subjects were asked to stand erect with the command "stand tall" with heels together, back of hips, upper part of back and head against the measuring stick as shown in Plate 12.

Plate 12. Height Measurement

The triangular headpiece was placed on top of the
head and held firmly at right angles to the anthropometer until enough pressure was exerted to "crush" the hair. Readings were checked at least twice before the height measurement was recorded. All subjects removed shoes before height measurement was determined.

2. Weight measurement.-- Weight was recorded on a modified standard physician's type scale and balanced with a calibrator adjuster before each testing period as shown in Plate 13. The subjects were clad in shorts and socks and assumed a balanced standing position in the center of the scales, as shown in Plate 14. All weights were checked at least twice and recorded to the nearest one fourth pound.

3. Chest girth.-- All subjects were measured with a special tape. Each subject was asked to stand erect and from a position to the subject's left, the tape was placed around the chest, in front at the level of the xiphoid cartilage and in a plane at right angles to the spine as shown in Plate 15. The special attached elastic band insured the position
of the tape. Three measurements were taken when the subject made a full expiration and the average recorded to the nearest one eighth of an inch.

4. **Upper arm girth.**—A steel tape was placed around the right upper arm (Plate 16). The girth was taken with the limb hanging freely, at a right angle to the long axis of arm, and at the same level as the skinfold measurement. Measurement
was recorded in centimeters to the nearest millimeter. All measurements were checked at least twice before the record was made.

5. **Thigh girth.**—A steel tape was placed around the largest part of the right thigh as shown in Plate 17. The subject was instructed to stand with the feet about one foot apart with the weight evenly distri-
Plate 15. Measuring Chest Girth

buted on both legs. The tape was passed around the thigh at right angles to its long axis slightly below the gluteal fold. Measurement was recorded in centimeters to the nearest millimeter and checked at least twice for accuracy before final record was made.
6. **Bi-iliac diameter.**—The measurement of the bi-iliac width was made at the greatest distance between the lateral margins of the iliac crests as shown in Plates 18a and 18b. The caliper was placed in front of the subject and measurement with the caliper blades pressing downward and backward.
Plate 17. Measuring Thigh Girth

Maximum pressure short of pain to the subject was used to insure proper orientation of the caliper to the iliac. Strong pressure was necessary over the contact surface of the caliper, especially on
Plates 18a and 18b. Measuring Bi-iliac Diameter

obese subjects, in order to minimize the amount of soft tissue which would otherwise be included in this measurement.
CHAPTER IV

ANALYSIS OF DATA

1. Introduction

The measurement and compilation of more than 7,000 skinfolds and other anthropometrical measures were prepared for analysis. The various phases of analyzing the data included:

1. Establishing percentile norms for eleven body measurements
2. Correlations between five skinfold measurements
3. Correlations between body build components
4. Correlations between total skinfold measurements and Wetzel Grid physique rating
5. Comparison of body fat, height and weight measurements between each ethnic group
6. Comparison of various height and weight studies with the present study.

Early treatment of data.-- The testing and recording of the various measurements was followed by placing each subject into their respective ethnic group on a one half year basis
extending from ten through twelve years of age.

The next procedure was to convert the chest girth measurements from inches to centimeters since the other girth measurements were recorded in metric measures.

A special recording form was devised in reporting the raw data for machine processing. The statistical computations were done by the I.B.M. 650 Data Processing Machine in the computation laboratory of Boston University. Frequency distributions were established with 850 percentiles calculations completed by the writer. Correlations were run on the data compiled from measuring 647 boys included in this study. The Pearson Product-Moment method was used:

\[ r = \frac{\sum xy}{N \sigma x \sigma y} \]

The technique in analysis of variance employing the F ratio was also used in the machine processing; 

\[ F = \frac{MS_{bg}}{MS_{Wg}} \]

to determine the statistical difference among group means between the selected ethnic groups.

The final analytical phase of the study compared selected percentiles with similar height and weight investigation.

The results are presented in various forms throughout this chapter.

\[^1/\text{Machine Processing Format--Appendix C, p. 239.}\]
2. Percentile Norms for Body Fat, Height, Weight
Girth of Chest, Arm, Thigh and Bi-iliac Diameter
of Each Ethnic Group

Eleven body measurements were compiled in a series of selected percentiles (10th, 25th, 50th, 75th, and 90th levels), and arranged on half year age values.

The method of percentiles in characterizing distributions are in common form and contribute to the ease of interpreting results. Individuals interested in growth and development can readily determine in what portion of the distribution a child falls with respect to each measurement taken through use of percentile tables. These percentile considerations help to understand what the child is like "at the moment" respective to his ranking within a classified group. Each half year age level is analyzed with summative interpretations discussed in the summary of each ethnic group. A final analysis relative to percentile norms between the Italian, Jewish, and Negro groups are presented in the concluding paragraphs of the percentile norms section.

Italian ethnic group.--

10 year olds.-- Table 3, page 69, revealed the largest median score (50 percentile) of 9.8 millimeters
Table 3. Selected Percentile Norms for Skinfold and Other Anthropometrical Measurements of the Italian Ethnic Group

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\(a/\) Skinfolds, measured in millimeters

\(b/\) Height, measured in centimeters

\(c/\) Weight, measured in pounds

\(d/\) Girths, measured in centimeters

\(e/\) Bi-iliac diameter, measured in centimeters

(continued on next page)
Table 3. (concluded)

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attributed to the posterior arm skinfold among the 10 year old Italians. The lateral arm measurement followed with a median of 9.6 millimeters. The smallest median fold was found at the chest site which scored a median of 4.2 millimeters. The 10th percentile of the chest measurement scored 2.6 which represented the smallest fold measured at the first decile level. The lateral arm revealed the largest fat fold figure at the 90th percentile level with a score of 21.8. The posterior and lateral arm skinfolds possessed the largest folds at all percentile levels. The chest fold measurements held the smallest percentiles values with a range of 2.6 millimeters at the 10th percentile to a corpulent 11.6 score registered at the 90th percentile level.

The median height of 136.6 centimeters and 75.5 pounds were recorded at the 50th percentile in Table 3, page 69. The height scores of 127.4 and 143.9 centimeters were registered at the 90th percentiles levels respectively. The 10th percentile score of 60.5 pounds for weight revealed that a portion of the distribution definitely contained light weight subjects. Heavy
weight individuals were also present with 98.5 pounds representing the 90th percentile. The chest girth measured a median score of 62.8 centimeters with a gradual increase in girth to 71.8 marking the 90th percentile level.

An interesting observation was discovered relative to the arm and thigh girths. The thigh measurements doubled the arm measurement at all selected levels with the exception of the 90th level. The thigh and girth lacked 1.8 centimeters for an equal double value of 26.3 centimeters possessed by the arm measurement. The median score for the upper arm and upper thigh girths were 21.6 and 43.0 centimeters respectively. These data revealed an initial trend in upper arm and thigh girth proportions.

The hip diameter ranged from 19.8 centimeters at the 10th percentile to 23.5 centimeters at the 90th percentile level which indicated a broad scope pelvic widths among the 10 year old Italian youngsters.

10½ year olds.-- Table 3, page 69, disclosed the lateral arm site as the largest median skinfold of 9.5 millimeters among the 10½ year old Italians. The smallest fold at the 50th percentile was measured 2.9 millimeters. The lateral arm site scored at the 90th
18.2 at the 90th percentile level followed by the posterior arm measurement of 13.4 at the same level. The arm measurements held the largest skinfolds at each percentile level. Slight increases in height over the 10 year olds were noticed with the median registered at 140.5 centimeters. Similar distributions at the 10th and 90th percentiles were also observed. Small gains in height between the 10 year and 10½ year old age levels were evident.

The weights of the 10½ year olds ranged from a 10th percentile of 62.1 pounds to 101.5 pounds at the 90th level. Again, as revealed in Table 3, page 70, light and heavy weights scattered the 10½ year old age bracket. The median chest girth measured a score of 63.5 centimeters which is slightly higher than the comparable value of the 10 year old level.

The upper arm and thigh girth again disclosed a two to one proportion with the thigh measurements approximately doubling the girth of the upper arm at each percentile level. The median girth of the upper arm scored 20.5 with the comparable 50th percentile of the thigh revealing an approximate double arm value of
42.3 centimeters.

Slight, but consistently larger hip diameters were revealed at the all selected percentiles over the 10 year old group. A consequent increase in growth of the pelvic girdle is congruent with slight increment in bi-iliac width.

11 year olds.-- Table 3, page 70, revealed the skinfold measurements of the lateral and posterior arm, among the 11 year old Italians, as the largest folds at the 50th percentile level. The chest skinfold continued to yield the smallest median of 5.0 millimeters. The abdominal skinfold registered the largest measurement with a reading of 25.8 score at the 90th percentile.

Considerable variations of scores were observed at each percentile level. The abdominal skinfolds disclosed a lean score of 4.0 millimeters at the 10th percentile and a marked degree of obesity with a measurement of 25.8 millimeters at the 90th percentile level. Slight, but consistently larger skinfolds were observed at the scapula site with the median fold scoring 5.8 millimeters as compared to 5.3 values found among the 10 and 10½ year old Italian group.
The height measurements revealed a continuous and steady increase in height within the 11 year old group. The median score was found at 143.7 centimeters with the 90th percentile yielding 153.3 centimeters. Heavier weights were disclosed by the greater 10th and 90th percentiles of 66.3 and 112.5 pounds found within the 11 year old group as compared with the same ethnic of the younger ages. Increased chest girth with a median of 67.0 centimeters also gave evidence of a slow but continuous growth in stature. Thigh measurements continued to yield percentile values which approximately doubled the girth of the upper arm. The hip diameter continued to increase in width with scores consistently reading larger measurements in each of the five selected percentiles.

11\(\frac{1}{2}\) year olds.-- Table 3, page 70, revealed scores of 11.9 and 10.7 millimeters for the posterior and lateral arm skinfolds as the largest values at the 50th percentile level within the 11\(\frac{1}{2}\) year age bracket. The largest fold was recorded at the 90th percentile with a score of 25.9 attributed to the abdominal measurement. The smallest skinfolds at each percentile level were
observed at the chest site. The arm measurements (lateral and posterior) contained the largest scores at all levels with the exception of the 90th percentile abdominal fat fold.

The height value of 144.5 millimeters represented a slight, but gradual increment in height at the median level as compared with the younger Italian age groups. The 50th and 75th percentiles disclosed slightly lower weight scores than the immediate preceding age bracket. All other percentiles gave evidence of increased weight. The fluctuation in the gradual increment of weight may be due to the onset of uncertain growth spurts characteristic of the initial stages of adolescence. Similar findings were observed relative to the chest girth. Smaller girths were observed at the 75th and 90th levels. The arm girths disclosed two scores at the 75th and 90th percentiles slightly smaller than observed within the 11 year old group. The thigh girth continued to approximate the double size of the arm with a median score of 46.1 centimeters. Hip diameter values were slightly lower with 0.3 millimeters at the lower 10th and 25th percentiles. The remaining three higher levels
disclosed slight increases of bi-iliac diameter with increased age.

12 year olds.-- Table 3, page 70, revealed lower median scores for all five skinfold sites as compared to the preceding Italian age brackets. The posterior arm fold followed by the lateral arm measurement received the largest median scores with 9.9 and 9.4 millimeters respectively. The largest skinfold at the 90th percentile was found at the abdominal site with a score of 21.4 millimeters.

The smallest measurements were discovered among the chest skinfolds with the 10th percentile scoring 2.8 millimeters and the 90th level yielding 9.9 millimeters. It is interesting to observe the lower median skinfold scores and the contrasting higher values in measured height at all percentile levels within the twelve year old unit.

The five percentile levels reflect greater height measures than the four preceding half year age brackets. The score of 158.9 centimeters at the 90th level disclosed a marked increase in height at the upper percentile. All of the scores in the 12 year bracket
were higher at each percentile level than the preceding age groups.

Weight showed a slight gain at the median level with a score of 89.1 pounds. Weight increases were observed at each percentile level with the exception of a small decrease between the 10th percentile of the 12 year old group and the parallel level within the 11½ year old bracket. Chest girths disclosed a median score of 67.8 centimeters which is slightly higher than the preceding age unit.

The thigh girth circumference continued to approximately double the size of the upper arm girth with the median score of 22.9 centimeters earned by the upper arm and 45.7 centimeters for the thigh. The 10th and 25th percentile of the upper arm and thigh among 12 year olds were exactly similar or lower than the 11 and 11½ year old brackets. The hip diameter continued to show a gradual increase in hip width and a score of 25.7 centimeters was registered at the 90th percentile level.

Summary of the Italian ethnic group percentile norms.--

1. Skinfolds.-- The lateral and posterior skinfolds revealed the largest median scores of all the
sites measured. The abdominal fat fold disclosed the largest measurements at the 90th percentile among the 11, 11½ and 12 year old brackets. The chest skinfold disclosed the smallest measurements among the five age units with the tenuous fold of 2.6 millimeters recorded within the ten year old group. Lateral and posterior arm measurements scored the highest values at the 50th percentiles among all age brackets, the posterior fold yielded slightly higher medians among the 11½ and 12 year old groups. An analysis of the median abdominal folds disclosed a consistent second in fat fold size among all age groups with the exception of the 10½ year bracket which scored 0.1 millimeter less than the scapula measurement.

The scapula measurement revealed slight gains in median fold size up to the 11½ year old bracket, with a decrease within 0.1 millimeter at the 12 year bracket. Smaller skinfolds were evident among the median percentiles within the 12 year age unit which gives an indication to a generalized weight reduction perhaps due to the initial stage of the adolescent growth spurt.

2. **Height.**—Gradual and consistent increases in height
were evident among all age units of the Italian group. The greatest growth spurt occurred within the 12 year old level with a difference of 21.2 centimeters from the 10th to the 90th percentiles. The slowest gains were observed at the 10½ year level with a 15.6 centimeter range from the 10th to the 90th percentile levels. As would be expected, the tallest Italians were found at the 12 year old level.

3. **Weight.**—Weight increases were observed at each age unit with the largest gains disclosed at the 12 year level and a range of 56.2 pounds from the 10th to the 90th percentiles. The range of the 50th percentiles registered from 75.5 to 89.1 pounds over the five one half year age levels.

4. **Chest girth.**—The chest circumferences gradually increased in girth with the medians ranging from 62.8 centimeters to 67.8 over the five half year age levels. The 12 year old bracket showed the largest gains between the 10th and 90th percentiles with a range of 14.9 centimeters.

5. **Upper arm girth.**—Gradual increases in upper arm girth were evident with increased age among the Italian boys. The range of the median percentiles
revealed 21.6 centimeters for the 10 year olds to 29.6 for oldest age group studied. The greatest scope in size from the 10th to the 90th percentiles was contained within the 12 year old unit which revealed a range of 10.5 centimeters.

6. **Thigh girth.**-- The thigh girth approximately doubled the girth of the upper arm at each of the five age levels. Inconsistent increases in median sizes were observed. Forty-three (43.0) centimeters characterized the 10 year olds, followed by a slight decrease to 42.3 centimeters in the 10½ year bracket. An increase to 44.8 centimeters followed at the 11 year bracket. Forty-six and one-tenth (46.1) centimeters was attributed to the 11½ year old and a final drop to 45.7 centimeters marked the median score of the 12 year olds. This irregularity points out the sporadic growth of the thigh girth within the five half year Italian groups.

7. **Bi-iliac diameter.**-- Gradual and steady increase of hip width was observed at all age levels with the smallest diameter recorded at 19.8 centimeters (10 year olds) and the largest width 25.7 centimeters scored at the oldest level (12 year olds). All
percentiles within each age bracket presented progressive increments parallel to increased age.

**Jewish ethnic group.**

**10 year olds.**-- Table 4, page 83, revealed the abdominal skinfold as the largest fat fold at the 90th percentile within the 10 year old age unit. Lateral and posterior arm measurements registered the largest median folds with 11.0 and 10.0 millimeters respectively. The chest fold scored the smallest "pinch" measurement with a range of 2.9 to 11.8 millimeters.

Table 4 also revealed 139.6 centimeters as the 50th percentile height score of the 10 year old Jewish boys. The range of 12.2 centimeters existed between the 10th and 90th levels. Fifty-seven and two-tenths (57.2) pounds represented the 10th percentile value. The 90th level was recorded at 90.8 pounds. A substantial difference of 33.6 pounds was evident between the 10th and 90th percentiles.

The chest girth disclosed a range of 15.7 centimeters from the 10th to the 90th percentiles and a median of 61.8 centimeters.

The median upper arm girth was 21.4 centimeters with the correspondent level of the thigh measuring
Table 4. Selected Percentile Norms for Skinfold and Other Anthropometrical Measurements of the Jewish Ethnic Group

<table>
<thead>
<tr>
<th>Measurement Sites</th>
<th>Percentiles</th>
<th>10th</th>
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<th>50th</th>
<th>75th</th>
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<tr>
<td></td>
<td></td>
<td>10 yr. olds</td>
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<tr>
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<tr>
<td>Height(^b)</td>
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<td>143.1</td>
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<table>
<thead>
<tr>
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<td>Bi-iliac Diameter</td>
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\(^a\)Skinsfolds, measured in millimeters

\(^b\)Height, measured in centimeters

\(^c\)Weight, measured in pounds

\(^d\)Girths, measured in centimeters

\(^e\)Bi-iliac diameter, measured in centimeters

(concluded on next page)
Table 4. (concluded)

<table>
<thead>
<tr>
<th>Measurement Sites</th>
<th>10th</th>
<th>25th</th>
<th>50th</th>
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<td>23.5</td>
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<td>48.0</td>
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<td>21.8</td>
<td>22.7</td>
<td>23.9</td>
<td>24.8</td>
</tr>
</tbody>
</table>

| 11½ yr. olds |
|------------------|------|------|------|------|------|
| Abdomen 11½ yr. olds | 4.5  | 7.1  | 13.5 | 24.9 | 32.1 |
| Chest 11½ yr. olds | 3.5  | 4.5  | 8.2  | 11.9 | 14.6 |
| Lateral Arm 11½ yr. olds | 6.3  | 11.2 | 13.9 | 20.3 | 23.3 |
| Posterior Arm 11½ yr. olds | 7.3  | 11.1 | 14.2 | 18.4 | 21.3 |
| Scapula 11½ yr. olds | 4.6  | 5.7  | 7.8  | 9.9  | 13.6 |
| Height 11½ yr. olds | 139.3 | 142.6 | 147.5 | 152.9 | 156.3 |
| Weight 11½ yr. olds | 74.9  | 83.6  | 95.9  | 112.5 | 127.8 |
| Chest Girth 11½ yr. olds | 62.5 | 64.3 | 68.1 | 73.4 | 78.3 |
| Upper Arm Girth 11½ yr. olds | 21.2 | 22.5 | 24.9 | 27.4 | 29.5 |
| Thigh Girth 11½ yr. olds | 42.7 | 45.1 | 49.6 | 53.9 | 56.3 |
| Bi-iliac Diameter 11½ yr. olds | 21.1 | 22.1 | 23.3 | 24.9 | 26.4 |

| 12 yr. olds |
|------------------|------|------|------|------|------|
| Abdomen 12 yr. olds | 4.3  | 5.6  | 10.0 | 25.2 | 31.8 |
| Chest 12 yr. olds | 2.7  | 3.9  | 5.6  | 9.9  | 13.8 |
| Lateral Arm 12 yr. olds | 6.4  | 8.6  | 13.0 | 18.1 | 20.9 |
| Posterior Arm 12 yr. olds | 6.4  | 8.5  | 12.3 | 15.5 | 18.6 |
| Scapula 12 yr. olds | 4.3  | 5.2  | 6.7  | 9.5  | 12.9 |
| Height 12 yr. olds | 143.2 | 146.2 | 149.5 | 155.1 | 157.7 |
| Weight 12 yr. olds | 72.5  | 84.0  | 99.5  | 110.8 | 128.8 |
| Chest Girth 12 yr. olds | 63.0 | 64.5 | 68.6 | 73.4 | 76.9 |
| Upper Arm Girth 12 yr. olds | 20.2 | 22.5 | 24.7 | 26.2 | 27.9 |
| Thigh Girth 12 yr. olds | 41.2 | 44.2 | 48.4 | 51.8 | 56.2 |
| Bi-iliac Diameter 12 yr. olds | 21.1 | 21.9 | 23.3 | 24.6 | 25.7 |
43.2 centimeters. Thigh measurements continued to approximately double arm girths at each percentile level. Three and seven tenths (3.7) centimeters represented the percentile range of the bi-iliac diameter with a median of 21.4 centimeters.

10½ year olds.-- The largest skinfold within the 10½ year old unit was observed at the abdominal site with a measurement of 32.2 millimeters as shown in Table 4, page 83. The lateral and posterior arm folds continued to hold the largest median scores of 9.3 and 9.0 millimeters respectively. The chest skinfold exhibited the smallest median score of 6.1. Proportionate smaller chest skinfold measurements were found at each percentile level as compared with the remaining four sites. The 50th percentile of the scapula was 6.3 with a range of 8.9 millimeters.

Higher percentile scores were observed for the height measurement at all percentile levels as compared with the 10 year old unit. A gradual increase in height was observed with an increase of 5.1 centimeters between the medians of the 10 and 10½ year old Jewish boys. Each percentile indicated similar increments in height with increased age.
The 10\(\frac{1}{2}\) year old Jewish group continued to gain weight steadily with a median score of 83.7 pounds. The range of 44.1 pounds from the 10th to the 90th percentiles revealed a field of light and heavy individuals throughout the 10\(\frac{1}{2}\) year old Jewish sampling.

The chest girth continued to show a gradual increase in circumference with the median girth recorded at 65.5 centimeters. The largest measurement at the 90th level yielded 73.5 centimeters.

The characteristic trend of thigh size doubling arm girth prevailed at all percentiles levels of the upper arm and thigh measurements. Slight increases in girths of arm and thigh were observed at the median level within the 10\(\frac{1}{2}\) year old Jewish group.

The bi-iliac diameter continued to increase with advance in age. The hip width measurement yielded a median of 22.1 and a range of 4.6 centimeters from the 10th to 90th percentiles.

11 year olds.-- Table 4, page 84, disclosed slightly larger skinfold scores than the preceding age units, particularly at the upper percentile levels. The 11 year unit exhibited slightly larger median folds at the lateral and posterior arm sites with measurements of 13.0 and 12.5
millimeters recorded at the 50th percentile respectively. The abdominal fold registered the largest fat fold at the 90th percentile with a corpulent 33.4 millimeters. The chest fold continued to hold the smallest skinfold size at each percentile level. The scapula site scored a median fold of 6.0 which was 0.3 millimeters lower than the preceding Jewish age unit.

A continued increment in height was evident within the 11 year old bracket. Table 4, page 84, revealed a median of 144.3 and a range of 15.8 centimeters from the 10th to 90th percentile. Greater height gains were observed at the upper percentile levels.

All weight percentile values of the Jewish 11 year olds yielded higher scores than the preceding age unit. The range of 56.7 pounds at this level indicated a larger dispersion of percentile scores between the 10th and 90th levels.

The median chest girth measurement of 65.5 centimeters reciprocated the exact 50th percentile value of the preceding one half year age unit. A slightly larger measurement at the 90th level was observed.

The upper arm girth exhibited small increases in circumference. The thigh measurement continued the
pattern of approximately doubling the arm girth at each percentile level.

The median bi-iliac diameter revealed 0.6 centimeters increase in hip width over the 10 year old unit. Extremely small increments were observed at each percentile which gave evidence of a continuous, but slow rate of width growth of the bi-iliac at this age level.

11½ year olds.-- Slightly larger skinfolds continued to trend the 11½ Jewish unit median fat folds as shown in Table 4, page 84. A decrease in the 90th percentile scores at the abdomen, chest and lateral arm sites was observed. The abdominal fold registered the largest score at the 90th percentile with a mark of 32.1 millimeters. The lateral and posterior arm sites continued to contain the largest folds at the 50th percentiles. The lowest scores were found at the chest location with a range of 3.5 to 14.6 millimeters. The scapula skinfolds exhibited small increases with a consistent ranking among the lowest scores with the exception of the chest fold measurements.

The height measurements continue to show progressive increases as revealed by Table 4, page 84. An increase of 3.2 centimeters was observed between the medians of
the 11½ year olds and the preceding one half year age level. Weight increment was also evident by the progressively larger median of 95.9 pounds contained within the 11½ year bracket.

The chest girth continued to increase in circumference with a median of 68.1 centimeters and expanse of 3.2 centimeters over the preceding one half year age level.

Slightly larger upper arm and thigh girths were observed with similar characteristics of thigh doubling the arm girth specifically found in previous age units.

The hip width yielded a median of 23.3 centimeters which was 0.6 centimeters larger than the equivalent percentile of the 11 year old group. Each of the bi-iliac percentiles revealed a trend of continued growth in hip width.

12 year olds.-- Lower percentile scores were observed in Table 4, page 84, relevant to all median skinfold measurements within the 12 year old unit. A decrease of 0.9 millimeters was disclosed between the largest median fold (lateral arm), and the immediate preceding age unit. Similar decreases in fat folds were observed at the 90th percentile with lower measurements at all five sites as compared with the 11½ year bracket. The chest skinfold
continued to score the smallest measurement with a median of 5.6 millimeters. The lateral and posterior arm sites contained the highest medians with skinfolds of 13.0 and 12.3 millimeters respectively. The largest skinfold was ascribed to the abdominal site with a measurement of 31.8 millimeters recorded at the 90th percentile. The scapula also demonstrated slight decreases in fat fold size within the 12 year old bracket with a median of 6.7 millimeters.

The overall decrease in fat folds perhaps gives rise to the loss of body fat and the increase in height with the advent of pubescence.

The height measurement continued to show progressive height increments with a median of 149.5 centimeters. Table 4, page 84 revealed a similar trend of higher percentile values within the 12 year old Jewish group as compared with previous age units.

Slight increases in weight were evident with a gain of 4.1 pounds over the preceding age group. The 90th percentile exhibited the largest weight score within the Jewish group with 128.8 pounds recorded in Table 4, page 84.

Chest girths continued to gain slight increases in
circumference. The median chest girth was recorded 68.6 or 0.5 centimeters larger than the 11½ year old unit.

Smaller upper arm girths were discovered at each percentile level among the 12 year olds. Similar findings were found among the thigh measurements.

Identical medians were revealed between the 11½ and 12 year bi-iliac diameter with scores of 23.3 centimeters. Slightly lower scores were observed at other percentile levels, however each percentile value was less than one centimeter in bi-iliac width.

Summary of the Jewish ethnic group percentile norms.--

1. Skinfolds.-- The largest median skinfold values were observed within the 11½ year old age unit, and the largest median fat fold of 14.2 millimeters was located at the posterior arm site. The largest skinfold was found within the 11 year old bracket (abdominal site), with a 90th percentile of 33.4 millimeters. The lateral and posterior arm measurements scored the highest medians among all age units. The chest skinfolds were consistently the lowest measurements within the five one half year age units. The smallest chest fold was found among the 12 year olds with a mark of 2.7 millimeters.
The largest chest skinfold was contained within the 11 year old bracket with a 90th percentile of 15.8 millimeters.

Slow, but gradual increases in all skinfolds were observed from 10 to 11 1/2 years. The largest median folds were discovered at the 11 1/2 year level. Smaller measurements emerged with the beginning of the 12th year as exhibited by a decrease of all percentile values in Table 4, page 84.

2. Height.-- Progressive increments in height were observed at each percentile level over the five one half year age spread. The lowest percentile was marked at the 10 year level with a score of 132.6 centimeters. The tallest Jewish subjects were found within the 12 year old bracket.

The height range of 25.1 centimeters was observed from the 10th through 12th year old levels.

3. Weight.-- Continued increases in weight were found from the youngest to the oldest groups investigated in this study. The scope of 57.2 to 157.7 revealed a range of 100.7 pounds. Although the heaviest subjects were discovered within the 12 year bracket, the largest fat folds were located within the 11 year
old group.

4. **Chest girth.**— An analysis of the chest girth medians disclosed gradual increments in chest circumference at each age level with the exception of the 10½ and 11 year brackets. Both age units disclosed identical median values of 65.5 centimeters. The smallest girth was recorded within the 10 year unit with a score of 56.8 centimeters. The largest girth was found within the 12 year age unit with a value of 76.9 centimeters.

5. **Upper arm girth.**— Progressive increments of the upper arm girths were observed from the 10 year old level to the 11½ year bracket with a range of 18.0 to 29.5 centimeters. However, slight decreases in girths were disclosed at the 12 year old bracket with the 50th and 90th percentiles yielding lower scores of 24.7 and 27.9 centimeters respectively.

6. **Thigh girth.**— Similar progression series were observed among the percentiles values of the thigh girths comparable to arm girth measurements. Continued increments were observed from the 10th to the 11½ year level. Slight decreases were found in the 12 year bracket as compared to the 11 year old unit. All thigh measurements approximately doubled
the arm girths at each one half year age bracket and exhibited a range of 36.8 to 56.3 centimeters.

7. **Hip diameter.**-- The smallest hip width was observed within the 10 year old unit with a 10th percentile of 19.7 centimeters. The largest value was discovered at the 11½ year old level (90th percentile) with a score of 26.4 centimeters. Small, but gradual increments in hip width were recorded among all the Jewish age units with the exception of two oldest age levels studied. Identical medians were recorded for the 11½ and 12 year levels with scores of 23.3 centimeters.

**Negro ethnic group.**--

**10 year olds.**-- Table 5, page 95 revealed the largest skinfold measurements located at the lateral and posterior arm sites with identical values of 9.9 millimeters recorded at the 90th percentile. The arm measurements also scored the largest folds at the 50th percentile level with the posterior site 0.1 millimeters higher than the lateral measurement. The chest measurement scored the smallest values with a percentile range of 3.5 to 6.9 millimeters. The scapula skinfold exhibited a range of 2.0 millimeters with the 10th
Table 5. Selected Percentile Norms for Skinfold and Other Anthropometrical Measurements of the Negro Ethnic Group

<table>
<thead>
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\(a/\) Skinfolds, measured in millimeters

\(b/\) Height, measured in centimeters

\(c/\) Weight, measured in pounds

\(d/\) Girths, measured in centimeters

\(e/\) Bi-iliac diameter, measured in centimeters

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Table 5. (concluded)
percentile rating of 4.2 and a 90th percentile score of 6.2 millimeters.

The height measurement revealed a range of 14.8 centimeters. The median for the 10 year old unit was recorded at 137.0 centimeters. The spurt of increased height is lower than the subsequent age units.

The median of 69.6 pounds characterized the weight value of the 10 year old Negro group.

A spread of 21.5 pounds disclosed the 10th and 90th percentiles as 61.0 and 82.5 pounds respectively.

The chest girth measurement disclosed a 10th percentile of 58.3 centimeters. The largest chest girth was recorded at an increase of 6.5 centimeters or 64.8 millimeters. Sixty-two (62.0) millimeters was revealed by Table 5, page 95, as the median.

The upper arm and thigh girths measured medians of 19.8 and 40.7 millimeters respectively. Each thigh circumference continued to approximate a double girth measurement of the upper arm.

A bi-iliac diameter range of 3.5 centimeters was observed within the 10 year old Negro group. A median of 19.9 centimeters characterized the hip width
of the youngest Negro set studied.

10½ year olds. -- Larger skinfolds at each median level were disclosed by Table 5, page 95, within the 10½ year old Negro unit. The posterior arm skinfold earned the largest median fat fold with a value of 8.6 millimeters. The lateral arm measurement followed with 7.8 millimeters. Large arm skinfolds were observed at the 90th percentile. The posterior and lateral arm folds yielded 19.5 and 16.4 millimeters respectively. The abdominal skinfold also produced a large measurement with a score of 16.4 millimeters. The chest skinfold received the smallest scores at each percentile with a 10th percentile of 2.4 and a 90th percentile of 9.1 millimeters.

Table 5, page 95, revealed progressive increments in height measurements with a median of 143.0 centimeters. A range of 17.0 centimeters indicated a slight gain in cumulative height as compared to the preceding age unit. Small increases in chest girths were observed at all percentile levels with a median of 63.6 recorded in Table 5. The upper arm and thigh girths continued to yield the double proportion
of thigh measurement to upper girth. The upper arm girth revealed a median of 21.3 millimeters, and the parallel percentile of the thigh measurement produced 44.0 millimeters.

Slightly larger bi-iliac widths were disclosed within the 10½ year old Negro group. The median score of 20.6 represented an increase of 0.7 millimeters over the preceding age unit.

11 year olds.-- Table 5, page 96, revealed lower median values for 11 year old Negroes among all five skinfold sites measured, as compared with the 10½ year old group. The posterior arm fold scored the largest median with a measurement of 6.3 millimeters. The lateral arm skinfold followed closely with 6.1 millimeters.

The 90th percentile values revealed similar findings with the lateral and posterior arm fold yielding the largest measurements of 11.8 and 10.7 millimeters. The chest skinfold held the smallest measurement scores at all percentile levels and yielded a median of 3.1 millimeters. The scapula skinfold followed the arm measurements in size with a median score of 5.2 millimeters.
Slight gains in height were observed within the 11 year old Negro group. A range of 15.2 centimeters indicated a slow but progressive increase in height as compared with the other age units. Table 5, page 96, revealed a median of 143.0 centimeters. The 10th percentile and 90th percentiles disclosed a spread of scores from 136.9 to 152.1 centimeters.

The 11 year old Negro weight measurement actualized a loss of 1.7 pounds between medians of the 10½ and 11 year old Negro groups. The median values yielded 78.8 pounds as compared to the equivalent percentile of 80.5 pounds found in the younger unit. A loss of 21.3 pounds was also observed at the 90th percentiles of each group. The 11 year old unit scored 90.2 pounds as compared to 111.5 pounds for the 10½ year olds. The chest girths measurements revealed a median of 63.5 and a range of 8.4 centimeters.

The median upper arm girth was scored at 21.0 centimeters and the thigh 50th percentile measured 42.1 centimeters. Smaller limb girths were observed among the 11 year olds as compared with the preceding
Slight bi-iliac width changes were noted within the 11 year old unit. The median of 21.0 centimeters represented a 0.6 centimeter loss in width as compared to the 10½ year old. The data presented in Table 5, page 96, indicates that the 11 year old Negro is taller and leaner than the 10½ year old Negro male youngster.

11½ year olds.-- Slightly larger skinfolds were observed within the 11½ year old Negro group as shown by Table 5, page 96. The largest measurement was recorded at the 90th percentile for the lateral arm fold with a mark of 12.4 millimeters. The posterior and lateral arm possessed the largest median skinfolds with caliper readings of 6.9 and 6.5 millimeters. The chest skinfold continued to produce the smallest fat fold thickness by yielding smaller measurements than the remaining four sites at each percentile level. The scapula skinfold surpassed the abdominal fold with an increase of 0.3 millimeters at the 50th percentile.

The 11 year old Negro unit received greater height scores than the preceding age bracket as
shown in Table 5, page 96. The median of 144.3 centimeters and a gradual increment in all percentile values disclosed continued progress in height with age advancement.

Slight increases in weight were observed in Table 5, page 96. The median weight of 79.9 represents a gain of 1.1 pounds over the 10 1/2 year age unit.

Small increases were evident among the chest girth measurements of the 11 year old Negroes. A median of 64.3 centimeters and a range of 9.7 centimeters was observed between the 10th and 90th percentiles.

Upper arm girth and thigh measurements revealed medians of 21.1 and 42.8 centimeters respectively. Slow, but progressive increase in arm and thigh girths are shown by Table 5, page 96.

A slight decrease of bi-iliac width was observed in median values of 11 and 11 1/2 year old Negroes. Slight decreases were also observed at the 10th, 25th and 50th percentiles. However, slight gains were disclosed at the 75th and 90th level. The median score of 20.7 centimeters represented a decrease of 0.3 millimeters in hip width under the 11 year old group.

12 year olds.-- The largest median skinfolds were.
found at the lateral arm site with a score of 8.2 millimeters as shown in Table 5, page 96. The posterior arm fold followed with a mark of 7.7 millimeters. The lateral and posterior folds yielded the greatest thickness at each percentile level. The largest measurements were made at the 90th percentile level with values of 15.9 and 14.8 millimeters respectively. The chest site continued to possess the smallest skinfolds with scores ranging from 2.3 to 7.0 millimeters. The scapula measurements were slightly larger than the abdominal folds at the 10th, 25th, and 50th percentiles, however, an analysis of the upper percentiles disclosed higher scores at the abdominal site.

The median height of the 12 year olds was 14.7 centimeters. Progressive increments were observed over previous age units. Weight continued to increase within the 12 year old bracket. A gain of 7.8 pounds was revealed between the 12 year old and 11 1/2 year old brackets.

Table 5, page 96, disclosed slight increases in chest girths at each percentile level with a median of 65.0 centimeters.

Slight increases in upper arm and thigh girth measurements were recorded with median values of 21.6
and 44.6 centimeters attributed to the upper and lower limb circumferences. The thigh girth continued to approximately double the upper arm girth within the 12 year old Negro group.

Larger bi-iliac diameters were observed at the 12 year old level with a median value of 21.3 centimeters. Progressive increases were disclosed at each selected percentile level over the four preceding age units.

Summary of the Negro ethnic group percentile norms.--

1. Skinfolds.-- An analysis of the median skinfold measurement among the Negro age units revealed the predominance of the lateral fold as the largest fat measurement with a range of 6.9 to 8.6 millimeters. The largest skinfold was located at the posterior site among the 10½ year olds with a mark of 19.5 millimeters. The abdominal fold followed the lateral arm measurement in the same age bracket with a 90th percentile of 16.4 millimeters shown in Table 5, page 95.

The chest skinfolds exhibited the smallest measurements among the five age units with a range from 2.3 to 9.1 millimeters. The largest series of skinfolds were observed within the 10½ year old age
unit with posterior fold scoring 19.5 and equivalent marks of 16.4 attributed to the lateral arm and abdominal sites. The 11½ year age unit continued the smallest medians of the five measured sites with the chest fold yielding a 50th percentile of 3.4 millimeters and the posterior arm thickness bearing 6.9 millimeters. Slightly lower percentile values were observed within the 11½ year old unit as compared to previous Negro age brackets.

2. **Height.**-- A consistent and gradual increase in height was observed from the 10 to 12 year old Negro age units. The greatest spurt in height was found within the 11½ year old unit with a range of 18.9 centimeters from the 10th to 90th percentiles. Table 5, page 96, also revealed a trend of greater height increments coupled with a decrease in median skinfolds over the five one half year Negro age units.

3. **Weight.**-- Gradual increments in weight with increased age was observed up to the 10½ year old age bracket. The median weight of the 11 year olds decreased 1.7 pounds which indicated a beginning weight loss. However, increased weight was disclosed with the subsequent 11½ and 12 year old units. The 10½ and
12 year old Negroes possessed the largest weight established at the 90th percentile with identical scores of 111.5 pounds. The lightest weight was recorded within the 10 year old unit with a 10th percentile of 61.0 pounds. The scope of the Negro weights ranged from 61.0 to 111.5 pounds over the five one half year age levels.

4. **Chest girth.**-- The chest girths ranged from 58.3 centimeters found within the 10 year level to 72.4 centimeters contained within the 10½ year bracket over the five age units studied. Gradual increased median chest girths were observed up to the 10½ year level. However, a slight drop of 0.1 centimeters in the 11 year old group interrupted the steady and consistent increase of chest circumference with the advance of age. Continued increase of chest girth size was resumed with 11½ and 12 year brackets yielding medians of 64.3 and 65.0 centimeters respectively.

5. **Upper arm girth.**-- The 10½ year old unit established the largest Negro upper arm girth of 26.7 centimeters. The smallest girth was found among the 10 year olds with a score of 18.4 centimeters. The entire range
of the upper arm girths over the five age units was from 18.4 to 26.7 centimeters as shown in Table 5, pages 95 and 96. It is observed, at this point, that the largest upper arm girths among the Negro group also contained the largest skinfolds.

6. **Thigh girth.** -- The thigh girths continued the trend of approximately doubling the upper arm girth at each percentile level over the five age levels studied. The largest thigh measurement was found at the 90th percentile among the $10^{1/2}$ year old age bracket with a score of 54.5 centimeters. The smallest thigh girth was observed at the 10th percentile of the 10 year olds with a score of 37.1 centimeters. The $10^{1/2}$ year old group contained the largest median with a score of 44.0 centimeters and the 10 year old unit possessed the smallest 50th percentile with a mark of 40.7 millimeters.

7. **Bi-iliac Diameter.** -- The bi-iliac diameter revealed a continuous development in size up to the 11 year old level with a median score of 21.0 centimeters. The median value of 20.7 centimeters represented a slight decrease in hip width within the $11^{1/2}$ year old unit as shown by Table 5, page 96. It is also
observed from Table 5, that the reduced hip diameter paralleled the decrease in skinfolds within the 11\frac{1}{2} year age bracket. The range of bi-iliac widths was established from 18.1 to 22.9 centimeters over the five age units.

**Summary of percentile norms among the Italian, Jewish, and Negro groups.**

A. **Skinfold measurements.**—An analysis of the skinfold medians, in Table 6, page 109, revealed the Jewish group in possession of the largest measurements at each age level. The Italians contained the second largest folds with the Negro group holding the smallest values at the 50th percentile.

The largest median skinfold was identified within the 11\frac{1}{2} year old Jewish group with a score of 14.2 millimeters located at the posterior arm site. The posterior arm skinfold also characterized the largest median measurement among the Italian and Negro groups. The smallest median value was found within the Negro group with a chest skinfold of 3.1 millimeters.

The 90th percentile within the 11 year old Jewish group contained the largest measurement of all the measured folds with an abdominal skinfold
Table 6. Percentile Norm Summary of the Italian, Jewish and Negro Ethnic Groups

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score of 33.4 millimeters. The abdominal site also held the largest equivalent percentile value within the 11\(\frac{1}{2}\) year old Italian group with a mark of 25.9 millimeters. The largest skinfold within the Negro group, however, was found at the 90th percentile, (posterior arm) with a score of 19.5 millimeters.

The chest skinfolds consistently scored the lowest values among the three ethnic groups. The Negro ethnic group contained the lowest measured fold with a chest fold of 2.2 millimeters. The Italians and Jewish followed with proportionately larger chest fold scores of 2.6 and 2.7 millimeters.

B. Height measurement.-- The 12 year old Jewish group scored the highest median percentile with a height mark of 149.5 centimeters as shown in Table 6, page 109. The 12 year old Negro group followed with 147.7 centimeters, and the Italians scored the lowest median value of 146.9 centimeters. An analysis of the 90th percentiles disclosed the Italian 12 year old group as the tallest at this level with a score 158.9 centimeters followed by the Jewish and Negroes with respective scores of 157.7 and 155.6 centimeters. The lower percentiles
exhibited taller scores for the Jewish, followed by the Negro and Italian ethnic groups.

C. **Weight measurement.**-- The Jewish ethnic group contained the heaviest subjects at the median percentiles with the score of 99.5 pounds recorded at the 12 year old bracket as shown in Table 6, page 109. The 12 year old Italian and Negro groups followed with median scores of 89.1 and 98.7 pounds respectively. Observation of the 10th and 90th percentiles revealed similar trends with the heaviest subjects found within the Jewish group followed by the Italian ethnic at all age levels with the exception of the 10th percentile. The largest score at the 90th percentile was disclosed within the 12 year old Jewish group with a score of 128.8 pounds. The lightest individuals at the 10th percentile level were identified among the Italian subjects with a score of 60.5 pounds.

D. **Chest girth measurement.**-- The median and upper percentiles revealed the largest chest measurements among the Jewish and Italian groups respectively as shown in Table 6, pages 109-110. The Jewish ethnic scored the largest measurement at the 90th percentile
with a mark of 78.3 centimeters. The Italian and Negro groups followed with scores of 76.9 and 72.4 centimeters. A similar pattern was observed at the 50th percentile, with the Jewish subjects leading in chest girth size.

The 10th decile revealed a reversed trend, at the 10 year old level, with the Jewish group scoring the smallest measurement of 56.8 centimeters. The Italians, followed by the Negro ethnic, yielded higher values than the Jewish group among the lower percentiles of the 10 year olds.

E. Upper arm girth measurement.-- The largest upper arm circumference was observed within the 12 year old Italian group with a score of 29.9 centimeters, as shown in Table 6, page 110. The Jewish and Negro groups followed with scores of 27.9 and 26.7 marked at the 90th percentile. A study of the median values disclosed the Jewish ethnic score of 24.9 centimeters as the largest 50th percentile among the three groups. The Negro subjects held the smallest median measurement with a score of 21.6 centimeters.

The smallest upper arm girth was found at the
10th percentile level within the 10 year old Jewish group with a score of 18.0 centimeters. However, the trend in other percentiles characterized the Negro ethnic with smaller upper girths.

F. **Thigh girth measurement.** -- The Jewish group contained the largest thigh girth measurements with 56.3 centimeters recorded at the 90th percentile, as shown in Table 6, page 110. The median values also revealed a pattern of higher scores attributed to the Jewish ethnic. The Italian and Negro groups followed respectively. The lower decile exhibited the smallest thigh girth among the 10 year old Jewish group. Identical 10th percentiles values of 37.1 centimeters were revealed by the 10 year old Negro and Italian subjects.

It was observed at all age and percentile levels that thigh measurements approximately doubled the corresponding upper arm measurements.

G. **Hip diameter.** -- The widest hip measurements were revealed within the 11½ year old Jewish group with a score of 26.4 centimeters, as shown in Table 6, page 110. The 11½ and 12 year old Jewish boys also scored the largest measurements at the 50th percentile
with a diameter of 23.3 centimeters.

The smallest score was observed within the 10 year old Negro group with a caliper reading of 18.1 centimeters.

3. Inter-relationships of Skinfold Measurements

Five selected sites were measured and ten possible inter-correlations were established. The correlations are presented in table form for each ethnic group and reported on one half year levels. The gathering of these data may serve to help determine the optimum possible skinfold combination in relation to computation of equations for estimating body fat from a single skinfold site in future research.

The inter-relationships between skinfolds measured are rather high with an exceedingly marked correlation of .97 reported between the lateral arm/posterior arm folds. The lowest "r" of .60 was found between the chest/lateral arm fold sites.

Each table has been classified by ethnic group with correlations listed in rank order from high to low values.

**Italian ethnic group.**

**10 year olds.**—It is observed from Table 7, page 116, that the chest/scapula combination for 10 year old Italians rated the highest relationship with an "r"
Table 7. Correlations Between Five Inter-skinfold Measurements of the Italian Ethnic Group

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Table 7. (concluded)

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of .93. The lateral/scapula sites revealed the lowest value of .76. All other combinations ranged from .81 to .92 with the exception of the posterior arm/scapula which earned an "r" of .79.

10\(\frac{1}{2}\) year olds.-- The abdomen/scapula sites scored a very high inter-relationship with an "r" of .95. The lateral arm/scapula set received the lowest rating .87 which is similar in rank order position found among the 10 year olds. All other combinations revealed .90 values or higher figures.

11 year olds.-- High to very high correlations were revealed among the 11 year old Italians as shown in Table 7, page 117. The chest/lateral arm measurements received the highest correlation of this group with a value of .92. The posterior arm/scapula combination held the lowest position with an "r" of .76. Six combinations from the total of ten sets received correlations of .80 to .87.

11\(\frac{1}{2}\) year olds.-- The abdomen/posterior arm folds held the lowest value of .88 and the lateral arm/posterior arm combination occupied the first position as shown in Table 7, page 117. One half of all the combinations scored .90 or higher correlations. The remaining five
pairs ranged from .88 to .89 among the 11\frac{1}{2} year old Italian group.

12 year olds.-- The first four combinations of the 12 year old Italians yielded a similar rank order found within the 11\frac{1}{2} year old Italian group. The lateral arm/posterior arm received an identical high correlation of .95 as compared to the parallel combination among the 11\frac{1}{2} year olds. The posterior arm/scapula sites represented the lowest correlation with an "r" rating of .83. All other combinations revealed high to very high correlations.

Summary of the Italian group skinfold inter-relationships.--

All age units within the Italian group revealed high to very high inter-skinfold correlations. The lateral arm/posterior arm combination consistently registered above .90 values. The arm skinfolds (lateral and posterior), firmly held the tenth ranking position when correlated with other measurement locations. All combinations disclosed a marked relationship between skinfold sites and hence any one measurement could be utilized to estimate total body fat among the investigated Italian group.
Jewish ethnic group.--

10 year olds.-- Table 8, page 121, rated the lateral arm/posterior arm skinfold inter-relationship with a very high .95 correlation. Four combinations scored .91 or higher. The lateral arm/scapula correlation of .81 represented the tenth ranking position in Table 8. The total range of .81 to .95 exhibited a confident degree of correspondence between inter-skinfold combinations within the 10 year old Jewish group.

10 ½ year olds.-- It is observed from Table 8, page 121, that the lateral arm/posterior arm combination held the first "r" position similar to the preceding 10 year old group with a value of .93. The abdomen/lateral arm association ranked tenth with an "r" of .70. Three combinations registered .90 or higher, two at .82, and the remaining lower half between .70 and .78. All correlations revealed a marked degree of relationship between the five skinfolds within the 10 ½ year old Jewish group.

11 year olds.-- The abdomen/chest skinfold pair possessed the first position as shown in Table 8, page 122. The abdomen/scapula combination followed in second place, and the lateral arm/posterior arm registered a
### Table 8. Correlations Between Five Inter-Skinfold Measurements of the Jewish Ethnic Group

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<tr>
<td>Chest-Scapula</td>
<td>.87</td>
</tr>
<tr>
<td>Posterior arm-Scapula</td>
<td>.87</td>
</tr>
<tr>
<td>Abdomen-Posterior</td>
<td>.86</td>
</tr>
<tr>
<td>Lateral arm-Scapula</td>
<td>.84</td>
</tr>
<tr>
<td>Chest-Lateral arm</td>
<td>.83</td>
</tr>
<tr>
<td>Chest-Posterior arm</td>
<td>.83</td>
</tr>
<tr>
<td><strong>11(\frac{1}{2}) yr. olds</strong></td>
<td></td>
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<tr>
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<td>.92</td>
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</tr>
<tr>
<td>Chest-Scapula</td>
<td>.86</td>
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<tr>
<td>Posterior arm-Scapula</td>
<td>.86</td>
</tr>
<tr>
<td>Abdomen-Scapula</td>
<td>.85</td>
</tr>
<tr>
<td>Lateral arm-Scapula</td>
<td>.83</td>
</tr>
<tr>
<td>Abdomen-Posterior arm</td>
<td>.83</td>
</tr>
<tr>
<td>Chest-Posterior arm</td>
<td>.82</td>
</tr>
<tr>
<td>Abdomen-Lateral arm</td>
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<tr>
<td>Chest-Lateral arm</td>
<td>.76</td>
</tr>
<tr>
<td><strong>12 yr. olds</strong></td>
<td></td>
</tr>
<tr>
<td>Abdomen-Chest</td>
<td>.87</td>
</tr>
<tr>
<td>Lateral arm-Posterior arm</td>
<td>.86</td>
</tr>
<tr>
<td>Abdomen-Scapula</td>
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<tr>
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<tr>
<td>Chest-Posterior arm</td>
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<td>Abdomen-Posterior arm</td>
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<tr>
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</tr>
<tr>
<td>Chest-Lateral arm</td>
<td>.76</td>
</tr>
<tr>
<td>Lateral arm-Scapula</td>
<td>.75</td>
</tr>
<tr>
<td>Abdomen-Lateral arm</td>
<td>.72</td>
</tr>
</tbody>
</table>
third rank order "r" of .89. Eight correlations were between .83 and .89. The remaining two scored above .90. The chest/posterior arm skinfolds held the tenth ranking position. Again, as demonstrated in the preceding correlations of two younger levels among the Jewish group, the 11 year olds retained an overall high degree of inter-skinfold relationship ranging from .83 to .92.

11\frac{1}{2} year olds.-- Table 8, page 122, revealed the 11\frac{1}{2} year old abdomen/chest inter-correlation at an identical "r" value of .92 as observed among the 11 year age unit. The lateral arm/posterior arm sites scored a continued high position in rank order with a rating of .90. The chest/lateral arm combination held the tenth position with an "r" of .76. Seven combinations ranged from .80 to .86. A high degree of inter-skinfold correlations was also demonstrated by the 11\frac{1}{2} year old age and Jewish ethnic group.

12 year olds.-- Observation of Table 8, page 122, disclosed an "r" value of .87 for the abdomen/chest skinfold measurements. Similar first rank positions are also observed within the 11 and 11\frac{1}{2} Jewish age units. The lateral arm/posterior arm measurements continued in second position with an .86 value. Five combinations
registered between .80 and .87 with the lower half revealing correlations between .72 and .78.

Summary of the Jewish group skinfold inter-relationships.--

The lateral arm/posterior arm measurements predominantly registered high "r" values as shown in Table 7, pages 116-117. The abdomen/chest combination also placed within the first three ranks with high correlations of .92, .91, .92, .92 and .87. Arm skinfolds correlations, including lateral and posterior sites, consistently ranked tenth in combination with scapula, abdomen, and chest. The correlation range of the Jewish group at all ages investigated, extended from .70 to .93. All sites measured within the Jewish group disclosed a high to very high inter-skinfold relationship at each half year age unit.

Negro ethnic group.--

10 year olds.-- Table 9, page 125, revealed a .91 correlation of the lateral arm/posterior arm sites within the 10 year old Negro group. The nine remaining correlations extended from .60 to .88. The chest/lateral arm sites held the tenth ranking position with a rating of .60.
Table 9. Correlations Between Five Inter-skinfold Measurements of the Negro Ethnic Group

<table>
<thead>
<tr>
<th>Skinfold Combinations</th>
<th>&quot;r&quot;</th>
</tr>
</thead>
</table>

### 10 yr. olds

<table>
<thead>
<tr>
<th>Skinfold Combinations</th>
<th>&quot;r&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral arm-Posterior arm.</td>
<td>.91</td>
</tr>
<tr>
<td>Abdomen-Scapula.</td>
<td>.88</td>
</tr>
<tr>
<td>Abdomen-Chest.</td>
<td>.81</td>
</tr>
<tr>
<td>Posterior arm-Scapula.</td>
<td>.78</td>
</tr>
<tr>
<td>Abdomen-Posterior arm.</td>
<td>.72</td>
</tr>
<tr>
<td>Chest-Scapula.</td>
<td>.72</td>
</tr>
<tr>
<td>Lateral arm-Scapula.</td>
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<tr>
<td>Chest-Posterior arm.</td>
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<tr>
<td>Abdomen-Lateral arm.</td>
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</tr>
<tr>
<td>Chest-Lateral arm.</td>
<td>.60</td>
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</table>

### 10½ yr. olds

<table>
<thead>
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<th>Skinfold Combinations</th>
<th>&quot;r&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral arm-Posterior arm.</td>
<td>.95</td>
</tr>
<tr>
<td>Abdomen-Chest.</td>
<td>.94</td>
</tr>
<tr>
<td>Chest-Posterior arm.</td>
<td>.93</td>
</tr>
<tr>
<td>Abdomen-Posterior arm.</td>
<td>.87</td>
</tr>
<tr>
<td>Chest-Lateral arm.</td>
<td>.87</td>
</tr>
<tr>
<td>Abdomen-Lateral arm.</td>
<td>.82</td>
</tr>
<tr>
<td>Chest-Scapula.</td>
<td>.79</td>
</tr>
<tr>
<td>Posterior arm-Scapula.</td>
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</tr>
<tr>
<td>Lateral arm-Scapula.</td>
<td>.68</td>
</tr>
<tr>
<td>Abdomen-Scapula.</td>
<td>.67</td>
</tr>
</tbody>
</table>

(concluded on next page)
Table 9. (concluded)

<table>
<thead>
<tr>
<th>Skinfold Combinations</th>
<th>&quot;r&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>11 yr. olds</strong></td>
<td></td>
</tr>
<tr>
<td>Abdomen-Chest</td>
<td>.95</td>
</tr>
<tr>
<td>Chest-Scapula</td>
<td>.93</td>
</tr>
<tr>
<td>Lateral arm-Posterior arm</td>
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<tr>
<td>Abdomen-Scapula</td>
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<td>Posterior arm-Scapula</td>
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<td>Chest-Posterior arm</td>
<td>.79</td>
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<tr>
<td>Lateral arm-Scapula</td>
<td>.77</td>
</tr>
<tr>
<td>Abdomen-Posterior arm</td>
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<tr>
<td>Chest-Lateral arm</td>
<td>.73</td>
</tr>
<tr>
<td>Abdomen-Lateral arm</td>
<td>.65</td>
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<td><strong>11 1/2 yr. olds</strong></td>
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<td>Lateral arm-Posterior arm</td>
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</tr>
<tr>
<td>Abdomen-Scapula</td>
<td>.96</td>
</tr>
<tr>
<td>Chest-Lateral arm</td>
<td>.96</td>
</tr>
<tr>
<td>Chest-Posterior arm</td>
<td>.96</td>
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<td>Abdomen-Lateral arm</td>
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<tr>
<td>Posterior arm-Scapula</td>
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<tr>
<td>Lateral arm-Scapula</td>
<td>.93</td>
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<tr>
<td>Abdomen-Chest</td>
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<td>Abdomen-Posterior arm</td>
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<tr>
<td>Chest-Scapula</td>
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<tr>
<td><strong>12 yr. olds</strong></td>
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</tr>
<tr>
<td>Lateral arm-Posterior arm</td>
<td>.95</td>
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<tr>
<td>Abdomen-Posterior arm</td>
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<tr>
<td>Posterior arm-Scapula</td>
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<tr>
<td>Abdomen-Lateral arm</td>
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<tr>
<td>Chest-Posterior arm</td>
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<tr>
<td>Chest-Scapula</td>
<td>.87</td>
</tr>
<tr>
<td>Lateral arm-Scapula</td>
<td>.85</td>
</tr>
<tr>
<td>Abdomen-Scapula</td>
<td>.85</td>
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<tr>
<td>Abdomen-Chest</td>
<td>.85</td>
</tr>
<tr>
<td>Chest-Lateral arm</td>
<td>.83</td>
</tr>
</tbody>
</table>
10½ year olds.-- The lateral arm/posterior arm continued to hold the first position within the 10½ year old Negro group with an "r" of .95. The abdomen/chest combination scored a second rating to the lateral arm/posterior arm sites with a value of .94. Three combinations revealed "r" values between .82 and .87. The chest/scapula and posterior arm/scapula received equivalent values of .79 and the remaining combinations of lateral arm/scapula, abdomen/scapula registered correlations of .68 and .67 respectively.

11 year olds.-- Table 9, page 126, affirms the abdomen/chest measurements in first position with a correlation of .95. The chest/scapula followed with an "r" value of .95. The lateral arm/posterior arm combination dropped to a third rank order for the first time, however a high value of .92 continued to characterize these skinfold sites. The upper half of the skinfold measurements received "r" values of .80 and higher. The lower half of the measured inter-skinfold sites ranged from .65 to .79.

11½ year olds.-- Observation of Table 9, page 126, disclosed a very high range of "r" values. The lateral arm/posterior arm pair yielded a .97 correlation. The
lowest inter-skinfold relationship within the 11½ year old Negro group was found between the chest/scapula sites with an "r" of .91. All combinations revealed compact agreement with each other.

12 year olds.-- It is observed from Table 9, page 126, that the lateral arm/posterior arm measurements ranked first again with a correlation of .95 within the 12 year old Negro group. The abdomen/posterior arm sites measured to second rank order position with a high of .93. The remaining eight combinations ranged between .83 and .88.

Summary of the Negro group skinfold inter-relationships.--

The lateral arm/posterior arm combination measured in first rank position at all age levels with the exception of the 11 year old unit. The correlations within the Negro group ranged from a chest/lateral arm value of .60 to a very high lateral arm/posterior arm score of .95 as observed in Table 9, pages 125-126. The 11 year old unit disclosed a concentrated range of "r" figures and revealed a high degree of inter-skinfold relationship between the measured sites. Substantial to very high values were found at all age levels within the investigated Negro ethnic group.
4. Correlations Between Skinfold, Height, Weight, Chest Girth, Upper Arm Girth and Bi-iliac Diameter

The correlation analyses of anthropometric measurements and body fat provides an insight to the degree of relationship between these two components of physique. Height, weight, chest girth, upper arm girth and bi-iliac diameter were considered relevant components of body build in the present study.

Height and girth structures furnish information allied to stature, whereas skinfold measurements supply quantitative data applicable to subcutaneous and adipose or soft tissue of the body.

Each ethnic group has been analyzed on one half year age levels.

**Italian ethnic group.**

*Skinfolds and height correlations.*--- Table 10, page 130, revealed a low to slight relationship between the abdominal skinfold and height of the 10 year old Italian group. The chest skinfold/height combination yielded the lowest value with a negligible correlation of .18. The lateral arm skinfold disclosed the highest value with a present, but meager "r" of .33.
Table 10. Correlations Between Skinfolds, Height, Chest Girth, Upper Arm Girth and Bi-iliac Diameter of the Italian Ethnic Group

<table>
<thead>
<tr>
<th>Skinfolds and Other Measurements</th>
<th>Ages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 yrs.</td>
</tr>
<tr>
<td>Abdomen(s) a/ - Height</td>
<td>.23</td>
</tr>
<tr>
<td>Chest(s) - Height</td>
<td>.18</td>
</tr>
<tr>
<td>L. b/ Arm(s) - Height</td>
<td>.33</td>
</tr>
<tr>
<td>P. c/ Arm(s) - Height</td>
<td>.31</td>
</tr>
<tr>
<td>Scapula(s) - Height</td>
<td>.20</td>
</tr>
</tbody>
</table>

**Skinfolds and Weight "r's"**

| Abdomen(s) - Weight             | .82     | .90         | .76     | .86         | .78     |
| Chest(s) - Weight               | .75     | .88         | .80     | .84         | .77     |
| L. Arm(s) - Weight              | .81     | .80         | .83     | .88         | .76     |
| P. Arm(s) - Weight              | .81     | .89         | .76     | .85         | .73     |
| Scapula(s) - Weight             | .70     | .92         | .88     | .85         | .79     |

**Skinfolds and Chest Girth "r's"**

| Abdomen(s) - Chest(g) d/        | .85     | .88         | .76     | .84         | .81     |
| Chest(s) - Chest(g)             | .81     | .88         | .80     | .86         | .79     |
| L. Arm(s) - Chest(g)            | .78     | .77         | .79     | .87         | .77     |
| P. Arm(s) - Chest(g)            | .83     | .84         | .72     | .86         | .77     |
| Scapula(s) - Chest(g)           | .77     | .90         | .88     | .87         | .76     |

---

a/Skinfold  
b/Lateral  
c/Posterior  
d/Girth  

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Table 10. (concluded)

<table>
<thead>
<tr>
<th>Skinfolds and Other Measurements</th>
<th>10 yrs.</th>
<th>10½ yrs.</th>
<th>11 yrs.</th>
<th>11½ yrs.</th>
<th>12 yrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdomen(s)-U. Arm(g)</td>
<td>.82</td>
<td>.89</td>
<td>.61</td>
<td>.78</td>
<td>.44</td>
</tr>
<tr>
<td>Chest(s) -U. Arm(g)</td>
<td>.72</td>
<td>.89</td>
<td>.72</td>
<td>.86</td>
<td>.47</td>
</tr>
<tr>
<td>L. Arm(s) -U. Arm(g)</td>
<td>.88</td>
<td>.83</td>
<td>.59</td>
<td>.84</td>
<td>.60</td>
</tr>
<tr>
<td>P. Arm(s) -U. Arm(g)</td>
<td>.86</td>
<td>.89</td>
<td>.60</td>
<td>.84</td>
<td>.52</td>
</tr>
<tr>
<td>Scapula(s)-U. Arm(g)</td>
<td>.72</td>
<td>.90</td>
<td>.62</td>
<td>.77</td>
<td>.48</td>
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<tr>
<td>Abdomen(s)-Bi-iliac D.</td>
<td>.58</td>
<td>.61</td>
<td>.65</td>
<td>.62</td>
<td>.56</td>
</tr>
<tr>
<td>Chest(s) -Bi-iliac D.</td>
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<td>.60</td>
<td>.61</td>
<td>.60</td>
<td>.52</td>
</tr>
<tr>
<td>L. Arm(s) -Bi-iliac D.</td>
<td>.56</td>
<td>.51</td>
<td>.65</td>
<td>.68</td>
<td>.48</td>
</tr>
<tr>
<td>P. Arm(s) -Bi-iliac D.</td>
<td>.57</td>
<td>.54</td>
<td>.60</td>
<td>.62</td>
<td>.46</td>
</tr>
<tr>
<td>Scapula(s)-Bi-iliac D.</td>
<td>.49</td>
<td>.64</td>
<td>.80</td>
<td>.61</td>
<td>.57</td>
</tr>
</tbody>
</table>

\[a/\] Upper

\[b/\] Diameter
Slightly higher correlations were found within the 10½ year age unit. The range of values extended from .43 to .52 and revealed a substantial body fat and height relationship. The chest skinfold/height pair scored an "r" of .52. An identical value of .49 was possessed by the abdominal/height and scapula/height correlations.

Low to substantial relationships were found within the 11 year old unit. The range of "r" values scored from a low .29 to a moderate .42 correlation as shown in Table 10, page 130.

A series of "r" values from small to substantial correlations were disclosed within the 11½ year Italian group. The chest fold/height sites received the lowest rating with .39, and the abdominal fold/height measurements revealed the highest value at this age level with an "r" of .46.

Table 10, page 130, also revealed a small degree of relationship between height and the five skinfold measurements within the 12 year old Italian unit with the exception of the scapula fold/height combination, which yielded a moderate value of .44.

**Skinfolds and weight correlations.**— Table 10, page 130, revealed a marked relationship between
The abdominal fold/weight pair rated a high correlation of .82 with chest fold/weight, lateral arm fold/weight following with equal "r" values of .81. The scapula fold/weight measurement received the lowest value within the 10 year group with an "r" of .70.

Two measurement combinations, abdominal fold/weight and scapula fold/weight received above .90 values within the 10½ year old group. The lateral arm fold/weight set received a .80 with the remaining chest fold/weight and posterior arm fold/weight relationship yielding .88 and .89 correlations respectively.

The coefficient of .88 represented the highest value within the 11 year old group. .76 was assessed to the posterior arm fold/weight pair and characterized the lowest "r" at this ethnic age level. The abdominal fold/weight and posterior arm fold/weight combinations received identical values of .76, and the remaining chest fold/weight set rated a high value of .80. All correlations within this ethnic age unit showed a marked relationship between skinfolds and weight.

The 11½ year old level received high "r" values. The lateral arm fold/weight combination lead this age
unit with a high .88 correlation. All other four combinations received values of .84 and above.

A marked relationship was also observed between all skinfolds and weight relationships within the 12 year old Italian group. The range of .73 to .79 was observed in Table 10, page 130.

Skinfolds and chest girth correlations.-- A high correlation range from .77 to .85 was revealed in Table 10, page 130, within the 10 year old Italian group. The abdominal fold/chest girth disclosed the highest "r" of .85 with the scapula fold/chest combinations holding a .77 value. All other combinations revealed marked relationships between chest girth and the skinfold sites measured.

Similar high correlations were found within the 10½ year group. The scapula fold/chest girth pair disclosed a very high "r" of .90. The lowest value of .77 was observed between the lateral arm fold/chest girth association. The remaining three combinations received values between .84 to .88.

Three skinfold and chest girth combinations ranged from .72 to .76 within the 11 year old unit. The remaining two pairs scored correlations of .79 and .88.
respectively.

All combinations within the 11½ year old bracket scored values above .80. The lateral arm fold/chest girth and scapula fold/chest girth scored an equivalent value of .87. The chest skinfold/chest girth and posterior arm fold/chest girth followed closely with a duplicate value of .86. The lowest value of .84 was revealed between the abdominal/chest girth pair.

Table 10, page 130, revealed four combinations of skinfolds and chest girths with a range of .76 to .79 "r" values. The highest correlation was observed between the abdominal fold/chest girth association with a rating of .81.

Skinfolds and upper arm girth correlations.-- Table 10, page 131, revealed high correlations between skinfolds and arm girths at the 10 year old level. The arm girths scored high values with (1) lateral arm fold, and (2) posterior arm fold, sites registering marked relationships of .88 and .86. The chest and scapula skinfolds revealed equivalent coefficients of .72.

Three sites, abdomen, chest, and posterior arm skinfolds earned triplicate values of .89 within the 10½ Italian unit. The scapula fold/arm girth pair
received the highest value within this ethnic age unit with a correlation of .90.

Moderate correlations were revealed within the 11 year age bracket. .59 was assessed to the lateral arm fold/arm girth which marked the lowest score of the "r" range at the 11 year level. The chest skinfold/arm girth combination yielded the highest correlation within this age unit with an "r" value of .72. The remaining three combinations of arm girth with (1) posterior arm, (2) abdomen, and (3) scapula skinfolds revealed "r" values of .60, .61 and .62 respectively.

A marked relationship was established between skinfolds and arm girths at the 11½ year level. A high of .86 was recorded between the chest fold and arm girth. Equivalent values of .84 were revealed between (1) lateral arm, and (2) posterior arm skinfolds and arm girth. The abdominal fold/arm girth correlation yielded .78. The scapula fold/arm girth relationship disclosed the lowest value within the 11½ year old unit with a coefficient of .77.

Table 10, page 131, revealed moderate correlations between skinfolds and arm girths within the 12 year old Italian unit. The "r" range of .44 to .60 prevailed
throughout this ethnic age level.

**Skinfolds and bi-iliac diameter correlations.**--

Table 10, page 131, revealed moderate correlations ranging from .49 to .58 at the 10 year old level. All skinfold/bi-iliac diameter values scored above .50 with the exception of the scapula fold/hip association which yielded a correlation of .49 at this age level.

The 10½ year level exhibited slightly higher correlations with the scapula fold/hip pair revealing a .64 value. The lowest rating was scored by the lateral arm fold/hip measurements with an "r" of .51.

Four combinations scored .60 values and higher at the 11 year old level. This age bracket contained the highest skinfold/hip diameter "r" within the Italian ethnic group, with a correlation of .80.

The remaining combinations scored "r" values between .60 and .65, and materially associated the measured skinfolds with hip diameter at the 11 year old level.

All skinfold sites and hip diameter correlations scored between .60 and .68 within the 11½ year bracket. Uniform and compact values characterized a moderate degree of relationship and were observed in Table 10, page 131.

Fair correlations predominantly marked the 12 year
old age bracket as shown in Table 10, page 131. The posterior arm fold/hip measurements scored a moderate "$r$" of .46. The hip diameter and scapula skinfold revealed a higher .57 correlation.

**Summary of skinfold, height, weight, chest girth, upper arm girth and bi-iliac diameter correlations of the Italian ethnic group.**

A. **Height.**-- Low to moderate correlations between skinfolds and height measurements were observed at all half year age levels within the Italian group. The highest correlation was found between the chest fold/height pair at the 10\textfrac{1}{2} year level with an "$r$" of .52. Paradoxically, the chest/height measurements received the lowest "$r$" of .18 at the 10 year old level.

B. **Weight.**-- The range of skinfold/weight correlations extended from .70 to a high of .90. The highest coefficients were observed within the 10\textfrac{1}{2} year age bracket with the lowest correlation figures dispersing the 12 year old classification. The 10 and 11\textfrac{1}{2} year age units predominantly supported .80 values and above, between weight and all skinfold sites measured.
C. **Chest girth.**-- Table 10, page 131, disclosed a range of "r" values from .76 assessed to the abdominal fold/chest girth measurements within the 11 year old unit, to .90 registered by the scapula fold/chest girth set within the 10\(\frac{1}{2}\) year bracket. All combinations disclosed marked to high correlations at each of the one half year age levels investigated.

D. **Upper arm girth.**-- A range of .44 to .90 prevailed between the skinfold and arm girth measurements among all age levels. The 12 year old bracket revealed the lowest set of "r" values with moderate correlations of .60 and below. The highest values were observed within the 10\(\frac{1}{2}\) year old group which scored a high "r" of .90 and registered its lowest correlation at .83.

Substantial to high relationships were revealed between skinfolds and arm girths at each level with the exception of the 12 year old group as shown by Table 10, page 131.

E. **Bi-iliac diameter.**-- Moderate relationships between skinfolds and hip diameter saturated all age units within the Italian ethnic group. The 11 year age bracket disclosed the highest series of correlations.
The lowest skinfold/bi-iliac relationship was found within the 12 year old unit which exhibited an "r" of .46 between the posterior arm fold and hip diameter.

Jewish ethnic group.--

Skinfolds and height correlations.-- Table 11, page 141, revealed low correlations between skinfolds and height measurements within the 10 year old Jewish group. Small relationships were established with the highest "r" recorded at a value of .36. The scapula skinfold scored the lowest coefficient of the 10 year olds with a .25 correlation. The remaining four combinations exhibited "r" values between .32 and .35.

A definite, but small degree of skinfold/height correspondence was observed within the 10½ year bracket. .38 marked the highest "r" figure at the 10½ year level. A low .27 value was assessed to the chest skinfold and height pair.

The chest and scapula skinfolds scored equivalent correlations of .38 with height at the 11 year level. The lateral arm and posterior arm folds revealed correlations of .24 and .23 respectively with height. Present, but slight correlations were observed between
Table 11. Correlations Between Skinfolds, Height, Chest Girth, Upper Arm Girth and Bi-iliac Diameter of the Jewish Ethnic Group

<table>
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<tr>
<th>Skinfolds and Other Measurements</th>
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a/Skinfold
b/Lateral
c/Posterior
d/Girth

(concluded on next page)
Table 11. (concluded)

<table>
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<tr>
<th>Skinfolds and Other Measurements</th>
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<td>P. Arm(s) -Bi-iliac D</td>
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<td>Scapula(s)-Bi-iliac D</td>
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</table>

_a/Upper
_b/Diameter
the five skinfold sites measured and height within the 11 year old Jewish classification.

Negligible to slight skinfold/height "r" values were disclosed by Table 11, page 141, relevant to the 11 1/2 year old Jewish group. The correlations ranged from .01 to .17. All "r's" received values of less than .20 with (1) chest fold/height, and (2) posterior arm fold/height exhibiting coefficients less than .10.

Very low or negligible correlations were disclosed in Table 11, page 141, relating to the 12 year old bracket. Three combinations scored less than .10 and the remaining two pairs achieved equal coefficients of .07. The mean "r" value revealed a small relationship of .12 between measured skinfolds and height at the 12 year age level.

**Skinfolds and weight correlations.**—Table 11, page 141, disclosed a marked relationship between skinfolds and weight within the Jewish 10 year old unit. All sites received "r" values of .80 and above with the mean coefficient established at .84. The highest coefficient within the 10 year bracket scored a .86 with the scapula marking an .80 degree of skinfold/height correspondence.

Substantial to high coefficients were observed
within the Jewish 10\(\frac{1}{2}\) year bracket. The scapula fold/weight combination achieved a high of .82 and the abdominal fold/weight pair ranked fifth with an "r" of .77.

Similar correlations were observed at the 11 year level. Three combinations scored .71 with equivalent coefficients of .82 recorded by the abdominal fold/weight and chest fold/weight relationships.

Four correlations disclosed values of .70 to .79 within the Jewish 11\(\frac{1}{2}\) year old group. The remaining scapula fold/weight pair scored a high "r" value of .85.

The 12 year old age unit revealed the lowest coefficients among the Jewish skinfold/weight relationships. The highest correlations of this age unit scored .78 with three combinations extending from .54 to .58.

**Skinfolds and chest girth correlations.**—Table 11, page 141, disclosed a high degree of relationship between skinfolds and chest girth circumference within the 10 year old Jewish group. Five skinfold and chest girth combinations scored "r" coefficients ranging from .81 to .86. The lateral arm fold/chest girth set held the lowest "r" in the 10 year old bracket with an .76 value.

A marked degree of correspondence between skinfolds
and chest girth was also observed at the 10½ year level. A high of .86 was earned by the scapula fold/chest girth pair with (1) lateral arm fold/chest girth, and (2) posterior arm fold/chest girth recording parallel coefficients of .73.

Moderate correlations were observed within the 11 year old Jewish unit. A range of .49 to .66 limited the degree of correspondence between measured skinfold sites and chest girth to a mild association at this half year age level.

Substantial "r" values prevailed between chest girth and skinfolds within the 11½ year old Jewish group. Three combinations extended from .71 to .77. The remaining two pairs, abdominal fold/chest girth and lateral arm fold/chest girth revealed coefficients of .69 and .68 respectively.

Moderate to marked relationships were observed in Table 11, page 141, relevant to the 12 year old Jewish unit. The range of "r's" extended from a substantial .58 to a high correlation of .80.

Skinfolds and upper arm girth correlations.— Moderate to high coefficients within the 10 year old Jewish unit were observed in Table 11, page 142. Two combinations
reflected values above .60. The three remaining skinfold/arm girth pairs extended from .72 to .76. The posterior arm fold/arm girth, and lateral arm fold/arm girth revealed the highest coefficients of .76 and .74, and established a substantial degree of relationship between arm girth and upper arm skinfolds.

Low to moderate coefficient figures were registered within the 10½ year old Jewish group. The lateral arm fold/arm girth set lead the 10½ year old bracket with a moderate correlation value of .43. Four combinations disclosed a moderate range of "r's" extending from .40 to .43. The chest skinfold/arm girth pair scored the lowest combination value of .35 at this Jewish age level.

Moderate correlations were found in the 11 year old bracket as observed in Table 11, page 142. The chest skinfold/arm girth lead this age bracket with a substantial coefficient of .67 followed by the lateral arm fold/arm girth set with a value of .58. The "r's" ranged from .45 to .67.

Table 11, page 142, distinctively characterized the 11½ year old Jewish unit with high skinfold/arm girth correlations. The lateral arm fold and posterior arm fold/arm girth skinfold associations, again scored the
largest coefficients in this age bracket with values of .87 and .90. The smallest "r" was .76, and assessed to the chest skinfold/arm girth combination.

The 12 year old age unit scored substantial "r" values above .60 with two combinations yielding .73 and .76. A marked degree of relationship between arm girth and skinfold sites were uniformly dispersed within the oldest Jewish unit.

**Skinfolds and bi-iliac diameter correlations.** -- Table 11, page 142, revealed moderate coefficients within the 10 year old Jewish group relevant to skinfold and hip width. An "r" of .71 lead the 10 year old unit with three combinations dispersed between .60 and .69. The lateral arm fold/hip diameter pair yielded the lowest value among the 10 year olds with a moderate "r" of .56.

Slightly lower skinfold/bi-iliac "r's" were recorded within the 10½ year old group. A moderate degree of relationship held the coefficient range of .48 to .49.

Similar, but slightly higher values were found within the 11 year old bracket. The chest skinfold/hip width measurement scored the largest "r" in this group with a correlation of .65. The lateral arm fold/bi-iliac relationship registered the smallest coefficient with a
value of .48.

All skinfold/bi-iliac measurement combinations within the 11½ year old Jewish unit ranged from .52 to .57. Coefficient sizes were uniformly dispersed, and provided a moderate overall degree of relationship between skinfolds and hip diameter within this age group.

The smallest Jewish skinfold/hip width coefficients were found within the 12 year old unit. A range of .26 to .60 also characterized the largest dispersion of "r" sizes, within the Jewish group. Present, but slight relationships characterized the skinfold and hip diameter associations at this age level.

Summary of skinfold, height, weight, chest girth, upper arm girth and bi-iliac diameter correlations of the Jewish ethnic group.--

A. Height.-- Low correlations predominantly characterized the skinfold/height relationship at all age levels within the Jewish ethnic group. Almost negligible coefficients were observed within the 12 year old bracket. All other age units registered correlations from very low to mild degrees of correspondence between skinfolds and height variables.

B. Weight.-- A marked relationship was evident between
skinfolds and weight at the five half year age levels within the Jewish group. The 10 year old bracket contained the highest coefficient of .86, and the 12 year old unit supported the lowest "r" value of .54. The 10½, 11 and 11½ year units predominantly contained high correlations ranging from .70 to .85.

C. Chest girth.-- A high degree of relationship was found between skinfolds and chest girth at all age levels investigated within the Jewish ethnic group. The ten year old bracket scored predominantly higher coefficients with four out of five combinations registering above .80. The 11 year old bracket contained the lowest "r" value of .49 and a lower series of coefficients.

D. Upper arm girth.-- The skinfolds and arm girth coefficients ranged from a low .35 to a high .90. Moderate to high coefficients were characteristic of the posterior arm and lateral arm skinfolds associated with arm girth. Marked relationships were found throughout the five half year age brackets with the posterior arm and lateral arm skinfolds revealing the largest coefficients of .90 and .87 respectively.

E. Bi-iliac Diameter.-- Moderate correlations were found
between skinfolds and hip diameter at each age bracket within the Jewish ethnic group. The 10 year old unit revealed the largest set of coefficients, and the oldest or 12 year old bracket scored the smallest correlations. The entire range of all skinfold/bi-iliac diameter coefficients extended from .26 to .69 values as observed in Table 11, page 142.

Negro ethnic group.--

Skinfolds and height correlations.-- It is observed from Table 12, page 151, that negligible or little relationship existed between skinfolds and height within the 10 year old Negro unit. The chest fold/height set scored a negative "r" of -.08. The remaining four combinations ranged from a very low "r" of .16 to .30 at this age level.

Slightly higher coefficients were found within the 10½ year old bracket. Each of the skinfold/height correlations yielded "r's" below .44.

All skinfold/height correlations registered below .10 within the 11 year old Negro group. Negligible relationships existed between each skinfold site and height with a range of coefficients from .01 to .09 as shown in Table 12, page 151.
Table 12. Correlations Between Skinfolds, Height, Chest Girth, Upper Arm Girth and Bi-iliac Diameter of the Negro Ethnic Group

<table>
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<tr>
<th>Skinfolds and Other Measurements</th>
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^a/Skinfold
^b/Lateral
^c/Posterior
^d/Girth

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Table 12. (concluded)

<table>
<thead>
<tr>
<th>Skinfolds and Other Measurements</th>
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| Abdomen(s)-Bi-iliac D. | .47 | .59 | .09 | .64 | .44 |
| Chest(s) -Bi-iliac D.  | .35 | .66 | .09 | .64 | .38 |
| L. Arm(s) -Bi-iliac D.  | .33 | .65 | .16 | .63 | .36 |
| P. Arm(s) -Bi-iliac D.  | .42 | .68 | .21 | .62 | .32 |
| Scapula(s)-Bi-iliac D.  | .52 | .56 | .00 | .65 | .32 |

_a/Upper

_b/Diameter
Very low correlations were also observed within the 11½ year old Negro unit. The largest coefficient was .17.

A small relationship of the five skinfold and height measurements were found with the 12 year old Negro group. A slight but definite "r" of .39 was disclosed as the largest coefficient within this ethnic half year age unit. A low "r" of .25 initiated the beginning limit of the coefficient range which extended to .39.

Skinfolds and weight correlations.-- Table 12, page 151, yielded moderate correlation values between skinfolds and weight within the 10 year old Negro group. The scapula fold/weight combination achieved the largest coefficient with the chest fold/height pair exhibiting the lowest value of .51 within this age unit.

Higher correlations were established within the 10½ year bracket. Three skinfold/weight combinations above .81 with the largest coefficient recorded at a high .89 value. The abdomen fold/weight combination yielded the lowest "r" of .73 within this age unit.

A marked degree of relationship between skinfolds and weight characterized the 11 year old bracket. Substantial coefficient sizes were observed with a range
of .58 to .62. Four skinfold/weight correlations scored .60 and above with the remaining combinations achieving an "r" value of .58.

Three skinfold/weight combinations scored .80 and above within the 11\(\frac{1}{2}\) year old Negro group. The remaining two sets yielded equivalent "r" values of .79. All skinfold sites correlated highly with weight measurements at the 11\(\frac{1}{2}\) year old Negro level.

A substantial relationship between skinfolds and weight within the oldest group of Negro boys was observed in Table 12, page 151. "r" values ranged from .69 to .81, and revealed a marked correspondence between the fat folds and height variables at this age level.

**Skinfolds and chest girth correlations.**— Table 12, page 151, revealed moderate correlations within the 10 year old Negro group relevant to skinfolds and chest girth. The coefficients ranged from .44 to .68 and characterized the 10 year old Negroes with a substantial degree of relationship between these two variables.

High skinfold/chest girth "r" values dispersed the 10\(\frac{1}{2}\) year old Negro unit. Three combinations earned "r's" above .80 with a high coefficient of .89. The smallest coefficient was revealed between the scapula fold/chest
girth measurements with a value of .76.

Moderate skinfold/chest girth \(r\) values were revealed in Table 12, page 151, within the 11 year old unit. The lateral arm fold/chest girth scored the smallest \(r\) of .47, and the abdominal fold/chest yielded the largest coefficient with a substantial .71 value.

High skinfold/chest girth correlations were found within the 11½ year old Negro group. The lowest correlation observed in Table 12, page 151, was .78, and the highest \(r\) registered .82.

The oldest Negro group exhibited a substantial degree of relationship between chest girth and skinfolds. Table 12, page 151, revealed an \(r\) range of .71 to .81 with one combination above .80, and the remaining four sets dispersed between .71 and .74.

Skinfolds and upper arm girth correlations.-- High correlations predominantly scattered the 10 year old Negro skinfold/arm girth relationship. Table 12, page 152, disclosed four combinations with \(r\)'s exceeding .69, and one pair scoring a coefficient of .64.

Higher correlations were evident within the Negro 10½ year level. Table 12 attributes (1) lateral arm fold/arm girth, and (2) posterior arm fold/arm girth
relationships with very high ratings of .91 and .93. The scapula skinfold/arm girth measurements revealed the lowest "r" at this age level with a coefficient of .77.

Substantial relationships were established at the 11 year level between skinfolds and arm girths. Three combinations achieved a marked correspondence with figures of .70 and above. The smallest "r" was found between the scapula fold/arm girth set with a moderate correlation of .64.

Table 12, page 152, exhibited the largest skinfold/arm girth sizes of the Negro ethnic group with four out of five combinations scoring .90 and above. The remaining posterior arm fold/arm girth pair yielded .89, and revealed a very high degree of association between the skinfolds and arm girth measurements at the 11½ year old level.

High skinfold/arm girth correlations were again evident within the 12 year old Negro group. Table 12, page 152, disclosed three combinations with "r's" of .80 and above. The two remaining pairs scored coefficient values of .73 and .78.

Skinfolds and bi-iliac diameter correlations.-- Low to moderate "r" values between skinfolds and hip width
within the 10 year old Negro group were observed in Table 12, page 152. The "r's" ranged from .33 to .52. The lateral arm fold/hip width set possessed the smallest coefficient, and the scapula fold/hip width combination supported the largest correlation value.

Slightly higher skinfold/bi-iliac "r" values within the 10½ year bracket were evident in Table 12, page 152. Three combinations scored "r's" of .65 and above. The lowest coefficient was attached to the scapula fold/hip width set with a moderate "r" of .56.

Very low to negligible correlations were disclosed by the skinfold/bi-iliac coefficients within the 11 year old Negro group. A negligible "r" of .00 characterized the scapula skinfold/hip diameter combination. The largest coefficient within the 11 year old group was exhibited between the posterior arm fold/hip diameter combination with a low "r" of .21.

Moderate skinfold/bi-iliac values were revealed within the 11½ year old bracket. All combinations yielded "r's" from .62 to .65.

Table 12, page 152, revealed low, but present skinfold/bi-iliac correlations within the 12 year Negro unit. Four pairs scored "r's" of .32 to .38. The
largest coefficient was established between the abdominal fold and hip diameter with a moderate "r" value of .44.

Summary of skinfold, height, weight, chest girth, upper arm girth and bi-iliac diameter correlations of the Negro ethnic group.--

A. **Height.**-- Low correlations characterized the skinfold/height relationship at all age levels within the Negro group. One negative coefficient was found within the 10 year old bracket. The 11 year old unit contained the smallest group of coefficients which revealed a negligible degree of correspondence. The largest coefficient was found between the posterior arm fold/height set within the 10\(\frac{1}{2}\) year unit with an "r" of .44. The range of coefficients extended from a positive "r" of .44 to a negative reading of -.08.

B. **Weight.**-- A marked to high degree of relationship was found between the skinfold and weight measurements of all the age levels within the Negro group. The largest coefficients were contained within the 10\(\frac{1}{2}\) year bracket. The values extended from a moderate "r" of .51 to a high of .89.
C. **Chest girth.**—A moderate to marked degree of correspondence between chest girth and skinfolds at all age levels were revealed in Table 12, page 151. The coefficients extended from a moderate .47 to a high .89 value. The 10½ year old group possessed the highest correlations with three measurement combinations above .81. The lowest "r" values were found within the 10 year group.

D. **Upper arm girth.**—High correlations were disclosed in Table 12, page 152, between skinfolds and arm girth measurements at each of the five half year levels. The "r's" ranged from a substantial .64 to a very high .93 coefficient. Very high correlations were evident within the 11½ year age group which supported four combinations with "r's" of .90 and above. The lateral arm and posterior arm skinfolds, again disclosed high correlations with the girth of the arm at all Negro age levels.

E. **Bi-iliac diameter.**—Table 12, page 152, disclosed a correlation range of .00 to .68 between skinfolds and hip diameter measurements. The 11 year old unit contained the lowest "r" values with the largest coefficient scoring .21. The 11½ year level supported
combinations with "r" values ranging from .62 to .65. The 10 1/2 year old bracket followed the 11 1/2 year level with slightly lower correlations.

The youngest (10 year), and oldest (12 year) units scored a small degree of relationship between the skinfolds and hip diameter variables.

5. Correlations Between Total Skinfold Measurements and Wetzel Grid Physique Rating

The Wetzel Grid physique rating method was selected to determine body build or physique of the three ethnic groups studied. The grid determines, through the measurement of height and weight; growth, development, nutritional grade, physical status, age advancement, maturation, basal metabolism, and caloric needs. However, this study is solely directed to the section used to determine physique. Wetzel employs nine principal varieties of physique classified by channels extending from A4 through M to B4. The slender individuals are identified with the extreme linear types beginning with B4. A graduated mathematical scale extending to the obese category of channel A4 is devised. The intermediary channels identify individuals with varying

physiques between A4 and B4.

The height of the subjects employed in this study was determined to the nearest millimeter and plotted on the grid. Weight was recorded to the nearest one quarter pound. Each subject was classified in an allotted channel rating from A4 to B4. The channel classifications were converted to quantitative values from one to nine, with "one" corresponding to channel B4, and 'nine" paralleling A4. These values were correlated with the total sum of the five skinfold measured sites. The coefficient values are shown in Table 13.

Table 13. Correlations Between Total Skinfold Measurements and Wetzel Grid Physique Ratings of Selected Ethnic Groups

<table>
<thead>
<tr>
<th>Age Units (Yrs.)</th>
<th>Total Skinfolds/Wetzel Grid Ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Italian &quot;r&quot;</td>
</tr>
<tr>
<td>10....</td>
<td>.73</td>
</tr>
<tr>
<td>10½...</td>
<td>.77</td>
</tr>
<tr>
<td>11....</td>
<td>.85</td>
</tr>
<tr>
<td>11½...</td>
<td>.80</td>
</tr>
<tr>
<td>12....</td>
<td>.82</td>
</tr>
</tbody>
</table>

Italian ethnic group.-- It is observed from Table 13 that high correlations were evident between total skinfolds and Wetzel Grid physique ratings within all age levels among the Italian group. The coefficients ranged from .73 to .85. The
eleven year old unit achieved the highest "r" value of .85, and the 10 year level exhibited the smallest coefficient of .73. All other age levels were substantially high with the 11½ and 12 year olds scoring .80 and .82.

Jewish ethnic group.-- Table 13, page 161, disclosed slightly higher correlations within each of the Jewish five age units. High "r" values were apparent with a range of coefficients extending from .79 to .85. The highest "r" value was exhibited by the 11 year old unit. The lowest coefficient was contained in the 11½ year group. Four age levels supported coefficients of .82 and above with one age bracket registering .79.

Negro ethnic group.-- It is observed from Table 13, page 161, that the Negro group supported a moderate to high association between total skinfolds and physique. The coefficients ranged from a substantial .69 "r" value to a high .82 mark. The smallest coefficient was found within the 11 year old bracket. The largest "r" was contained in the 12 year old unit.

Summary of total skinfold measurements and Wetzel Grid physique ratings.--

A marked relationship was found between total skinfolds and physique as determined by the Wetzel Grid technique.
The Jewish ethnic group achieved the highest "r" values with four age levels supporting coefficients between .82 and .84.

The Italian group followed with slightly lower coefficient sizes.

The Negro group contained the smallest correlations with two age levels earning .69 and .66. The coefficients, among the three ethnic groups, ranged from .66 to .85 which revealed a substantial to high degree of correspondence between the total sum of the fat folds measured and body build.

6. Comparison of Body Fat, Height and Weight Measurements Between Each Ethnic Group

The analysis of variance procedure was employed to determine the measure of significance relating to the five skinfolds, height and weight variables among the Italian, Jewish and Negro groups. This technique enabled the writer to test a number of samples, apparently drawn from several different populations, in order to determine if they would by chance have come from the same total population.

The computation of the analysis of variance was machined processed by the IBM electronic computer operated by the statistical research office of Boston University.
The F-ratio, defined by the equation \( F = \frac{MS_b}{MS_w} \), was found for each body fat and selected anthropometrical measurement. The procedure of testing the null hypothesis and the degree of significance at the 1 per cent level was established. The required "F" values were determined from Snedecor's table, (Table F) of the sampling distribution of "F," under the proper number of freedoms of the variances involved.

The following analysis is based upon one half year levels for each group and presented in table and summary form.

Skinfold measurements.--

Abdominal skinfolds.-- Table 14, page 165, revealed a significant difference between the abdominal skinfolds among the Italian, Jewish, and Negro groups within the five age units at the 1 per cent level. The tabled value of "F" was disclosed at 3.06 which represented a score lower than the computed F-ration of 8.49 and a consequent rejection of the null hypothesis at the 1 per cent level for

\[ \text{a/ Mean square between groups} \]
\[ \text{b/ Mean square within groups} \]


Table 14. The Means, Standard Deviations, F-Ratios, and Level of Significance for Skinfolds Between Each Ethnic Group

<table>
<thead>
<tr>
<th>Age Units (yrs.)</th>
<th>Abdominal Skinfolds</th>
<th>Chest Skinfolds</th>
<th>Lateral Arm Skinfolds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Italian</td>
<td>Jewish</td>
<td>Negro</td>
</tr>
<tr>
<td></td>
<td>$\bar{X}$</td>
<td>S.D.</td>
<td>$\bar{X}$</td>
</tr>
<tr>
<td>10...</td>
<td>10.03</td>
<td>8.89</td>
<td>10.86</td>
</tr>
<tr>
<td>10½...</td>
<td>8.00</td>
<td>6.87</td>
<td>13.19</td>
</tr>
<tr>
<td>11...</td>
<td>11.98</td>
<td>8.82</td>
<td>14.88</td>
</tr>
<tr>
<td>11½...</td>
<td>12.32</td>
<td>9.98</td>
<td>16.35</td>
</tr>
<tr>
<td>12...</td>
<td>9.93</td>
<td>9.47</td>
<td>14.87</td>
</tr>
<tr>
<td></td>
<td>6.17</td>
<td>4.86</td>
<td>6.32</td>
</tr>
<tr>
<td>10½...</td>
<td>5.20</td>
<td>3.14</td>
<td>7.75</td>
</tr>
<tr>
<td>11...</td>
<td>6.83</td>
<td>3.79</td>
<td>7.92</td>
</tr>
<tr>
<td>11½...</td>
<td>6.78</td>
<td>3.55</td>
<td>8.64</td>
</tr>
<tr>
<td>12...</td>
<td>5.68</td>
<td>3.30</td>
<td>7.23</td>
</tr>
<tr>
<td></td>
<td>11.94</td>
<td>6.48</td>
<td>11.60</td>
</tr>
<tr>
<td>10½...</td>
<td>10.67</td>
<td>4.86</td>
<td>13.43</td>
</tr>
<tr>
<td>11...</td>
<td>11.85</td>
<td>5.52</td>
<td>14.54</td>
</tr>
<tr>
<td>11½...</td>
<td>12.61</td>
<td>5.23</td>
<td>15.62</td>
</tr>
<tr>
<td>12...</td>
<td>11.19</td>
<td>5.71</td>
<td>13.31</td>
</tr>
</tbody>
</table>

<sup>a</sup>/Significant

<sup>b</sup>/Non-Significant

(concluded on next page)
Table 14. (concluded)

<table>
<thead>
<tr>
<th>Age Units (yrs.)</th>
<th>Posterior Arm Skinfolds</th>
<th>Scapula Skinfold</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Italian</td>
<td>Jewish</td>
</tr>
<tr>
<td></td>
<td>$\bar{X}$</td>
<td>S.D.</td>
</tr>
<tr>
<td>10....</td>
<td>11.13</td>
<td>4.41</td>
</tr>
<tr>
<td>10 $\frac{1}{2}$....</td>
<td>9.91</td>
<td>3.68</td>
</tr>
<tr>
<td>11....</td>
<td>11.76</td>
<td>4.45</td>
</tr>
<tr>
<td>11 $\frac{1}{2}$....</td>
<td>12.66</td>
<td>4.41</td>
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<tr>
<td>12....</td>
<td>11.19</td>
<td>4.06</td>
</tr>
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<td></td>
</tr>
</tbody>
</table>
the 10 year old ethnic groups. Similarly larger F-ratios were observed in Table 14, page 165, as compared with Snedecor's tabled values, and a resultant rejection of the null hypothesis at each age level.

It is also observed from Table 14, page 165, that the abdominal fold means are considerably larger than the Italian and Jewish averages. The larger standard deviation indicated a greater degree of dispersion within the Jewish group. A lower series of deviations from the means were evident within the Negro group. The percentile norms paralleled the findings of the mean comparisons which rates the Jewish group with the largest mean abdominal skinfold measurements.

The smallest abdominal means were observed within the Negro group which also concurs with the percentile analysis in rating this ethnic group with the lowest abdominal mean skinfolds.

The largest mean abdominal fold was observed among the 11 1/2 year old Jewish group with a measurement of 16.35 millimeters and a F-ratio of 9.80. The smallest mean abdominal skinfold was found within the 10 year old Negro group.

The mean skinfold values shown in Table 14, page 165,
disclosed a consistent pattern of large to small abdominal skinfolds in rank order of; (1) Jewish, (2) Italian, and (3) Negro ethnic groups.

Chest skinfolds.-- Table 14, page 165, revealed significant degrees of difference between the measured chest skinfolds of the three ethnic groups, and a rejection of the null hypothesis for each of the five age levels studied. The largest F-ratio was found at the 11\frac{1}{2} year old age unit which also produced considerable variations in the mean measurements of the three groups. The 11\frac{1}{2} year old Jewish group also disclosed the largest mean chest skinfold. The smallest mean chest fold was found within the 10 year old Negro group. An analysis of the standard deviations of the three groups revealed a greater degree of dispersion within the Jewish group. The smallest measure of dispersion was found within the Negro group. The mean values of the chest skinfolds paralleled those of the percentile norms, and indicated a similar abdominal measurement trend of scoring the Jewish, Italian, and Negro ethnic from largest to smallest chest skinfolds respectively.

Lateral arm skinfolds.-- It is observed from Table 14, page 165, that significant differences among the lateral arm skinfold measurements were found at
every half year age bracket except the 10\(\frac{1}{2}\) year old unit.

Similar means of 10.67 and 10.09 millimeters among the Italian and Negro groups resulted in a lower F-ratio than the tabled value needed for the rejection of the null hypothesis at the 10\(\frac{1}{2}\) year age bracket. The Jewish group disclosed slightly larger means than the Italians with the exception of the 10 year old unit. The largest mean fold was observed within the 11\(\frac{1}{2}\) year old Jewish group. The smallest mean skinfold was registered by the 10 year old Negro classification. Both Jewish and Negro elements disclosed larger standard deviations, and therefore, a greater degree of distribution dispersion.

Table 14, page 165, disclosed the largest mean scores for the Jewish ethnic followed by the Italian and Negro groups respectively. The Italian subjects received a score of 11.94 or .3 of a millimeter larger figure than the equivalent Jewish age level. The trend continued to rank the Jewish boys with the largest mean lateral arm skinfold measurements.

**Posterior arm skinfolds.**—Table 14, page 166, revealed significant differences between the posterior arm skinfolds among the three ethnic groups throughout
the five age units at the 1 per cent level. The Jewish
element continued to hold the largest mean skinfolds,
and registered the highest mean score of 14.62 millimeters
at the 11\(\frac{1}{2}\) year old bracket. The Italian ethnic group
followed the Jewish classification with slightly lower
mean scores. The Negro group scored lower mean values
at each age level with the exception of the 10\(\frac{1}{2}\) year old
unit, which registered 10.25 millimeters or .3 of a
millimeter larger than the equivalent Italian age level.
Smaller distribution dispersions were observed with the
Negro group. Slightly larger standard deviations were
evident within the Jewish and Italian groups. The
skinfold trend of largest to smallest measurements
continued to hold in rank order; (1) Jewish, (2) Italian,
and (3) Negro groups respectively with significant
differences observed in Table 14, page 166.

Scapula skinfolds.-- Table 14, page 166, revealed
significant differences between the scapula skinfolds
at the 11 and 11\(\frac{1}{2}\) year old age levels, however non-sig-
nificant F-ratios were recorded at the 10, 10\(\frac{1}{2}\) and 12
year age units. An analysis of the mean scores registered
at the non-significant levels revealed close mean values,
and a resultant lower to F-ratio. The largest mean
difference between the Jewish and Negro group was 1.7 millimeters. Smaller differences were observed at the 10 and 12 year old age levels.

The Jewish group continued to exhibit the largest mean among the three ethnic groups at all age brackets. The largest mean scapula skinfold was observed within the 11 1/2 year old Jewish group, and the smallest fold was contained within the 10 year old Negro element with a score of 5.3 millimeters. The Negro group continued to exhibit smaller standard deviations. The Italian and Jewish ethnic groups possessed a greater degree of distribution dispersion with larger standard deviations at each of the five age levels.

Height and weight measurements.--

Height.-- Table 15, page 172, revealed non-significant degrees of differences and acceptance of the null hypothesis, that the five samples would have, by chance, come from the same total population. There is some question in the relationship of height measurements between the three ethnic groups. Slight variations of mean scores were observed at each level with slightly larger means exhibited by the Jewish group, followed by the Negro and Italian elements respectively. However,
Table 15. The Means, Standard Deviations, F-Ratios, and Level of Significance of Height and Weight for Each Ethnic Group

<table>
<thead>
<tr>
<th>Age Units (yrs.)</th>
<th>Height Measurements</th>
<th>Weight Measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Italian</td>
<td>Jewish</td>
</tr>
<tr>
<td></td>
<td>$\bar{X}$</td>
<td>S.D.</td>
</tr>
<tr>
<td>10...</td>
<td>136.34</td>
<td>6.21</td>
</tr>
<tr>
<td>10½...</td>
<td>139.66</td>
<td>5.88</td>
</tr>
<tr>
<td>11...</td>
<td>144.09</td>
<td>6.44</td>
</tr>
<tr>
<td>11½...</td>
<td>144.72</td>
<td>6.15</td>
</tr>
<tr>
<td>12...</td>
<td>148.21</td>
<td>7.46</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10...</td>
<td>77.17</td>
</tr>
<tr>
<td></td>
<td>10½...</td>
<td>78.67</td>
</tr>
<tr>
<td></td>
<td>11...</td>
<td>88.41</td>
</tr>
<tr>
<td></td>
<td>11½...</td>
<td>90.56</td>
</tr>
<tr>
<td></td>
<td>12...</td>
<td>92.67</td>
</tr>
</tbody>
</table>

$^a$/Non-Significant

$^b$/Significant
strict adherence to this rank order was not evident by the analysis of each group mean. The 11 year old Italian group scored a slightly higher value over the Negro group. Slightly higher mean values relative to the Italian group above the Negro ethnic were also observed at the 11½ and 12 year old levels. However, these differences represented .3 of a millimeter and less.

Weight.-- The 10, 10½, and 12 year old age groups disclosed non-significant differences in weight between the three ethnic groups as shown in Table 15, page 172. Significant differences at the 1 per cent level were observed within the 11 and 11½ year old units. The age units which revealed significant differences disclosed the heaviest weights within the Jewish and Italian classifications followed by the lighter Negro group. The mean scores of the 11 and 11½ year old group corresponded with the percentile norms which classified the Jewish as the heaviest ethnic followed by the Italians and Negroes at this age level. Although larger mean scores were disclosed by the Jewish group with the exception of the 10 year old bracket, the higher values were not great enough to attain the F-ratio necessary at the 1 per cent level to effect the rejection of the null hypothesis, and a
Summary

Summary of body fat, height and weight measurements between each ethnic group -- 10½ and 12 year old age brackets.

Skinfold measurements -- A summary analysis of the skinfold variances disclosed significant differences of the abdominal, chest and posterior measurements among the three ethnic groups at each of the five half year age levels. A rejection of the null hypothesis was concluded, and the selected skinfold differences between these three groups cannot reasonably be accounted for by chance at the 1 per cent level. Significant differences were observed at each age bracket of the lateral arm site except the 10½ year old level. Non-significant degrees of significance were observed at three age levels, 10, 10½ and 12 relative to the scapula skinfold. Inspection of the non-significant F-ratio figures revealed a considerable compactness of means, and a resultant F value which supported the hypothesis that the parameter (difference of the means) is zero. The measurements}
Italian groups.

Height and weight measurements.-- Non-significant degrees of significance were observed at all age brackets in the height measurements. Analysis of the age level means disclosed small variations between each group. Again, the resultant statistics may be partially explained by the limited number of samples, and the effect of extreme scores on the mean. However, the percentile norms revealed the tallest subjects among the Jewish and Negro groups. Observation of the raw data clearly showed several extremely tall and short subjects among each of the ethnic classifications. These extreme scores may well have effected the resultant non-significant F-ratios in height measurements.

Significant degrees of difference between group means were observed in the weight measurements at the 11 and 11½ year old age bracket. Lower F-ratios, and the resultant acceptance of the null hypothesis that the weight of the three ethnic groups might equally well have come from the same population were found at the 10, 10½ and 12 year age levels. Extreme weight scores were observed in securing the actual data among the Negroes and Jewish groups. This factor, in addition to the
limited samples, may partially explain the resultant lower F-ratios.

7. Comparison of Percentile Norms With Other Height and Weight Studies

The final analytical phase of this study is a comparison of the present height and weight percentiles with other similar studies in child growth research. The writer has selected three of the better known studies in the current literature for comparison with the present height and weight data. The data is presented in table form and analyzed on the basis of ten, eleven and twelve year levels.

Stuart-Meredith tables - 1946. -- These data, collected between 1940-1945, were based on 3,771 measurements of several hundred Iowa City children of northwest European ancestry. Boys were measured in light socks and shorts. Charts based on these data for boys and girls, aged five through eighteen, were published in 1946.

Height. -- Table 16, page 177, revealed greater height values within the Stuart-Meredith tables as compared with the present ethnic groups at the 10 year old level. An analysis of the 10 year old medians disclosed a range of 3.7 centimeters from the tallest,

1/Milicent L. Hathaway, op. cit., p. 78.
Table 16. Comparison of Stuart-Meredith and Selected Ethnic Percentile Norms for Height and Weight

<table>
<thead>
<tr>
<th>Percentiles</th>
<th>Stuart-Meredith</th>
<th>Italian</th>
<th>Jewish</th>
<th>Negro</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Height-Weight</td>
<td>Height-Weight</td>
<td>Height-Weight</td>
<td>Height-Weight</td>
</tr>
<tr>
<td>10 yr. olds</td>
<td>10</td>
<td>132.8</td>
<td>61.1</td>
<td>127.4</td>
</tr>
<tr>
<td></td>
<td>25</td>
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<td>90</td>
<td>151.8</td>
<td>99.3</td>
<td>153.3</td>
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<td>12 yr. olds</td>
<td>10</td>
<td>142.4</td>
<td>72.0</td>
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<td>96.0</td>
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<td>90</td>
<td>157.9</td>
<td>109.6</td>
<td>158.9</td>
</tr>
</tbody>
</table>

10 yr. olds: Height and Weight Stanine norms for Italian, Jewish, and Negro boys ages 10-12 years, compared with norms for Italian boys from the Stuart-Meredith Growth Study.
(Stuart-Meredith) subjects to the shortest, (Italian) individuals. A similar trend was observed at the lower and upper percentiles of this age level.

The 11 year old unit disclosed a smaller range of height scores at each percentile level. The Jewish group contained the tallest subjects at the median level. The Stuart-Meredith data supported slightly lower scores below the Jewish group at the median and lower percentiles. The Negro and Italian ethnics followed the height scores of the Jewish and Stuart-Meredith norms with the exception of the 90th percentile. The Stuart-Meredith height of 151.8 centimeters earned the lowest height mark at this upper percentile.

The median scores within the 12 year unit disclosed the Stuart-Meredith group as the tallest subjects by .1 of a centimeter above the Jewish ethnic. The Negro and Italian groups followed in respective order at the 50th percentile. The upper or 90th percentile disclosed taller height values for the Italian ethnic followed by the Stuart-Meredith, Jewish and Negro groups respectively. The lower 10th percentile rated the Jewish group as the tallest at this level, with a height score of 143.2 centimeters. The Stuart-Meredith data followed closely.
with 142.4 or less than one centimeter. The 12 year old Italian boys were the shortest individuals at the 10th percentile with a height score of 137.7 centimeters.

Considerable variability in height was observed at the 12 year old level among the four groups studied. Each group attained a leading height score in each of the computed percentile levels. Although variability was evident, the Jewish and Stuart-Meredith subjects consistently exhibited higher values throughout Table 16, page 177. The Italian group predominantly scored the lower height measurements among the investigated groups.

Weight.-- An analysis of the medians at the 10 year old level revealed the Italian and Jewish groups as heavier than those subjects reported in the Stuart-Meredith tables at this level.

Similar findings were observed at the 90th percentile. The Italians and Jewish groups scored up to 8.6 pounds more than the Stuart-Meredith subjects at this age and percentile level. The lower 10th percentile positioned the Stuart-Meredith group with the highest score of 61.1 pounds, followed by the Negro, Italian and Jewish ethnics respectively.

Weight variations were observed among the 11 year old
subjects at each of the selected percentiles. The Jewish and Italian boys scored the heaviest weights at the median level. The Stuart-Meredith group contained the lightest individuals at the 50th percentile. A similar weight trend was observed at the 90th percentile with the Italians registering the largest score followed by the Jewish group. All ethnics exceeded the Stuart-Meredith scores at the 11 year 90th percentile.

The lower or 10th percentile of the 11 year olds revealed the Stuart-Meredith group as the heaviest among the four groups. A concentrated range of scores was evident at the 10th percentile with a difference of 3.9 pounds from heaviest to the lightest weights.

The 12 year old Jewish and Italian ethnics predominantly weighed more than the equivalent Stuart-Meredith age level. The median and upper percentiles revealed heavier values for all the subjects currently measured as compared with the older Stuart-Meredith tables. Inspection of the three age levels at each of the percentile levels revealed a trend of heavier subjects among the Jewish and Italian boys, particularly at the upper percentiles. The Stuart-Meredith tables exhibited their heaviest weights at the lower or 10th percentile level.
Boyd tables - 1952. — The data represented in the Boyd tables represented nearly 1,200 measurements of the height and weight of children aged two to eighteen. These data were compiled by Edith Boyd and comprised of Denver Child Research Council boys and girls. They were published and intended for use by first year medical students.

**Height.** — It is observed from Table 17, page 182, that the 10 year old subjects in the Boyd tables were generally taller than the equivalent age bracket of the Negro and Italian groups. However, the Jewish ethnic scored a slightly higher median than the Boyd data. The 90th percentile among the 10 year olds revealed identical values for the Boyd and Jewish groups with a lead score of 144.8 centimeters.

The 11 year old Jewish classification consistently yielded taller measurements at each percentile. The Boyd data directly followed the Jewish ethnic at the 10th and 50th percentiles with less than .1 of a centimeter lower score. An analysis of the 90th percentile among the 11 year olds identified the subjects of the Boyd tables with the shortest height measurements. This change in height was noted in London and described by Milicent L. Hathaway, *op. cit.*, p. 78.
Table 17. Comparison of Boyd and Selected Ethnic Percentile Norms for Height and Weight

<table>
<thead>
<tr>
<th>Percentiles</th>
<th>Boyd</th>
<th>Italian</th>
<th>Jewish</th>
<th>Negro</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Height-Weight</td>
<td>Height-Weight</td>
<td>Height-Weight</td>
<td>Height-Weight</td>
</tr>
<tr>
<td>10 yr. olds</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10...........</td>
<td>133.4</td>
<td>60.4</td>
<td>127.4</td>
<td>60.5</td>
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<td>25...........</td>
<td>136.4</td>
<td>64.8</td>
<td>131.7</td>
<td>66.3</td>
</tr>
<tr>
<td>50...........</td>
<td>139.4</td>
<td>71.4</td>
<td>136.6</td>
<td>75.5</td>
</tr>
<tr>
<td>75...........</td>
<td>142.4</td>
<td>78.0</td>
<td>140.5</td>
<td>85.8</td>
</tr>
<tr>
<td>90...........</td>
<td>144.8</td>
<td>84.2</td>
<td>143.9</td>
<td>98.5</td>
</tr>
<tr>
<td>11 yr. olds</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10...........</td>
<td>137.9</td>
<td>65.7</td>
<td>135.8</td>
<td>66.3</td>
</tr>
<tr>
<td>25...........</td>
<td>140.8</td>
<td>71.2</td>
<td>139.5</td>
<td>75.0</td>
</tr>
<tr>
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<td>144.0</td>
<td>78.9</td>
<td>143.7</td>
<td>87.3</td>
</tr>
<tr>
<td>75...........</td>
<td>147.8</td>
<td>86.4</td>
<td>148.7</td>
<td>99.5</td>
</tr>
<tr>
<td>90...........</td>
<td>150.1</td>
<td>93.5</td>
<td>153.3</td>
<td>112.5</td>
</tr>
<tr>
<td>12 yr. olds</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10...........</td>
<td>142.2</td>
<td>71.0</td>
<td>137.7</td>
<td>69.6</td>
</tr>
<tr>
<td>25...........</td>
<td>145.1</td>
<td>77.8</td>
<td>143.9</td>
<td>79.3</td>
</tr>
<tr>
<td>50...........</td>
<td>149.0</td>
<td>86.0</td>
<td>146.9</td>
<td>89.1</td>
</tr>
<tr>
<td>75...........</td>
<td>153.2</td>
<td>94.8</td>
<td>152.6</td>
<td>107.0</td>
</tr>
<tr>
<td>90...........</td>
<td>156.1</td>
<td>102.7</td>
<td>158.9</td>
<td>125.8</td>
</tr>
</tbody>
</table>
position was evident only at the upper percentile of the 11 and 12 year old age units.

A similar height trend was observed at the 12 year age bracket. The Jewish group achieved the tallest measurements at each selected percentile level. The Boyd group followed a close second with less than .1 of a centimeter difference between the medians of the two groups. The upper or 90th percentile placed the Boyd group below the Jewish and Italian ethnics with a score of 156.1 centimeters.

The Boyd data generally exhibited a trend of greater height values as compared with the Negro and Italian subjects among the three age levels. The Jewish group disclosed the tallest measurements of the 10th, 50th and 90th percentiles with the exception of the 10th percentile among the 10 year olds.

Weight.-- The Jewish and Italian groups leaned toward the heaviest weights as compared to the Boyd and Negro data within the 10 year old age bracket.

The Italian and Jewish groups dominated the largest scores at the 10th, 50th and 90th percentiles within the 11 year old unit. The Boyd group scored 8.8 pounds less than the heaviest Jewish weight at the median level.
An analysis of the 12 year old unit placed the Jewish group with the heaviest weights, and the Boyd data with the lowest or lightest scores at the 50th and 90th percentile levels. The Boyd group, (12 year olds) followed the Jewish group at the 10th percentile. Table 17, page 182, further characterized the 12 year old Jewish and Italian groups with predominantly larger percentile values throughout the three age brackets.

Canadian Height and Weight Study -1953. -- The Canadian tables represent a stratified sample of the entire Canadian population (15 million), and directed by L. B. Pett, Chief of Nutrition Division, Department of National Welfare, Canada. The field work was done by nutritionists and nurses of the Nutrition Division, Department of National Welfare. The measuring equipment included a spring-like scale with a telescopic measuring rod for height. The subjects were weighed with indoor clothing, except shoes. The Pett percentile values were recorded on the 25th, 50th and 75th levels only, therefore, comparable levels were used in making score comparisons between the Pett tables and the present study.

The weight measurements were recomputed from kilograms to pounds.

**Height.**—The Pett data yielded the lowest height measurements at each of the percentile levels among the four groups studied, as shown in Table 18, page 186. The 10 year old Canadian group median scored 4.0 centimeters below the tallest Jewish classification. Similar comparisons were observed within the 11 and 12 year old brackets.

An identical range was recorded at the 12 year old level with a difference of 4.2 centimeters between the tallest (Jewish) and the shortest (Pett) 50th percentile scores.

**Weight.**—The weight measurements revealed the Pett subjects as the lightest of the four groups studied. The Canadian data consistently scored lower weight values than the Jewish, Italian and Negro groups with the exception of the 75th percentile of the 10 year old Negro ethnic.

The largest median range was observed at the 12 year old level with 18.1 pounds difference between the heaviest, (Jewish) and the lightest, (Pett) subjects.

Similar weight differences of 18 to 21 pounds were also observed between the tallest 11 year old Jewish and
Table 18. Comparison of Pett Canadian Study and Selected Ethnic Percentile Norms for Height and Weight

<table>
<thead>
<tr>
<th>Percentiles</th>
<th>Pett Height-Weight</th>
<th>Italian Height-Weight</th>
<th>Jewish Height-Weight</th>
<th>Negro Height-Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 yr. olds</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25...........</td>
<td>130.8</td>
<td>61.2</td>
<td>131.7</td>
<td>66.3</td>
</tr>
<tr>
<td>50...........</td>
<td>135.4</td>
<td>67.8</td>
<td>136.6</td>
<td>75.5</td>
</tr>
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<td>75...........</td>
<td>140.5</td>
<td>75.9</td>
<td>140.5</td>
<td>85.8</td>
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<tr>
<td>11 yr. olds</td>
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</tr>
<tr>
<td>25...........</td>
<td>135.4</td>
<td>67.3</td>
<td>139.5</td>
<td>75.0</td>
</tr>
<tr>
<td>50...........</td>
<td>140.5</td>
<td>74.6</td>
<td>143.7</td>
<td>87.3</td>
</tr>
<tr>
<td>75...........</td>
<td>145.8</td>
<td>83.6</td>
<td>148.7</td>
<td>99.5</td>
</tr>
<tr>
<td>12 yr. olds</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>25...........</td>
<td>140.2</td>
<td>73.2</td>
<td>143.9</td>
<td>79.3</td>
</tr>
<tr>
<td>50...........</td>
<td>145.3</td>
<td>81.4</td>
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<td>89.1</td>
</tr>
<tr>
<td>75...........</td>
<td>150.9</td>
<td>92.4</td>
<td>152.6</td>
<td>107.0</td>
</tr>
</tbody>
</table>
Pett groups at the 75th percentile levels.

The subjects of the present study were both taller and heavier than those of the Canadian study. The lower scores of the Canadians, may in part, be due to variances in measuring procedures. The Pett study was conducted on a nationwide basis by different examiners and utilized a spring-type scale in contrast to the spring-less, balance beam type employed in the present study.
CHAPTER V

SUMMARY AND CONCLUSIONS

This study employs the latest and newest Harpenden skinfold caliper to determine the subcutaneous body fat of American preadolescent school children. This investigation also presents an ethnic approach to body fat measurement in the selection of three group classifications namely; Italian, Jewish and Negro male subjects. An attempt was also made to select individuals of similar socio-economic levels by the measurement of children in known middle to low socio-economic neighborhoods within the Boston and surrounding area.

This chapter summarizes the research including the percentile norms established from compiling skinfold and other anthropometrical data on 647 boys, (ages 10, 11 and 12 years) based upon the one half year units to the nearest birthday.

Correlations between five inter-skinfold measurements were established. Correlations between skinfolds, height, weight, chest girth, upper arm girth and bi-iliac diameter were also made to secure "r" values between body fat and
components of body build. Correlation values were also established between total skinfold measurements and the Wetzel Grid technique of appraising physique.

The statistical procedure in the analysis of variance was employed to determine the significant difference, (if any) among group means between each ethnic group relative to height, weight and body fat measurements. The final analytical phase of this study involved a comparison of the present percentile norms with other selected height and weight tables.

The discussion also presents conclusions concerning the analysis of the data, a statement in the limitations of the research, and suggestions for further study.

1. Summary of the Study

Percentile norms.--

Skinfold measurements.-- Five percentile levels at each half year age bracket for the Italian, Jewish and Negro groups were established. This technique made it possible to place each of the subjects in the proper percentile rank for his particular body measurements and age to the nearest one half year level.

The percentile tables revealed the Jewish group as predominantly heavier, and in possession of the largest
skinfold measurements of the three groups studied. The abdominal skinfold site yielded the largest measurement at the 90th percentile of the Jewish and Italian groups. The posterior arm skinfold revealed the largest fold within the Negro ethnic classification.

The skinfold pattern followed a trend of higher abdominal values with increase in body fat. Lower scores at the abdomen were observed in the measurement of the leaner subjects. This tendency was evident in measuring the heavier Jewish and Italian groups as contrasted with the more slender Negro subjects.

The lowest skinfold measurements were registered at the chest site among all groups. The Negro ethnic contained the smallest chest fold with a score of 2.2 millimeters.

Skinfold measurements generally increased in size from ages 10 to $11\frac{1}{2}$ among the Italian and Negro groups, however reduced fold thicknesses were observed at all sites from the $11\frac{1}{2}$ to 12 year age brackets. Although median weight values continued to increase, body fat diminished between $11\frac{1}{2}$ and 12th year units. The Negro group displayed their highest median fat folds within
the 10½ year bracket.

A decrease in folds of all sites at the 11th year level was observed. Gradual increases occurred within the 11½ and 12 year old Negro group, however, the 12 year olds did not attain the larger scores which characterized the younger 10½ year unit. The onset of pubescence, and spurt of growth may partially explain the increased weight with the correspondent skinfold decreases of the 12 year old Jewish and Italian groups.

Other anthropometrical measurements. -- The median height measurements disclosed the Jewish as the tallest group with a score of 149.5, and the Italian ethnic as the shortest with a score of 146.9 at the 12 year old level. A similar pattern was observed at the 10 year old level, however, the Negro ethnic registered the highest median at age 10½ years. The Jewish classification held the largest score at 11 years, and the Italian ethnic contained the largest median measurement of 144.5 at the 11½ year age bracket. Each of the ethnic groups measured contained lead height scores in at least one age bracket, however a study of the 10th, 25th, 75th and 90th percentiles confirmed the predominance of tallness
among the Jewish group as compared with the Negroes and Italian subjects.

The median weight values clearly identified the Jewish group as the heaviest ethnic group at each age level with the exception of the 10 year old bracket. The Italian subjects disclosed an increase of .4 pound over the Jewish subjects at the 10 year old level.

The Negro group consistently registered the lowest median weight scores of the three ethnic categories. A similar trend was observed at each percentile with the exception of the 10th percentile. The 10 year old Negro subjects possessed the largest score of 61.0 pounds, followed by the Italian and Jewish groups respectively. This reversal in weight position, at the lower percentiles, may be partially explained by the several extremely heavy Italian and Negro subjects measured in the sample data.

The Jewish subjects were followed by the Italian and Negro groups with the largest chest girths at all age levels at each selected percentile, except the 10th decile. A difference of 1.7 millimeters was recorded between the highest score, (Italian) and the lowest,
(Jewish) at this percentile. Again, the reversal in trend of chest girth size is probably due to the several extreme cases measured among the Negro and Italian groups.

The Italian and Jewish groups contained the largest upper arm girths. The Italian subjects yielded the largest upper arm measurement with a girth of 29.9 centimeters. The Negro subjects contained the smallest upper arm girths with 18.0 centimeters recorded within the 10 year old unit. The Jewish and Italian groups disclosed larger girths as compared with the Negro group. A proportion of approximately two to one, or double the upper arm measurement was consistently found among the thigh girths of the three ethnic groups at all age brackets.

The largest hip widths were found within the 12 year old Jewish and Italian groups with an identical bi-iliac diameter of 25.7 centimeters. The Jewish boys contained the widest measurement at the median level followed by the Italian and Negro groups. The smallest measurement of 18.1 centimeters was exhibited by the Negro group.
Inter-skinfold correlations.-- All subcutaneous fat thicknesses measured at each skinfold site were significantly inter-correlated with "r" values ranging from .60 to .97 among the three ethnic groups. The Italian ethnic contained the highest inter-correlations with a range of .76 to .93. The lowest coefficient was scored within the Negro group with an "r" of .60 recorded at the 10 year old level. The lateral arm/posterior arm inter-correlation yielded the highest "r" value within the 11½ Negro group with a score of .97. The Negro group also contained the greatest range of "r" values extending from .60 to .97.

Less variability was shown within the Italian group which contained higher inter-correlations than the Negro and Jewish groups. Fat measurement inter-correlation generally exhibited marked to extremely high "r" values which indicated that any one or more of the sites measured in the present study may be used to establish regression equations for predicting body fat from skinfolds.

Skinfold body build relationships.--

Height.-- Low correlations were found between height
and skinfolds among the three ethnic groups within the five one half year age brackets. The Italian subjects scored the highest \( r \) values followed by the Jewish group. The Negro classification recorded the lowest mean \( r \) value of .21. A negative relationship was observed between the 10 year Negro chest skinfold/height with a -.08 value. The highest \( r \) value was established between chest skinfold and weight within the 10\( \frac{1}{2} \) year old Italian group. Predominantly low correlations disclosed a small degree of relationship between the five measured fat fold sites and height.

**Weight.**-- A marked to high series of \( r \) values were found between skinfolds and weight among the three ethnic groups. The Italian group contained values predominantly .80 and above. The Jewish group contained slightly lower values, and the Negro element possessed the lowest aggregate of skinfold/weight correlations.

The Italian and Jewish groups appeared to have the highest degree of relationships at the younger age brackets (10, 10\( \frac{1}{2} \)) with a decrease in fat/weight association toward the 11\( \frac{1}{2} \) and 12 year age units. Dissimilar patterns of fat distribution were evident
within the Negro element. The Negro classification displayed an "r" range of .51 to .89 with four sites above .80 at the 11½ and 12 year brackets.

**Chest girth.**—A moderate to high degree of relationship was established between skinfolds and chest girth of the three ethnic groups. The Italian group contained the highest "r" values and were followed by the Jewish and Negro ethnics respectively. The largest coefficient was recorded among the 10½ year old Italian subjects with a value of .90. The lowest "r" was found within the 11 year old Negro group with a correlation of .47.

**Upper arm girth.**—Moderate to high coefficients were found among the three ethnic groups. The Negro classification contained the highest "r" values with a range of .64 to .93. The Italian group followed with a range of .44 to .90. The Jewish group predominantly held moderate "r" values with a low of .35 to a high of .90.

**Bi-iliac diameter.**—Negligible to marked "r" values between skinfolds and hip diameter were found with a range of .00 to .80 among the three ethnic groups.
studied. The Italian group possessed the highest coefficients with a range of .48 to .80. The Jewish and Negro classifications followed respectively. A moderate degree of skinfold/bi-iliac relationship was observed within the Jewish ethnic group which earned a mean "r" of .54 among the five age brackets. Negligible to moderate coefficients dispersed the Negro sample which revealed a range of .00 to .65 "r" values.

**Skinfolds and Wetzel Grid physique relationship.** -- A substantial to high degree of relationship was found between skinfolds and physique as determined by the Wetzel Grid technique. A range of .66 to .85 revealed a marked association among the three ethnic groups. Each group yielded a high of .85 within their respective ethnic classification.

The lowest coefficient was found within the 11 year old Negro category with a moderate correlation of .66. The Jewish subjects registered the highest mean "r" value of .83. The lowest mean "r" value was found within the Negro group with a correlation of .75.

**Comparison of body fat, height, and weight measurements between each ethnic group.** --

**Skinfold measurements.** -- Significant differences at
the 1 per cent level were found between the three ethnic groups relative to the abdominal, chest and posterior arm skinfold measurements. Fat folds of these three sites disclosed significant "F" values and a rejection of the null hypothesis at each of the five half year age units. Significant differences of the lateral arm fold sites were also found at every age unit except the 10½ year level. Non-significant differences of the scapula fold measurements were revealed at three age levels, (10, 10½ and 12 years). Significant F-ratios were found at the 11 and 11½ year old levels. The lateral arm and scapula skinfolds were the only sites measured which contained three non-significant F-ratio values.

**Height.**—Although the percentile norms revealed the predominance of tallness among the Jewish group, non-significant differences in the height measurements at the 1 per cent level were disclosed between the five half year age levels. Group means exhibited similar scores which effected lower F-ratios, and resultant acceptance of the null hypothesis; consequently, it was concluded that the three samples relevant to height could have
come, by chance, from the same population.

**Weight.**—Significant ethnic differences at the 1 per cent level were found at the 11 and 11½ year old age levels. The Jewish and Italian groups possessed the heaviest mean weights at these age brackets. The Negro group yielded the lightest means at the same age levels. Mean weight differences were not significant at the 1 per cent level within the 10, 10½ and 12 year age units.

**Selected height and weight comparisons.**—

**Stuart-Meredith Tables.**—The median values of the ten year old age units identified the Stuart-Meredith subjects as taller than those of the present study. The Jewish group followed the older tables with 139.6 centimeters; the Negro and Italians ensued in succeeding order.

The Jewish group held the tallest median measurement within the 11 year old bracket with a score of 144.3 centimeters. The Stuart-Meredith, Italian and Negro groups followed respectively.

The Jewish group exhibited predominantly highest scores at each percentile level.

Similar scores were observed between the Jewish and Stuart-Meredith groups at the 12 year old level. The
median value of 149.6 (Stuart-Meredith), represented .1 of a centimeter taller score over the Jewish group. The Negro and Italian groups followed the Stuart-Meredith subjects with slightly lower median measurements.

The Jewish and Italian subjects were considerably heavier than the Stuart-Meredith individuals at the median and upper percentiles.

The Negro ethnic disclosed heavier weights among the 11 and 12 year olds medians, however, the lightest weight at the 10 year old level, was found among the Negro group as compared with the Stuart-Meredith tables.

**Boyd Tables.**-- The Jewish group scored predominantly higher measurements than the Boyd subjects at each percentile level with the exception of the lower percentiles at the 10, 11 year units, and the 75th percentile of the 12 year old level. The Boyd measurements were followed by the Negro and Italian subjects. Slightly higher Italian scores were found in the upper percentiles of the 11 and 12 year old units.

The median weights predominantly supported the present three ethnic groups as heavier than those subjects found in the Boyd tables with the exception of the Negro
group. The Negro ethnic scored a larger median than the Boyd subjects within the 12 year old bracket. Percentile values at each age level predominantly placed the Boyd subjects as slightly heavier than the Negro group, but generally lighter than the Jewish and Italian subjects.

Pett Canadian Study.-- The Pett percentile norms revealed the Canadian subjects as shorter than those measured in the present study. Each selected percentile also disclosed the individuals as lighter in weight at every age bracket. Consequently, the present Italian, Jewish and Negro groups were found to be taller and heavier than the nationwide Pett study.

2. Conclusions of the Study

1. The skinfold measurement technique, employing the Harpenden caliper provides an accurate method of estimating subcutaneous body fat.

2. Skinfold measurements should be included in all child growth and anthropometrical studies in the appraisal of quantitative leanness/fatness.

3. The use of percentile tables permits those interested in child growth and development to readily determine
in what portion of a distribution a child falls with respect to each measurement taken.

4. Quantitative skinfold and other anthropometrical measurement data are provided for preadolescent, Italians, Jewish and Negro boys in the Boston area.

5. The largest skinfold measurements were possessed by the Jewish subjects followed by the Italian and Negro groups respectively.

6. The largest skinfolds were found at the abdominal site among the Jewish and Italian groups.

7. The posterior arm skinfolds revealed the largest measurements within the Negro group.

8. The chest skinfolds disclosed the smallest measurements among the three groups.

9. The percentile data revealed a predominance of taller subjects among the Jewish ethnic, followed by the Negro and Italian groups respectively.

10. A trend of heavier subjects were found within the Jewish group with the Italian and Negro groups following in rank order.

11. The largest chest girths were found within the Jewish group followed by the Italian and Negro subjects
respectively.

12. Predominantly larger arm girths were found within the Jewish group followed by the Italian and Negro subjects.

13. The thigh girth approximately doubled the upper arm girth measurement among the three ethnic groups.

14. The Jewish group contained the largest thigh girths followed by the Italian and Negro groups.

15. The Jewish group predominantly scored the largest bi-iliac measurements followed by the Italian and Negro subjects.

16. Substantial to very high inter-correlations were found between skinfold measurements within each of the three ethnic groups.

17. Low correlations were found between skinfold measurements and height.

18. Substantial to high correlations were found between skinfold and weight measurements.

19. A moderate to high degree of relationship was found between skinfolds and chest girth measurements.

20. A moderate to high relationship was found between skinfold measurements and upper arm girth.
21. Inconsistent correlations existed between bi-iliac diameter and skinfolds ranging from negligible to high values.

22. A substantial to high degree of relationship was found between total skinfold measurements and Wetzel Grid physique rating.

23. Significant differences, at the 1 per cent level, between the three ethnic groups at all age brackets were found relative to the abdominal, chest and posterior arm skinfold measurements.

24. The lateral arm skinfold measurement recorded significant differences between ethnic groups except the 10\(\frac{1}{2}\) year old age bracket.

25. The scapula skinfold measurement revealed significant differences between ethnic groups at the 1 per cent level at the 11 and 11\(\frac{1}{2}\) year age units. However, non-significant differences prevailed at the 10, 10\(\frac{1}{2}\) and 12 year age levels.

26. The height measurement revealed non-significant differences at the 1 per cent level between the three ethnic groups.

27. The weight measurement revealed significant ethnic differences, at the 1 per cent level, at the 11 and 11\(\frac{1}{2}\)
year old units, however, non-significant differences occurred among the 10, 10½ and 12 year old units.

28. The Jewish ethnic group was taller than those in three older studies, except the subjects found in the Stuart-Meredith tables at the 10 and 12 year age brackets.

29. The Negro and Italian groups were not as tall as those found in the Stuart-Meredith and Boyd studies.

30. The three ethnic groups were taller than those found in the Pett Canadian nationwide study.

31. The Jewish and Italian groups were generally heavier than those found in the three older studies.

32. The Negro subjects were generally heavier than those found in the Stuart-Meredith tables, however, lighter than the subjects found in the Boyd and Canadian tables.

3. Limitations

Limiting factors in the study.—There are certain limitations which have been recognized by the writer as factors
which may have an influence on the outcome of this study.

1. No claim is made by the writer that the sample distribution is representative of the total population throughout the country. The data analyzed herewith is applicable to the ethnic groups of the Boston and surrounding area.

2. The source of age and ethnic background, in some cases, were the word and knowledge of the subjects. This information, particularly among several 10 year olds, may have been inaccurate.

4. Suggestions for Further Study

1. Similar research is needed on boys of younger ages.
2. Similar research is needed on girls of all ages.
3. Skinfold measurement and comparison of ethnic classifications other than the groups employed in the present study.
4. The measurement and comparison of subjects located in different geographic areas.
5. The measurement and comparison of subjects before and after programs of strenuous physical activities.

In conclusion, the writer recommends that similar
investigations be made employing larger groups over wider geographical regions.
APPENDICES
Table 19. Test, Re-Test of Skinfold and Other Anthropometrical Measurements of Fifty (50) Italian Subjects (Ages: 10, 11, 12 Years)

<table>
<thead>
<tr>
<th>Skinfold and Other Measurement Sites</th>
<th>Skinfolds</th>
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<td></td>
<td>X</td>
<td>S.D.</td>
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<tr>
<td>Abdomen(s) a/</td>
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<tr>
<td>Chest(s)</td>
<td>5.95</td>
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<tr>
<td>Lateral Arm(s)</td>
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<td>Posterior Arm(s)</td>
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<td>Weight</td>
</tr>
<tr>
<td>Chest(g)</td>
</tr>
<tr>
<td>Arm(g)</td>
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<tr>
<td>Thigh(g)</td>
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<td>Bi-iliac D. c/</td>
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a/Skinfolds
b/Girths
c/Diameter
Table 20. Consistency of Repeated Skinfold Measurements of Twelve (12) Negro Subjects Between Two Different Investigators

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<td></td>
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<td>Dr. C.W. Thompson</td>
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<td>( \bar{X} )</td>
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<td>.006</td>
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\( a/ \) Skinfolds
Table 21. Raw Scores of Skinfold and Other Anthropometrical Data of the Italian Ethnic Group

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/ Age at the time of testing
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/ Day
/ Year

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</table>

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Abdomen | Chest L. | P. Arm | Scapula | Hgt. | Wgt. | Chest | Arm | Thigh | Hip
--- | --- | --- | --- | --- | --- | --- | --- | --- | ---
7. 3/15/49 | 13.0 | 7.1 | 12.5 | 9.8 | 8.2 | 140.5 | 89 | 27 1/4 | 23.1 | 45.5 | 24.0
8. 3/28/49 | 6.2 | 3.8 | 10.5 | 7.9 | 4.6 | 131.2 | 66 | 23 3/4 | 20.5 | 40.5 | 21.0
9. 2/11/49 | 4.5 | 3.2 | 7.9 | 7.2 | 4.1 | 142.0 | 74 | 24 7/8 | 20.2 | 40.3 | 22.0
0. 2/3/49 | 10.1 | 7.6 | 17.1 | 13.6 | 6.6 | 142.0 | 87 1/2 | 25 1/2 | 24.5 | 47.7 | 21.0
1. 3/31/49 | 4.6 | 3.6 | 8.5 | 7.6 | 5.2 | 148.9 | 84 1/2 | 27 1/4 | 21.4 | 42.5 | 23.0
2. 4/12/49 | 4.7 | 3.5 | 11.2 | 10.2 | 5.3 | 133.5 | 67 | 24 1/8 | 19.9 | 41.5 | 22.0
3. 2/23/49 | 3.7 | 3.3 | 8.1 | 7.2 | 3.8 | 134.1 | 63 | 24 3/4 | 19.8 | 38.5 | 20.0
4. 4/1/49 | 5.8 | 4.3 | 9.6 | 8.5 | 5.1 | 142.6 | 77 1/2 | 25 1/2 | 20.5 | 43.5 | 21.0
5. 2/11/49 | 4.6 | 4.0 | 10.5 | 8.9 | 6.3 | 137.1 | 79 1/2 | 25 3/4 | 22.5 | 42.7 | 20.5
6. 1/23/49 | 3.6 | 3.2 | 8.5 | 7.9 | 4.6 | 142.3 | 68 | 24 1/4 | 18.9 | 38.7 | 22.0

**11 Yr. Olds**

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b/Month

c/Day

d/Year

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/ Month
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| 10½ Yr. Olds          |           |           |        |        |       |       |       |      |       |      |      |      |
| 1. 5/8/48             | 16.8      | 7.8       | 17.3   | 17.9   | 8.6   | 153.5 | 108   | 27   | 1/2   | 27.0 | 53.0 | 21.0 |
| 2. 6/7/48             | 8.2       | 4.6       | 11.0   | 10.7   | 6.6   | 142.5 | 82½   | 25   | 22.1  | 47.2 | 20.0 |
| 3. 6/8/48             | 4.2       | 2.9       | 6.3    | 6.2    | 4.3   | 146.1 | 80    | 23   | 1/2   | 21.0 | 42.1 | 21.5 |
| 4. 5/22/48            | 5.5       | 4.2       | 10.5   | 9.5    | 6.0   | 140.7 | 85½   | 25   | 1/4   | 22.0 | 44.5 | 20.5 |
| 5. 5/12/48            | 3.8       | 2.7       | 4.5    | 4.2    | 4.1   | 149.5 | 80    | 25   | 1/2   | 21.6 | 41.0 | 22.5 |
| 6. 6/10/48            | 4.0       | 2.7       | 6.1    | 7.1    | 4.2   | 146.8 | 78½   | 23   |       | 20.5 | 40.6 | 21.0 |
| 7. 4/10/48            | 4.6       | 2.7       | 7.8    | 7.6    | 5.6   | 145.2 | 84½   | 26   | 1/2   | 20.6 | 42.5 | 20.5 |
| 8. 4/24/48            | 5.2       | 3.6       | 8.2    | 7.6    | 5.3   | 145.2 | 80½   | 25   | 1/2   | 21.5 | 42.0 | 21.5 |
| 9. 4/29/48            | 9.3       | 4.3       | 11.6   | 10.8   | 7.6   | 143.7 | 83½   | 25   | 1/8   | 22.5 | 48.5 | 20.0 |
| 10. 4/26/48           | 3.7       | 2.2       | 4.4    | 6.3    | 4.4   | 145.7 | 74½   | 24   | 3/4   | 19.0 | 39.5 | 21.0 |
| 11. 5/13/48           | 4.1       | 2.8       | 6.2    | 7.3    | 4.7   | 146.9 | 79    | 23   | 1/2   | 20.5 | 41.8 | 21.5 |
| 12. 5/22/48           | 10.6      | 6.0       | 12.1   | 10.5   | 7.5   | 146.8 | 94    | 26   | 1/2   | 25.2 | 49.0 | 21.5 |
| 13. 4/29/48           | 5.5       | 3.4       | 6.5    | 5.5    | 6.2   | 152.1 | 98½   | 27   | 1/4   | 23.0 | 46.2 | 23.0 |
| 14. 4/20/48           | 4.3       | 3.2       | 7.3    | 7.7    | 4.8   | 141.2 | 71    | 24   | 1/4   | 20.2 | 42.0 | 19.0 |
| 15. 7/5/48            | 5.1       | 3.7       | 10.5   | 7.2    | 6.0   | 141.6 | 86    | 25   | 1/2   | 22.2 | 45.5 | 21.5 |
| 16. 2/22/48           | 4.3       | 2.7       | 5.0    | 5.1    | 3.8   | 146.1 | 77    | 24   | 1/2   | 19.7 | 42.5 | 21.0 |
| 17. 7/24/49           | 4.1       | 2.7       | 6.3    | 7.2    | 4.4   | 136.5 | 74    | 24   | 1/2   | 22.2 | 44.0 | 20.5 |
| 18. 7/18/48           | 6.1       | 4.2       | 9.4    | 9.3    | 5.7   | 138.2 | 72    | 24   | 1/2   | 20.0 | 41.5 | 20.0 |
| 19. 4/9/48            | 5.4       | 3.7       | 10.3   | 9.4    | 5.4   | 143.6 | 86½   | 25   |       | 22.2 | 46.0 | 21.0 |
| 20. 4/27/47           | 5.0       | 3.5       | 8.1    | 7.4    | 5.4   | 145.1 | 80    | 24   | 1/4   | 21.0 | 41.5 | 21.0 |
| 21. 5/3/48            | 3.7       | 2.7       | 4.4    | 4.1    | 4.0   | 148.0 | 79½   | 25   | 1/2   | 21.2 | 40.3 | 23.0 |
| 22. 4/17/48           | 5.1       | 3.3       | 6.3    | 7.8    | 4.6   | 141.5 | 71½   | 24   |       | 20.6 | 39.5 | 20.0 |
| 23. 4/4/48            | 4.5       | 2.6       | 7.7    | 7.5    | 5.5   | 145.0 | 84    | 26   |       | 20.1 | 43.7 | 20.0 |
| 24. 8/3/48            | 3.4       | 2.9       | 6.2    | 5.7    | 4.9   | 142.4 | 76    | 25   | 1/4   | 21.2 | 41.2 | 20.0 |
| 25. 8/26/48           | 5.8       | 3.1       | 9.0    | 9.2    | 5.7   | 155.6 | 75    | 24   | 1/2   | 21.0 | 39.5 | 20.0 |

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### 11 1/2 Yr. Olds

| 1. 1/17/48           | 5.5       | 3.7         | 8.3    | 7.7          | 6.4  | 146.7 | 80  | 26  | 20.5 | 42.5 | 21.0 |
| 2. 12/26/47          | 9.6       | 5.5         | 8.5    | 9.2          | 7.7  | 152.3 | 102 | 28  | 24.0 | 48.3 | 22.0 |
| 3. 11/28/47          | 4.2       | 3.3         | 5.9    | 7.0          | 5.2  | 134.0 | 74  | 25 1/4 | 22.6 | 42.9 | 20.0 |
| 4. 11/26/47          | 38.0      | 17.4        | 35.5   | 36.0         | 16.0 | 148.1 | 153 | 33 1/2 | 34.2 | 66.8 | 25.5 |
| 5. 12/31/47          | 5.2       | 2.8         | 4.9    | 5.9          | 4.6  | 151.5 | 88  | 25 1/4 | 19.5 | 45.1 | 21.0 |
| 6. 2/16/48           | 5.7       | 3.9         | 10.0   | 10.6         | 6.2  | 146.0 | 82  | 25 1/4 | 23.0 | 45.6 | 20.5 |
| 7. 12/12/47          | 4.5       | 3.1         | 6.7    | 7.2          | 5.1  | 144.5 | 72  | 24 3/4 | 20.5 | 42.5 | 20.0 |
| 8. 11/7/47           | 4.8       | 3.2         | 5.4    | 7.2          | 5.3  | 138.0 | 76  | 25 7/8 | 22.5 | 43.9 | 20.5 |
| 9. 1/10/48           | 4.6       | 3.2         | 3.8    | 4.8          | 4.4  | 137.1 | 66  | 23 1/2 | 19.7 | 40.5 | 19.0 |
| 10. 8/19/47          | 3.6       | 2.4         | 5.8    | 6.2          | 4.0  | 139.1 | 63  | 23  | 18.4 | 38.0 | 21.0 |
| 11. 11/3/47          | 4.0       | 2.4         | 4.5    | 6.0          | 4.8  | 147.5 | 87  | 25 3/4 | 21.0 | 46.0 | 20.0 |
| 12. 12/29/47         | 4.3       | 2.5         | 5.0    | 7.4          | 5.3  | 140.0 | 68  | 23 1/2 | 19.0 | 40.0 | 19.5 |
| 13. 12/17/47         | 4.3       | 2.8         | 4.7    | 4.9          | 4.6  | 138.5 | 71  | 23 1/2 | 19.5 | 42.6 | 20.0 |
| 14. 1/13/48          | 10.1      | 7.9         | 15.2   | 15.1         | 8.4  | 141.2 | 85  | 26 1/8 | 24.5 | 47.0 | 21.0 |
| 15. 12/8/47          | 6.4       | 3.7         | 6.9    | 5.9          | 5.9  | 150.2 | 96  | 27  | 23.0 | 49.5 | 20.5 |

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(concluded on the next page)
Table 23. (concluded)

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<td>Hgt. Wgt. Chest Arm Thigh Hip</td>
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Table 24. Form for Classifying and Recording Original Skinfold and Other Anthropometrical Measurements

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<td>Ethnic (S)</td>
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<td>Occupation (F):</td>
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<td>2. Wgt.</td>
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<td>3. Chest (g)</td>
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<td>2. Index No.</td>
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<tr>
<td>a. Type</td>
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<td>b. Date</td>
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<table>
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<th>Comments</th>
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<td>3. Arm</td>
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<tr>
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<tr>
<td>b. Posterior</td>
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<td>4. Scapula</td>
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| Organization or School: |     |
|                        |     |

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SKINFOLD AND OTHER ANTHROPOMETRICAL MEASUREMENTS OF PRE-ADOLESCENT BOYS FROM SELECTED ETHNIC GROUPS (Ages 10-11-12 years)

By

John Piscopo

**IDENTIFICATION #**

**AGE**

**ETHNIC**

**ABDOMEN**

**CHEST**

**LATERAL (ARM)**

**POSTERIOR (ARM)**

**SCAPULA**

**HEIGHT**

**WEIGHT**

**CHEST**

**ARM**

**THIGH**

**HIPS**

**WETZEL GRID**

**TOTAL SKINFOLDS (5 sites)**

**WETZEL GRID**

**TOTAL SKINFOLDS**
BIBLIOGRAPHY
SELECTED BIBLIOGRAPHY


