NATIONAL CENTER For HEALTH STATISTICS | Series 11 Number 35

VITAL and HEALTH STATISTICS
DATA FROM THE NATIONAL HEALTH SURVEY

Skinfolds, Body Girths, Biacromial Diameter, and Selected Anthropometric Indices of Adults

United States, 1960-1962

Age and sex distributions for right-arm and infrascapular skinfolds; right arm, waist, and chest girths; sum of skinfolds; ponderal index; ratios of height to cube root of weight, sitting height erect to stature, chest girth to stature, and biacromial diameter to stature; also the equations for predicting each of the physical measurements from height, weight, and age, and the interrelation of all the measurements.

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Health Services and Mental Health Administration

Washington, D.C. February 1970

Public Health Service Publication No. 1000-Series 11-No. 35

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C., 20402 - Price 60 cents

NATIONAL CENTER FOR HEALTH STATISTICS

DIVISION OF HEALTH EXAMINATION STATISTICS

COOPERATION OF THE BUREAU OF THE CENSUS

In accordance with specifications established by the National Health Survey, the Bureau of the Census, under a contractual agreement, participated in the design and selection of the sample, and carried out the first stage of the field interviewing and certain parts of the statistical processing.

Public Health Service Publication No. 1000-Series 11-No. 35

Library of Congress Catalog Card Number 72-601417

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IN THIS REPORT findings for adults in the United States on six of the 18 measurements of body size taken during the examinations of the first cycle of the Health Examination Survey are presented as well as certain commonly used anthropometric indices. Field operation phases of the survey were started in October 1959 and completed in December 1962. Out of the nationwide probability sample of 7,710 persons 18-79 years of age selected to represent the 111 million persons in the U.S. civilian, noninstitutional population, 6,672 (or more than 85 percent) were examined.

The measurements and indices contained in this report are ones which are commonly used in clothing design, epidemiology, physical education, and rehabilitation. As indicators of body build they are useful in evaluating growth, nutrition, metabolic status, and disease processes.

In the report are findings by age for men and women on right arm skinfold, infrascapular skinfold, sum of the two skinfolds, right arm girth, chest girth, waist girth, biacromial diameter, ponderal index (height/weight$^{1/3}$), 100 x sitting height erect/stature, 100 x chest circumference/stature, and 100 x biacromial diameter/stature. The degree of linear association of the original measurements and equations for the prediction of each of them from height, weight, and age are also included. In addition, measurement techniques for the six direct measurements are described.

Comparisons are made with findings from previous anthropometric surveys among various groups in this and foreign countries. Some possible explanations for the results are discussed.

SYMBOLS

Data not available	---
Category not applicable	...
Quantity zero	-
Quantity more than 0 but less than 0.05	0.0
Figure does not meet standards of reliability or precision	*

SKINFOLDS, BODY GIRTHS, BIACROMIAL DIAMETER,

AND SELECTED ANTHROPOMETRIC INDICES OF ADULTS

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INTRODUCTION

This report presents findings on six of the 18 physical measurements of adults obtained in the first cycle of the Health Examination Survey, as well as some of the more frequently used anthropometric indices; equations for the prediction of the entire 16 measurements from weight, height, and age; and the interrelation of the various physical measurements.

The Health Examination Survey is one of three major programs of the National Health Survey designed to secure statistics on the health status of the population of the United States. It obtains data through medical examinations, tests, and measurements on a scientifically selected probability sample of the population. The other programs include the household interview and the medical and hospital records survey.

The purpose of the first cycle of the Health Examination Survey was to determine the prevalence of certain chronic diseases; the status of auditory and visual acuity; the level of dental health; and certain measurements of body size. A nationwide probability sample of 7,710 persons 18-79 years of age in the civilian, noninstitutional population was selected. During the survey, which extended from October 1959 through December 1962, 6,672 sample persons were examined. Medical and other survey staff performed the standard examination, which lasted about 2 hours, in mobile clinics especially designed for the purpose.

Previous publications describe the general plan and initial program of the Health Examination Survey,[1] as well as the sample population response and the effect of nonresponse on the findings.[2] Data available from the examination, the household interview preceding the examination, and a subsequent physician record check with a subsample of respondents and nonrespondents indicate that no major feature of the adult population of the United States is seriously distorted and that the effects of nonresponse on the demographic picture are not serious.

The distribution of the 12 physical measurements of greatest use in human engineering and the distribution of weight by height are contained in previous reports.[3,4]

Utility of the Data

The anthropometric measurements in this report are useful for many health, scientific, and practical purposes. Body circumferences are essential in clothing design; chest circumference is the basic measurement for jackets, sweaters, overalls, and undershirts; and waist circumference for skirts, trousers, and other clothing. Circumferences are also useful indicators of body build and composition. Body composition, wherein the body components of water, fat, muscle, bone, and other tissue are considered, is important in evaluating growth, nutrition, metabolic status, and disease. Body build analysis is useful in

epidemiology, physical education, and rehabilitation. A high ratio of chest to waist circumference suggests an athletic build, a low ratio the reverse. Historically, the chest circumference to stature ratio has been regarded as an index of robusticity; men with low values of the ratio were often rejected as candidates for military service or for insurance, as being particularly prone to tuberculosis.[5]

Arm circumference, at the level of the triceps (midback of arm) skinfold, measures three body components: bone, muscle, and fat. Since fat is measured directly by the triceps skinfold, the remainder, after subtraction of triceps skinfold from arm diameter, indicates robusticity of build (mesomorphy) for an individual or group in comparison with others.

Skinfold measurements, first suggested in 1918 by Matiegka,[6] became feasible in 1929 with the invention of constant-tension calipers by Franzen[7] in the United States. Skinfolds have become established as the easiest and most direct measure of body fat available in the doctor's office, the clinic, or in large-scale population surveys. Two instruments have become standard—the Lange caliper in the United States and the Harpenden caliper in Britain. Skinfold calipers measure subcutaneous fat, which constitutes about 50 percent of the total body fat in young adults.[8] Estimates of the proportion of weight of subcutaneous fat in total weight for persons of "standard" or relatively normal weight by age and sex are shown in table A. With age, an individual adds more fat internally than subcutaneously, so that middle-aged and older adults have relatively more internal fat and less subcutaneous fat than young adults. Detailed study of skinfolds in many sites in the body shows that the upper arm site, over the triceps muscle, and the infrascapular site correlate as highly with total body fat (measured densitometrically by underwater weighing) as do a much larger number of sites.[9]

The upper arm and infrascapular sites have therefore become standard for purposes of nutritional appraisal,[10] cardiovascular epidemiology,[11] and general description of physique. It has been shown by Damon and Goldman[9] that these two skinfolds permit close prediction of body fat among young men, to within 2 percent

Table A. Percent of weight of subcutaneous fat in total weight, by age and sex, estimated for persons of "standard" weight for height

Age	Estimated percent of total body weight	
	Men	Women
	Percent	
25 years	13	26
35 years	17	30
45 years	22	34
55 years	26	38
	Number of persons	
Number of adults	103	62

Source: See reference nos. 13 and 14.

of the densitometrically determined percentage. Among obese girls, the upper arm, or triceps skinfold alone, was closely correlated with the percentage of total body fat.[12]

Skinfolds permit a closer estimate of body fat than do tables of relative weight, whether based on average or "ideal" weights for age, sex, and height, since total body weight includes tissues other than fat. Weight gain since age 25, if documented by actual measurements, would provide a good estimate of body fat, but recall is too inaccurate to permit general use of this technique.[15]

Biacromial diameter, a measure of skeletal breadth, has little utility by itself, other than to characterize populations for purposes of comparison. When combined with other measures, however, it is a useful investigative tool, since it can indicate whether population differences in weight or stockiness have a skeletal component. Tanner's[16] "index of androgyny," ([3 times biacromial breadth] minus bi-iliac breadth), a rough index of masculinity-femininity of build, has been reported to distinguish women at greater risk of developing vomiting or toxemia of pregnancy in studies of Coppen.[17,18] Several indices

involving biacromial diameter have been used to study personality, delinquency, and occupational choice and performance by Seltzer,[19,20] and Damon[21] and Damon and Crichton.[22]

The chest circumference/stature index has already been mentioned as a traditional measure of body build. Military surgeons in particular have regarded a low value as suggesting constitutional weakness and a predisposition to tuberculosis.[5] The other two indices, height/weight$^{1/3}$ and sitting height/stature, are of major importance in human biology. The ratio of height to the cube root of weight, which establishes a scale of leanness-stockiness of build, is the single best measure of body build. Any height-weight ratio would serve, but the present one has been applied to many populations for various purposes—primarily, to use as guidelines for assessing under- or over-nutrition and to correlate physique with physiological function, disease, and behavior.[23] Since the time of Hippocrates, scientists, literary men, and others have noted this continuum and have observed rough correlations between human structure and function. Many investigators have confirmed the Hippocratic contrast between the lean habitus, particularly prone to tuberculosis, and the stocky habitus, prone to hypertension and "strokes." Numerous studies including those of Mayr[24] have shown that the geographic distribution of mankind roughly follows the "laws" of animal distribution, in that inhabitants of cold climates tend to be stockily built, conserving body heat, while those in hot climates are linear in build, maximizing surface area and dissipating heat.

Certain body measurements, including those in the first cycle of the Health Examination Survey, are designed for use in analyzing body bulk, or stockiness of build, into its components of fat, muscle, and skeletal mass.

The sitting height/stature index is likewise useful in medicine and anthropology. Patterns of growth and of adult proportions can signify accelerated or retarded growth. Since most linear growth occurs in the long bones, leg length is the main factor in stature variations. Endocrine, genetic, and chromosomal anomalies cause characteristic patterns of relative trunk and leg length, such as the high sitting height/stature index in Turner's syndrome (XO chromosome constitution) and in achondroplastic dwarfism, and the low index in acromegaly and eunuchoidism. Among normal persons, "mesomorphs" (muscular physiques) have typically high indices while "ectomorphs" (linear physiques) have low ones. Women generally have higher indices than men. Of the major racial stocks in the United States, Orientals and American Indians typically have the highest indices, and Negroes the lowest, with Caucasians being intermediate. Even when immigrant groups increase in size in the U.S. environment, as the Japanese have done in Hawaii, they retain their original indices according to studies of Miller[25] and Froehlich.[26]

THE MEASUREMENTS

Data on the six additional measurements taken during the examination but not described in the earlier publications[3,4]—body breadths, girths, and skinfolds—are contained in this report.

Measuring Techniques

As described previously, all measurements were made with the examinee stripped to the waist and without shoes, but wearing paper slippers and a lightweight, knee-length examining gown. Men's trouser pockets were emptied. Sitting measurements were made with the examinee seated on a flat, horizontal board, with the knees and ankles at right angles, thighs horizontal, and popliteal areas lightly touching the seat surface. This was accomplished by inserting or removing the necessary number of ½-inch plywood boards under the feet. All measurements not in the midsagittal plane (parallel to the long axis of the body) were measured on the right side of the body, unless otherwise noted.

Measurements were taken by a team of two trained observers using the following standardized procedures as illustrated in appendix I. The nurse member of the team took the chest girth measurement of women.

Skinfold measurements.—These were taken on the right side using the standard caliper developed by Oscar Lange of the University of Kentucky in Lexington, Kentucky, manufactured by the Cambridge

Scientific Instruments, Cambridge, Maryland in accordance with accepted standards. Two measurements were made and recorded for each skinfold in the following order:

Right upper arm
Right infrascapular
Right upper arm
Right infrascapular

When a skinfold was difficult to measure an indication of "tight skin" was recorded next to the measurement so that this could be taken into consideration in analyzing the data.

Upper arm skinfold.— The examinee stood with his arms hanging loosely at his sides. The observer grasped a skinfold parallel to the long axis of the right arm over the triceps area (back of arm, not side) and 1 centimeter above the midpoint mark (see arm girth). Applying the caliper at the level of the mark for arm girth the observer counted silently, 1-2-3, and called out the reading to the recorder who repeated and recorded it as for all other measurements.

Infrascapular skinfold. —This measurement was taken 1 centimeter below the tip of the right scapula. The observer grasped a skinfold below the lower border of the scapula with his fingers on top, thumb below, and forefinger at the lower tip of the scapula. The skinfold was angled about 45 degrees from the horizontal, going medially upward and laterally downward. The calipers were placed 1 centimeter below the forefinger, 1-2-3 was counted silently and the reading called out, repeated, and recorded as for the upper arm skinfold.

Arm girth.— This measurement was taken from the right side. With the examinee standing and holding his forearm at a right angle to the upper arm, the arm was marked with a steel tape on the lateral aspect (outer side, not back) of the right arm. The observer measured the distance from the acromion (at the shoulder) to the olecranon process (at the elbow). With the zero mark of the tape at the acromion, the tape was allowed to hang free and the midpoint of the acromion-olecranon distance was marked with a ballpoint pen or skin-marking pencil on both sides of the tape. The arm girth measurement was made horizontally at this level, while the arm was hanging loose, with a steel tape held in contact without deforming the contours of the arm.

Chest girth.—On men this measurement was taken while the examinee was standing relaxed, breathing normally, with his arms slightly raised. A steel centimeter tape was applied, without deforming the skin contours, in the horizontal plane around the chest at the nipple line.

On women the measurement was taken without a brassiere while the examinee was standing relaxed, breathing normally, with her arms slightly raised. A steel centimeter tape was applied in the horizontal plane at the uppermost part of the axillary folds, without deforming the skin contours.

Waist girth.— For this measurement, men were asked to loosen their belt so that the steel tape could be applied horizontally at the natural indentation of the waistline or at a level midway between the iliac crests and the lower edge of the rib cage, if no natural indention was present.

Biacromial diameter.— The observer stood behind the examinee, who was standing without support, placed his hands on the examinee's shoulder, asked him to roll his shoulders slightly forward, and assisted him to do so. The observer located the outermost edges of the acromial process by following the scapular spines laterally and forward. The location of the acromial process was marked with a ballpoint pen or skin-marking pencil without distorting the position of the skin over the acromion. The measurement was taken with the bars of the anthropometer held short, fingers at

the tips of the bars, and palms on the rod. The movable bar was adjusted to measure the width between the most lateral surfaces of the acromial process with firm contact. The reading was taken at the inner edge of the movable bar, without changing the position of the movable bar, on the scale that increased downward from the fixed bar.

Reliability of Measurements

As indicated in the first physical measurement report in this series,[3] the quality of the data obtained through standardized measurement procedures was maintained in three ways—by training, by using automatic measuring devices where possible, and by building safeguards into a team system.

Prior to the start of the survey, the staff nurse and technician on each of the two caravans were given intensive training by two of the authors, who advised on the selection of the series of measurements and developed the specific techniques used in the survey. At several times during the course of the survey, these authors visited the examining units to observe and retrain the staff team. Determinations of the reproducibility of the measurements were made on a small group of subjects. The more difficult of the measures to reproduce closely, the skinfolds, were taken twice for each examinee.

All measurements, other than height and weight for which automatic measuring devices were used, were taken by a team of two persons—the nurse and the technician—one acting as observer and the other as recorder. The observer took the measurements, calling out the results (read to the nearest millimeter) to the recorder, who repeated them and then called out the name of the next measurement. The observer kept the measuring instrument in place until the recorder repeated the number. The recorder generally checked the examinee's position during the procedure.

Any modification in measurement techniques—such as left-side rather than right-side measurements required because of amputations or casts, abnormal conditions such as height decreased from a hunched condition, or girth increased from pregnancy—were noted on the record, where they could be taken into consideration in data analysis. Measurements, other than weight, were recorded to the nearest millimeter. Body dimensions measured with the upper sections of the anthropometer were recorded as read from the anthropometer scale, and the length of the base section not used was later subtracted mechanically. Conversion of all linear measurements, other than skinfolds, from centimeters to inches, was also done later mechanically.

Statistical notes on the survey design, reliability of the data, and sampling and measurement errors are shown in appendix II.

FINDINGS

Anthropometric data are presented here for the adult, civilian, noninstitutionalized population of the United States aged 18-79 years. These estimates were obtained from direct measurements taken on a highly representative national sample of examinees in the first cycle of the Health Examination Survey during 1960-62. These measurements and indices are in addition to those included in an earlier publication in this series.[3] The findings are discussed, and comparisons are made with data from recent reliable anthropometric surveys of segments of the U.S. population and of certain foreign populations as well. Differences between this and other studies could result from secular (long term) changes in body size and proportion as suggested by some studies repeated over time among specific subgroups; from differences in socioeconomic status, occupation, race, ethnic group or national origin; or from other factors. Where the data are not strictly comparable for technical reasons such as differences in measuring instruments or procedure, these special problems are discussed.

In evaluating changes with age in the data presented below, the possibility of a secular trend toward an increase in overall body size, as measured by height and weight, should be kept in mind. This trend is suggested from the cross-sectional data reported earlier from the Health Examination Survey,[3] and it has been documented from other sources as well, particularly those dealing with national samples of young men examined for military service.[27]

When subjects of different generations are compared, for example, older and younger age subgroups in the present series, some body-size differences could be expected to result solely from these secular changes; that is the older subjects, who are smaller in overall size, might be expected to have slightly smaller body dimensions for that reason alone. However, this tendency must be evaluated in conjunction with the observed chronological increases in body fat and fat-related measurements with individual aging.

Here, as with all "cross-sectional" data—those obtained for many age groups at one point in time—a basic question may be raised as to the meaning of physical changes with age. Infrascapular skinfold, for example, increases to ages 54 in men and 64 in women, and thereafter decreases. Do people tend to lose fat beyond middle age, or do fewer fat people survive into the older age groups? Are both factors at work? Only "longitudinal" studies, where the same persons are followed for many years, will give the answer.

Right Arm Skinfold

The average right arm skinfold, taken over the middle of the triceps muscle, was 1.3 centimeters among American civilian males. About 90 percent of men fell between 0.5 and 2.8 centimeters, a range of 2.3 centimeters, and 98 percent between 0.4 and 4.1 centimeters, a tenfold range of 3.7 centimeters. Changes with age were not marked except for the 0.3 centimeter rise from 1.1 centimeters at 18-24 years to 1.4 centimeters at 25-34 years. The triceps skinfold remained constant through the next decade, then declined slowly to 1.1 at 75-79 years (table 1 and fig. 1).

For American women the values for triceps skinfolds were consistently larger than for men. Their average triceps skinfold measured 2.2 centimeters, or 0.9 centimeter larger than the male average. Approximately 90 percent of women varied between 1.1 and 3.8 centimeters, a range of 2.7 centimeters and about 98 percent between 0.8 and 4.6 centimeters, a sixfold range of 3.8 centimeters. The minimum average value for women, 1.8 centimeters, occurred at the youngest age, 18-24 years, increasing to 2.1 centimeters at 25-34 years. From there it increased each decade to a maximum average of 2.5 centimeters at 55-64 years. By 65-74 years there was a slight drop to 2.4, and finally a decline to 2.0 centimeters at 75-79 years.

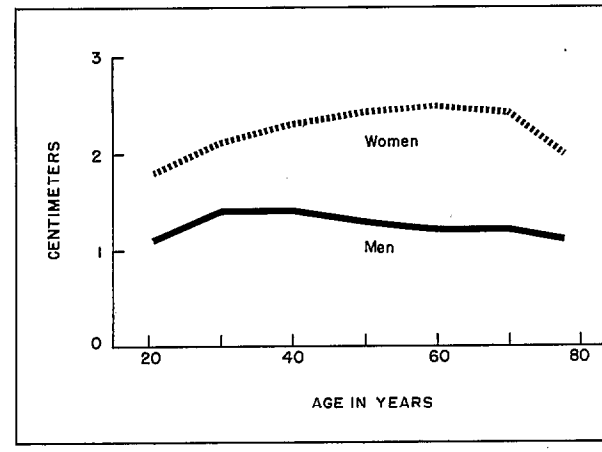

Figure 1. Average right-arm skinfold for adults, 18-79 years.

Maximum values in triceps skinfolds occur considerably later in life for women than for men, 55-64 compared with 25-44 years. The oldest women have skinfolds slightly but not significantly larger than the youngest women, whereas for men the values are the same for both extreme age groups (table 1 and fig. 1).

Comparison of skinfold measurements from the present study with those of other studies should be made only when the measuring site and techniques are similar. In addition, the same type of caliper should have been used, since the present authors from Harvard University have found differences between the three most commonly used models, the Lange, Harpenden, and the Minnesota. Among 46 men whose triceps skinfolds were measured by each of the three calipers, with identical technique and systematically altering the sequence of caliper use, the mean with the Harpenden caliper was 1.07 centimeters, the Lange 1.13 centimeters, and the Minnesota model, 1.27 centimeters. The direction of the difference for the individual subjects was similar to the differences for the means. Such differences need to be taken into consideration in comparing studies based on different calipers. These results differ somewhat from those reported by Keys et al.,[28]

who stated that "no significant differences were observed when different calipers [Harpenden and Lange] were used for repeated measurements on the same men," but who nevertheless reported mean differences of up to 0.04 centimeter. Differences between individual calipers of the same manufacture are negligible compared with intercaliper differences. The Minnesota caliper, no longer in production, has the largest intramanufacturer variability.

The most nearly comparable large study in which skinfold measurements were obtained is the survey of Canadian civilians in which a stratified random sample of that population was measured. In the Canadian study as reported by Pett and Ogilvie,[29] triceps skinfold was measured by Minnesota calipers. The pattern that emerges in this comparison (table B) is the consistently, and substantially, larger values found in the United States. The differences vary from 0.5 to 0.6 centimeters greater at each age interval. The magnitude and consistency of these differences cannot be attributed to the different caliper used, since the Minnesota caliper used in the Canadian survey gives larger values than the Lange caliper in the Health Examination Survey. In all likelihood, Americans have fatter arms than their Northern neighbors. These differences hold throughout the percentile range, but are more marked at the upper end of the distributions, ranging from 0.2 centimeter at the 10th percentile to 1.1 centimeters at the 90th percentile.

The arm skinfold values for adults in the United States as determined in the Health Examination Survey are similar to those of other groups in this country, such as those in the Tecumseh, Michigan Community Health Study.[30] Only about 0.1 centimeter or less difference was found between median values in these two studies for comparable age subgroups. The very slight tendency for the Michigan subjects to be larger could be explained by the Minnesota calipers used in the latter study. The railroad switchmen, clerks, and executives reported by Keys et al.,[28] had slightly larger median values than the present study, but only by 1 or 2 millimeters. A large group of former naval aviators[34] had mean values similar to those of the present study over the comparable age range, while subjects in a longitudinal growth study in Boston[36] had identical mean values. Healthy U.S. veterans[31] differed by only 0.1 centimeter at 25-34 and 35-44 years, and at 45-54 years the values were identical. A series of 133 Spanish-American War veterans ranging in age from 72-91 years[32] had the same value as the present men aged 75-79 years. A group of 407 young white Army men[33] were found to have average values which did not differ significantly from those in the present study. Thus the triceps skinfold values for various group studies in the United States appear quite similar to those for the general population.

When compared with foreign populations, however, the U.S. values generally are appreciably larger. Taking the age groups in the forties and fifties as an example, the American men had median values larger than three Italian groups by about 0.2 centimeter, and substantially larger than a third Italian group by about 0.6 centimeters.[28] They had larger median values than Yugoslavs and Greeks by about 0.6 centimeter, larger than Finns by about 0.5 centimeter, and even larger than Netherlanders, usually considered a well-fed population, by about 0.2 centimeter.[28]

When comparisons are made at the upper end of the range, i.e. "fattest versus fattest", the contrast is even more marked. For example, U.S. men at the 95th percentile from the present study were 1.1 centimeters larger than their counterparts in the Netherlands study, 0.4 centimeter larger than 95th percentile Italians from one group, and fully 1.8 centimeters larger than those from another group. They were also 1.5 centimeters larger than 95th percentile Greeks from the island of Crete.

Women in the United States as determined from the present study showed a pattern like that of the men when they were compared with the Canadian civilian, female population at similar ages. U.S. women had larger mean triceps skinfolds than their Canadian counterparts, the differences ranging from 0.5 centimeter for those 18-24 years of age, 0.6 to 0.7 centimeter for those 24-64 years, and 0.8 centimeter for the oldest group. Again the differences held consistently throughout the distribution. For the 35-44-year age groups, for example, the 10th percentile differences were 0.4 centimeter, while the 90th percentile differences were 1.0 centimeter. As

Table B. Right upper arm skinfold in centimeters for selected groups

Sex and group	Number measured	Age			Right upper arm skinfold		
		Mean	Standard deviation	Range in years	Mean	Standard deviation	Median
Men							
Present study[a]	3,091	---	---	18-79	1.3	---	1.1
	411	---	---	18-24	1.1	---	0.9
	675	---	---	25-34	1.4	---	1.2
	703	---	---	35-44	1.4	---	1.2
	547	---	---	45-54	1.3	---	1.1
	418	---	---	55-64	1.2	---	1.2
	265	---	---	65-74	1.2	---	1.1
	72	---	---	75-79	1.1	---	1.0
Canadians[b](29)	538	---	---	18-24	0.6	---	0.5
	532	---	---	25-34	0.8	---	0.7
	632	---	---	35-44	0.8	---	0.7
	457	---	---	45-54	0.8	---	0.7
	284	---	---	55-64	0.7	---	0.6
	318	---	---	65+	0.6	---	0.4
Tecumseh, Michigan Community Health Study[b](30)	111	---	---	20-24	---	---	1.1
	172	---	---	25-29	---	---	1.0
	196	---	---	30-34	---	---	1.2
	214	---	---	35-39	---	---	1.2
	158	---	---	40-44	---	---	1.2
	143	---	---	45-49	---	---	1.3
	100	---	---	50-54	---	---	1.2
	93	---	---	55-59	---	---	1.4
	55	---	---	60-64	---	---	1.2
	52	---	---	65-69	---	---	1.1
	36	---	---	70-74	---	---	1.2
	20	---	---	75-79	---	---	1.4
Railroad switchmen[c](28)	835	---	---	40-59	---	---	[1]1.2
Sedentary clerks[c](28)	859	---	---	40-59	---	---	[1]1.3
Nonsedentary clerks[c](28)	155	---	---	40-59	---	---	[1]1.4
Executives[c](28)	250	---	---	40-59	---	---	1.4
U.S. veterans[a](31)	144	---	---	25-34	1.3	0.6	---
	259	---	---	35-44	1.3	0.5	---
	158	---	---	45-54	1.3	0.4	---
Spanish-American War veterans[a](32)	133	81	3.5	72-91	1.1	0.4	1.1
U.S. Army, white[a](33)	347	---	---	18-24	1.1	0.6	---
	60	---	---	25-34	1.2	0.5	---
Former naval aviators[a](34)	675	47	---	42-62	1.2	0.4	---
Italians, Rome[c](28)	766	---	---	40-59	---	---	[1]1.0
Italians, Crevalcore[c](28)	990	---	---	40-59	---	---	[1]1.0
Italians, Montegiorgio[c](28)	715	---	---	40-59	---	---	[1]0.6
Yugoslavs, Dalmatia[c](28)	670	---	---	40-59	---	---	[1]0.6
Finns, West[c](28)	859	---	---	40-59	---	---	[1]0.7
Netherlanders[c](28)	877	---	---	40-59	---	---	[1]1.0
Greeks, Corfu[c](28)	529	---	---	40-59	---	---	[1]0.6

See footnotes at end of table.

Table B. Right upper arm skinfold in centimeters for selected groups—Con.

Sex and group	Number measured	Age			Right upper arm skinfold		
		Mean	Standard deviation	Range in years	Mean	Standard deviation	Median
Men—Con.							
Italians, military[a](35)----	1,358	22	---	18-59	1.1	0.5	1.0
Greeks, military[a](35)------	1,084	22	---	17-43	0.9	0.4	0.8
Turks, military[a](35)-------	915	22	---	17-45	0.8	0.4	0.7
Longitudinal growth study, Boston[a](36)--------	60	---	---	28-36	1.4	0.55	1.3
Women							
Present study[a]----------	3,581	---	---	18-79	2.2	---	2.2
	534	---	---	18-24	1.8	---	1.7
	746	---	---	25-34	2.1	---	2.0
	784	---	---	35-44	2.3	---	2.3
	705	---	---	45-54	2.4	---	2.4
	443	---	---	55-64	2.5	---	2.5
	299	---	---	65-74	2.4	---	2.4
	70	---	---	75-79	2.0	---	2.2
Canadians[b](29)----------	582	---	---	18-24	1.3	---	1.2
	805	---	---	25-34	1.4	---	1.2
	805	---	---	35-44	1.6	---	1.4
	592	---	---	45-54	1.8	---	1.8
	410	---	---	55-64	1.8	---	1.7
	353	---	---	65+	1.6	---	1.4
Tecumseh, Michigan Community Health Study[b](30)--	171	---	---	20-24	---	---	1.8
	194	---	---	25-29	---	---	1.8
	226	---	---	30-34	---	---	1.8
	216	---	---	35-39	---	---	2.0
	149	---	---	40-44	---	---	2.1
	135	---	---	45-49	---	---	2.2
	95	---	---	50-54	---	---	2.3
	82	---	---	55-59	---	---	2.3
	65	---	---	60-64	---	---	2.5
	59	---	---	65-69	---	---	2.2
	44	---	---	70-74	---	---	2.1
	24	---	---	75-79	---	---	2.0
"Normal women", Upstate New York[a](37)----------	94	---	---	16-30	2.5	0.68	---
	26	---	---	30-40	2.4	0.66	---
	27	---	---	40-50	3.0	0.78	---
	21	---	---	50-60	2.9	0.86	---
	14	---	---	60-70	2.8	0.54	---
Longitudinal growth study, Boston[a](36)----------	60	---	---	28-36	2.0	0.66	1.9

[a]Lange calipers; [b]Minnesota calipers; [c]Lange and Harpenden calipers.

[1]Values recomputed from age subgroups.

NOTE: Numbers in parentheses refer to source of data, see references.

with the men, differences of such magnitude could not have resulted from inter-caliper variability.

When the women in the present study were compared with those in the Tecumseh, Michigan Community Health Study[30] they were found to have slightly, but only slightly, larger median values over the various age subgroups. The differences were usually about 0.1 to 0.2 centimeters. When they were compared with "normal women," from Upstate New York,[37] their mean triceps skinfold values were somewhat lower. They were, however, very similar to a group of women measured in a longitudinal growth study in Boston.[36]

Infrascapular Skinfold

For men in the general civilian population the infrascapular skinfold on the right side averaged 1.5 centimeters. About 90 percent of this population fell between 0.7 and 3.0 centimeters, a range of 2.3 centimeters, and 98 percent between 0.6 and 4.1 centimeters, a range of 3.5 centimeters. Changes with age in this measurement were relatively small. The measurement was smallest for the youngest and oldest age groups, 1.3 centimeters, and reached a maximum of 1.6 centimeters at ages 35-54 years (table 2 and fig. 2).

Women had consistently larger subscapular (infrascapular) skinfolds than men, though the difference was smaller than for the triceps skinfold. The average value for women was 1.8 centimeters, or 0.3 centimeter larger than for men. Approximately 90 percent of all women varied between 0.7 and 3.6 centimeters, a range of 2.9 centimeters, and 98 percent between 0.6 and 4.5 centimeters, a range of 3.9 centimeters.

Changes in this measurement with age were more marked for women than for men. Though the average value was the same for both sexes for the 18-24-year age group, 1.3 centimeters, and for the 25-34-year group, 1.5 centimeters, increases thereafter were greater for women. By 35-44 years the measurement had increased 0.3 centimeter, by 45-54, 0.2 centimeter more, and by 55-64 an additional 0.2 centimeter for a maximum of 2.2 centimeters. For the next two age groups there were declines of 0.2 and 0.3 centimeters to a value of 1.7 centimeters for

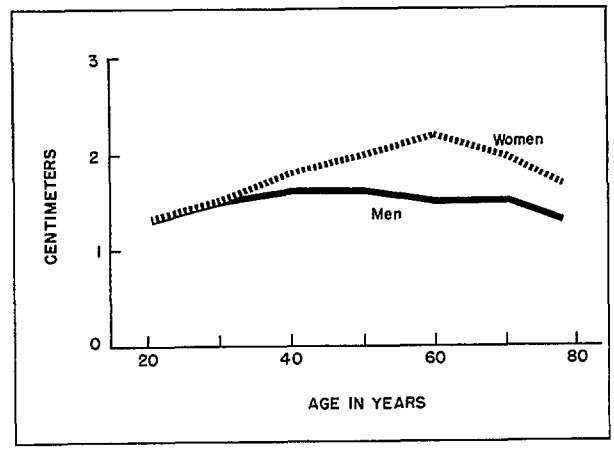

Figure 2. Average infrascapular skinfold for adults, 18-79 years.

those 75-79 years old. Women in the oldest age group had markedly larger subscapular skinfolds than the youngest women, whereas for men the two groups were identical (table 2 and fig. 2).

In a comparison of calipers for this site, 46 men measured by the authors gave the following mean subscapular skinfold values: Harpenden calipers 1.69 centimeters, Lange calipers 1.84 centimeters, and Minnesota calipers 2.19 centimeters. The order of difference is the same as that for triceps skinfolds, and, though the magnitude of differences are larger, the measurements themselves are larger. These differences need to be taken into account whenever the subscapular skinfold data from the present study are compared with the results from other studies.

The median values for infrascapular skinfolds from the present study closely parallel those for men from the Tecumseh, Michigan Community Health Study[30] except at 55-64 years where values in the present study are 0.4 centimeter lower (table C). Such differences as occur, i.e., present study lower by about 0.05 to 0.2 centimeters, could well be accounted for by chance and the two calipers used. A large group of former naval aviators aged 42-62 years[34] had almost identical mean infrascapular skinfold values to those from the same general age range in the present study. Subjects in a Boston longitudinal growth study[36] had the highest mean value, 1.9 centimeters, about 0.3 to 0.4 centimeters larger than those of roughly comparable

Table C. Infrascapular skinfold in centimeters for selected groups

Sex and group	Number measured	Age			Infrascapular skinfold		
		Mean	Standard deviation	Range in years	Mean	Standard deviation	Median
Men							
Present study[a]	3,091	---	---	18-79	1.5	---	1.4
	411	---	---	18-24	1.3	---	1.1
	675	---	---	25-34	1.5	---	1.3
	703	---	---	35-44	1.6	---	1.5
	547	---	---	45-54	1.6	---	1.5
	418	---	---	55-64	1.5	---	1.4
	265	---	---	65-74	1.5	---	1.4
	72	---	---	75-79	1.3	---	1.2
Tecumseh, Michigan Community Health Study[b] (30)	111	---	---	20-24	---	---	1.2
	172	---	---	25-29	---	---	1.2
	196	---	---	30-34	---	---	1.5
	214	---	---	35-39	---	---	1.5
	158	---	---	40-44	---	---	1.6
	143	---	---	45-49	---	---	1.7
	100	---	---	50-54	---	---	1.7
	93	---	---	55-59	---	---	1.9
	55	---	---	60-64	---	---	1.7
	52	---	---	65-69	---	---	1.3
	36	---	---	70-74	---	---	1.4
	20	---	---	75-79	---	---	1.5
U.S. veterans[a] (31)	144	---	---	25-34	1.7	0.8	---
	259	---	---	35-44	1.7	0.7	---
	158	---	---	45-54	1.8	0.7	---
Spanish-American War veterans[a] (32)	133	81	3.5	72-91	1.6	0.7	1.6
U.S. Army[a] (33)	347	---	---	18-24	1.4	0.8	---
	60	---	---	25-34	1.4	0.6	---
Former naval aviators[a] (34)	675	47	---	42-62	1.5	0.5	---
Italians, military[a] (35)	1,358	22	---	18-59	1.4	0.6	1.2
Greeks, military[a] (35)	1,084	22	---	17-43	1.1	0.5	1.0
Turks, military[a] (35)	915	22	---	17-45	1.0	0.5	0.9
Longitudinal growth study, Boston[a] (36)	60	---	---	28-36	1.9	0.95	1.6

See footnotes at end of table.

Table C. Infrascapular skinfold in centimeters for selected groups—Con.

Sex and group	Number measured	Age			Infrascapular skinfold		
		Mean	Standard deviation	Range in years	Mean	Standard deviation	Median
Women							
Present study[a]	3,581	---	---	18-79	1.8	---	1.6
	534	---	---	18-24	1.3	---	1.3
	746	---	---	25-34	1.5	---	1.3
	784	---	---	35-44	1.8	---	1.6
	705	---	---	45-54	2.0	---	1.9
	443	---	---	55-64	2.2	---	2.2
	299	---	---	65-74	2.0	---	1.9
	70	---	---	75-79	1.7	---	1.7
Tecumseh, Michigan Community Health Study[b] (30)	171	---	---	20-24	---	---	1.3
	193	---	---	25-29	---	---	1.3
	226	---	---	30-34	---	---	1.4
	216	---	---	35-39	---	---	1.7
	149	---	---	40-44	---	---	1.8
	135	---	---	45-49	---	---	2.1
	95	---	---	50-54	---	---	2.1
	82	---	---	55-59	---	---	2.2
	65	---	---	60-64	---	---	2.2
	59	---	---	65-69	---	---	2.1
	44	---	---	70-74	---	---	2.3
	24	---	---	75-79	---	---	2.2
"Normal women" Upstate New York[a] (37)	94	---	---	16-30	1.2	0.41	---
	26	---	---	30-40	1.3	0.53	---
	27	---	---	40-50	1.7	0.57	---
	21	---	---	50-60	1.9	1.01	---
	14	---	---	60-70	2.3	0.75	---
Longitudinal growth study, Boston[a] (36)	60	---	---	28-36	1.5	0.92	1.2

[a]Lange calipers; [b]Minnesota calipers.

NOTE: Numbers in parentheses refer to source of data, see references.

age in the general population as determined by the present study.

When the means from the present study are compared with groups of healthy veterans of similar ages,[31] the values are again fairly close. Spanish-American War veterans with an average age of 81 years[32] had subscapular skinfold measurements 0.3 centimeter higher than those aged 75-79 in the present study. A group of U.S. Army men at age 18-24 years had a mean slightly higher but at 25-34 years slightly lower (0.1 centimeter) than present civilians.

Compared with foreign populations, the pattern observed for triceps skinfolds is somewhat modified. Italian military personnel with an average age of 23 years were 0.1 centimeter smaller at the median than the present civilians, aged 18-24, and indistinguishable at the 5th and 95th percentiles. Greek military personnel, average age 22, were smaller at the median by 0.3 centimeter, identical at the 5th percentile, and 0.4 centimeter smaller at the 95th percentile. Turkish military personnel, also with an average age of 22 years, were smaller—0.4 centimeter at the median, 0.1 at the 5th percentile, and 0.7 at the 95th percentiles.

For women, median values for infrascapular skinfold were generally comparable to those from the Tecumseh, Michigan Community Health Study.[30] While the latter tend to be slightly larger, the difference, again, could be ascribed to chance and the different skinfold calipers used. "Normal women" from Upstate New York[37] had mean infrascapular skinfold values generally slightly less over the comparable age subgroups, though the differences are small enough to be due to chance with such limited groups. Women in the Boston longitudinal growth study[36] were similar to those in the present study.

Sum of Skinfolds

The sum of the previously discussed triceps and subscapular skinfolds exhibits the combined distribution that would be expected on the basis of its components. As noted, although women are absolutely larger than men in both of these measurements, the relative difference in size between these two skinfolds is reversed within the two sexes, i.e., for men the subscapular skinfold is larger than the triceps, but among women the reverse is true. Hence for men, the subscapular skinfold contributes the larger part of the combined sum; for women, the triceps skinfold. These larger skinfolds for women than for men reflect the marked sex difference in percent of fat in total weight at all ages, as in table A. While the absolute values in the table are small in the light of the present research, the age and sex trends are clear.

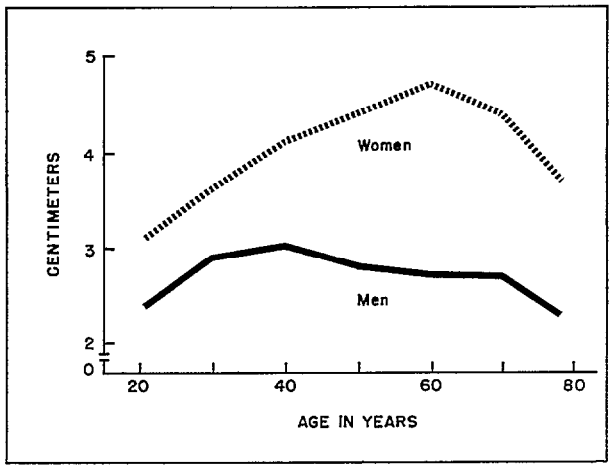

Figure 3. Average sum of skinfolds for adults, 18-79 years.

For men in the United States, the sum of skinfolds averaged 2.8 centimeters, about 90 percent fell between 1.2 and 5.4 centimeters, a range of 4.2 centimeters, and 98 percent between 1.0 and 7.1 centimeters, a sevenfold range of 6.1 centimeters. Age changes are present but not striking. For the youngest age group, 18-24 years, the sum of skinfolds was 2.4 centimeters, increasing to a maximum of 3.0 centimeters at 35-44 years of age, then declining gradually to a low of 2.3 centimeters at 75-79 years. This differs slightly from the report of Keys et al.,[28] that sum of skinfold thicknesses showed almost no age trends from 40 through 59 in a variety of U.S. and foreign male populations (tables C and 3 and fig. 3).

Among women, the sum of skinfolds averaged 4.0 centimeters, 1.2 centimeters greater than the value for men. The middle 90 percent varied from 1.8 to 7.1 centimeters, a range of 5.3 centimeters; the middle 98 percent from 1.4 to 8.6 centimeters, a sixfold range of 7.2 centimeters. Changes with

age in this combined measurement were greater for women than for men. The lowest mean value, 3.1 centimeters, was found again in the youngest group with the increase for ensuing decades of 0.3 to 0.5 centimeters to a high of 4.7 centimeters at 55-64 years, followed by a decline to 3.7 centimeters at 75-79 years (table 3 and fig.3). For both men and women, the magnitude of the difference from the thinnest to the fattest, as measured by these skinfolds, was quite striking.

The results of comparison with special population groups in the United States, civilian and military, can easily be inferred from the discussions above of the two components of the sum of skinfolds. However, it is of interest to compare the present data with those of several selected studies. Taking men in their forties and fifties, the span within which maximum values are usually found, the present findings for men in the United States showed median values around 2.7 centimeters (table D). Four groups within this age range were reported by Keys et al.,[28] to show somewhat higher median values: railroad switchmen 3.1, nonsedentary clerks 3.3, sedentary clerks 3.4, and executives 3.4 centimeters. For the Tecumseh, Michigan Community Health Study,[30] median values for sum of skinfolds were more similar to those from the present study. Differences here, if any, showed the former to have slightly higher values. Healthy U.S. veterans[31] had nearly identical mean sums of skinfolds—0.1 centimeter higher at 25-44 years, but larger by 0.3 centimeter at 45-54 years than the present study. Former naval aviators[34] had values very similar to those in the present U.S. population over the same general age range. The group of young military males[33] were also very close in size to those in the present study, taking age distributions into consideration. The Boston longitudinal growth study[36] again had the largest skinfolds, a mean of 3.3 centimeters as against 2.9 for the roughly comparable age group in the present study.

With foreign populations, the expected differences were also found. Civilian men in the United States from the present study had larger sum of skinfold measurements than any foreign group presented in table D. Only the group of Italians from Rome are close, only 0.1 centimeter less; with the other groups the differences range up to 1.4 centimeters. The one Asiatic population represented, from Japan, had a sum of skinfold value similar to that of the leaner Europeans. They were 1.2 centimeters smaller than American men at the median, and less variable with a striking 3.2 centimeter difference at the 95th percentile.[28] For foreign military groups, the Italians from Rome are fairly similar to the present findings for civilian men in the United States, whereas the Greeks and Turks had markedly lower values.[35]

When the women in the entire United States, as estimated from the present study are compared with the Tecumseh, Michigan Community Health Study,[30] the differences in the median values are found to be very slight. "Normal women" from Upstate New York[37] are slightly larger, while those from the Boston longitudinal growth study[36] are slightly smaller, when approximately the same age ranges are considered (table D).

Right Arm Girth

Men in the general civilian population had right arm girths averaging 12.1 inches. About 90 percent of these men varied between 10.1 and 14.2 inches, a range of 4.1 inches, and 98 percent varied between 9.2 and 15.4 inches, a range of 6.2 inches. The youngest age group had an average arm girth of 11.8 inches. After a rise to 12.3 inches at 25-34 years, there was little change with age until 55 years, the mean values for the three intervening age decades varied only from 12.3 to 12.4 inches. By 55-64 years, there was a decline to 11.9 inches, a further decline to 11.6 inches by 65-74 years, and a group low of 10.9 inches for those 75-79 years of age (table 4 and fig. 4).

For women in the general population, right arm girths averaged 11.2 inches, or 0.9 inches less than the comparable figure for men. Some 90 percent of these women varied between 9.0 and 14.4 inches, a range of 5.4 inches, while 98 percent fell between 8.3 inches and 15.8 inches, a range of 7.5 inches. Thus it is evident that women were more variable in this measurement than men. Age changes in arm girth for women differed somewhat from those for men in that there was a fairly steady increase from 10.2 inches for the youngest group to a high of 11.9 inches at 55-64

Table D. Sum of skinfolds in centimeters for selected groups

Sex and group	Number measured	Age			Sum of skinfolds	
		Mean	Standard deviation	Range in years	Mean	Median
Men						
Present study[a]	3,091	---	---	18-79	2.8	2.5
	411	---	---	18-24	2.4	1.9
	675	---	---	25-34	2.9	2.6
	703	---	---	35-44	3.0	2.8
	547	---	---	45-54	2.8	2.7
	418	---	---	55-64	2.7	2.6
	265	---	---	65-74	2.7	2.5
	72	---	---	75-79	2.3	2.2
Sedentary clerks[c] (28)	858	---	---	40-59	---	[1] 3.3
Nonsedentary clerks[c] (28)	156	---	---	40-59	---	[1] 3.4
Railroad switchmen[c] (28)	835	---	---	40-59	---	[1] 3.1
Executives[c] (28)	249	---	---	40-59	---	[1] 3.4
Tecumseh, Michigan Community Health Study[b] (30)	111	---	---	20-24	---	2.3
	172	---	---	25-29	---	2.3
	196	---	---	30-34	---	2.7
	214	---	---	35-39	---	2.7
	158	---	---	40-44	---	2.9
	143	---	---	45-49	---	3.0
	100	---	---	50-54	---	2.9
	93	---	---	55-59	---	3.3
	55	---	---	60-64	---	2.9
	52	---	---	65-69	---	2.3
	36	---	---	70-74	---	2.6
	20	---	---	75-79	---	2.8
U.S. veterans[a] [2] (31)	144	---	---	25-34	3.0	---
	259	---	---	35-44	3.0	---
	158	---	---	45-54	3.1	---
Spanish-American War veterans[a] [2] (32)	133	81	3.5	72-91	2.7	---
U.S. Army, white[a] [2] (33)	347	---	---	18-24	2.5	---
	60	---	---	25-34	2.6	---
Former naval aviators[a] [2] (34)	675	47	---	42-62	2.7	---
Longitudinal growth study, Boston[a] [2] (36)	60	---	---	28-36	3.3	---
Italians, Rome[c] (28)	767	---	---	40-59	---	2.6
Italians, Crevalcore[c] (28)	991	---	---	40-59	---	2.2
Italians, Montegiorgio[c] (28)	716	---	---	40-59	---	1.5
Italians, Nicotera[c] (28)	470	---	---	40-59	---	1.3
Yugoslavs, Dalmatia[c] (28)	670	---	---	40-59	---	1.4
Finns, West[c] (28)	859	---	---	40-59	---	1.6
Netherlanders[c] (28)	876	---	---	40-59	---	2.3
Greeks, Corfu[c] (28)	529	---	---	40-59	---	1.5
Japanese[c] (28)	499	---	---	40-59	---	1.5

See footnotes and note at end of table.

Table D. Sum of skinfolds in centimeters for selected groups—Con.

Sex and group	Number measured	Age			Sum of skinfolds	
		Mean	Standard deviation	Range in years	Mean	Median
Men—Con.						
Italians, military[a] (35)	1,358	22	---	18-59	2.5	---
Greeks, military[a] (35)	1,084	22	---	17-43	2.0	---
Turks, military[a] (35)	915	22	---	17-45	1.8	---
Women						
Present study[a]	3,581	---	---	18-79	4.0	3.9
	534	---	---	18-24	3.1	2.9
	746	---	---	25-34	3.6	3.3
	784	---	---	35-44	4.1	3.9
	705	---	---	45-54	4.4	4.3
	443	---	---	55-64	4.7	4.6
	299	---	---	65-74	4.4	4.3
	70	---	---	75-79	3.7	3.8
Tecumseh, Michigan Community Health Study[b] (30)	171	---	---	20-24	---	3.1
	193	---	---	25-29	---	3.1
	226	---	---	30-34	---	3.2
	216	---	---	35-39	---	3.7
	149	---	---	40-44	---	3.8
	135	---	---	45-49	---	4.3
	95	---	---	50-54	---	4.4
	82	---	---	55-59	---	4.5
	65	---	---	60-64	---	4.7
	59	---	---	65-69	---	4.3
	44	---	---	70-74	---	4.4
	24	---	---	75-79	---	4.2
"Normal women" Upstate New York[a] [2](37)	94	---	---	16-30	3.7	---
	26	---	---	30-40	3.7	---
	27	---	---	40-50	4.7	---
	21	---	---	50-60	4.8	---
	14	---	---	60-70	5.1	---
Longitudinal growth study, Boston[a] [2](36)	60	---	---	28-36	3.5	---

[a]Lange calipers; [b]Minnesota calipers; [c]Lange and Harpenden calipers.

[1]Values recomputed from age subgroups.

[2]Values summed from group means of right upper arm and infrascapular skinfolds.

NOTE: Numbers in parentheses refer to source of data, see references.

years of age, when it declined to 11.5 inches at 65-74, and to 11.0 inches at 75-79 years. The oldest women were 0.8 inches *larger* in this measurement than the youngest women whereas the oldest men were 0.9 inches *smaller* than the youngest men (table 4 and fig.4).

Right arm girths measured in the same way on special groups in the United States showed the following patterns (table E): A group of healthy male veterans[31] aged 25-34 years and 45-54 years had a mean value 0.2 inch greater than the same age subgroup from the present study while those aged 35-44 were the same size. Spanish-American War veterans[32] with an age range between 72 and 91 years had a mean value in this girth only slightly larger than this value for men 75-79 years in the present study. A group of former naval aviators[34] with a mean age of 47 years had a right arm girth of 12.9 inches, larger by 0.6 inch on the average than those of comparable age in the present study.

The subjects of the longitudinal growth study in Boston[36] were also larger on the average by 0.6 inch than the corresponding group in the general population. Both of these groups, however, were also larger in overall gross size, i.e., height and weight, than those in the present study. The group of U.S. Army men[33] was only slightly larger than civilian American men, when age was taken into consideration.

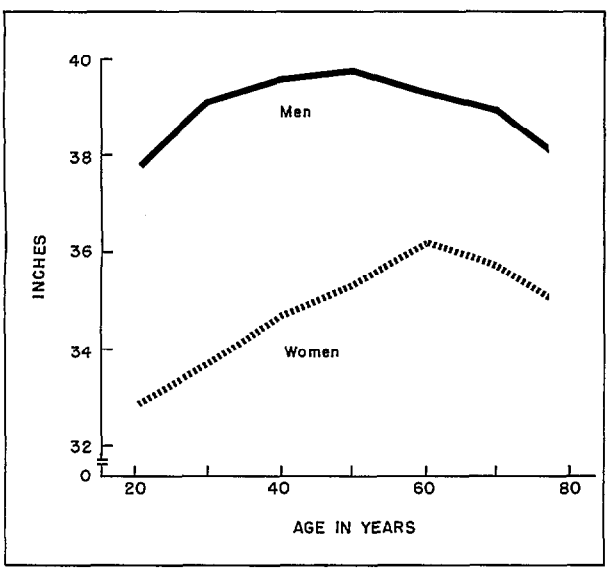

Figure 4. Average right arm girth for adults, 18-79 years.

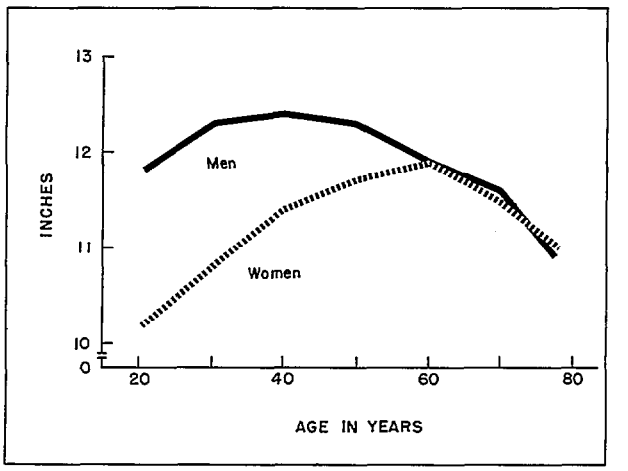

Figure 5. Average chest girth for adults, 18-79 years.

For women, comparisons with two other series, the Boston longitudinal growth study[36] and "normal women" from Upstate New York,[37] showed very similar mean values for right arm girth for approximately the same age groups in the general population.

Chest Girth

Men in the civilian noninstitutional population of this country had an average chest girth of 39.2 inches. About 90 percent of these men fell between 34.3 inches and 44.9 inches, a range of 10.6 inches, while roughly 98 percent varied between 32.5 inches and 47.7 inches, a range of 15.2 inches. There was a steady increase in average girth with age from 37.8 inches at 18-24 years to a maximum of 39.8 inches at 45-54 years. Much of this increase results from increased fat deposition with age rather than changes in the size or structure of the rib cage except among the older groups. From 45-54 years on there was a steady decline with the oldest age group having virtually the same value as the youngest (table 5 and fig. 5). Beyond age 65, fat loss overbalances the increase in diameters of the bony thorax, which occurs in older persons.

Since chest girth was taken at a different anatomical location for women than for men, the

two sexes cannot be compared. For all women, chest girths, as measured, averaged 34.7 inches; 90 percent fell between 30.4 and 40.5 inches, a range of 10.1 inches; and 98 percent between 29.0 inches and 43.5 inches, a range of 14.5 inches.

With regard to age changes in chest girth, the youngest women 18-24 years of age were the smallest, 32.9 inches. Thereafter there was a steady increase by decades of age to a high of 36.2 inches at 55-64 years. A decline then set in with

Table E. Right arm girth in inches for selected groups

Sex and group	Number measured	Age			Right arm girth	
		Mean	Standard deviation	Range in years	Mean	Standard deviation
Men						
Present study	3,091	---	---	18-79	12.1	---
	411	---	---	18-24	11.8	---
	675	---	---	25-34	12.3	---
	703	---	---	35-44	12.4	---
	547	---	---	45-54	12.3	---
	418	---	---	55-64	11.9	---
	265	---	---	65-74	11.6	---
	72	---	---	75-79	10.9	---
U.S. veterans (31)	142	---	---	25-34	12.5	1.14
	259	---	---	35-44	12.4	1.03
	157	---	---	45-54	12.5	0.91
Spanish-American War veterans (32)	133	81	3.5	72-91	11.3	1.1
Former naval aviators (34)	675	47	---	42-62	12.9	0.93
U.S. Army (33)	525	24	5.4	17-51	12.3	1.23
Longitudinal growth study, Boston (36)	60	---	---	28-36	12.9	1.15
Women						
Present study	3,581	---	---	18-79	11.2	---
	534	---	---	18-24	10.2	---
	746	---	---	25-34	10.8	---
	784	---	---	35-44	11.4	---
	705	---	---	45-54	11.7	---
	443	---	---	55-64	11.9	---
	299	---	---	65-74	11.5	---
	70	---	---	75-79	11.0	---
Longitudinal growth study, Boston (36)	60	---	---	28-36	10.8	1.21
"Normal women" Upstate New York (37)	94	---	---	16-30	10.1	2.29
	26	---	---	30-40	10.7	1.16
	27	---	---	40-50	11.6	0.91
	21	---	---	50-60	11.7	1.31
	14	---	---	60-70	11.7	1.01

NOTE: Numbers in parentheses refer to source of data, see references.

the average measurement dropping steadily to 34.8 inches at 75-79 years. Thus for women, chest girth was fully 1.9 inches *larger* for the oldest group than for the youngest group (table 5 and fig. 5), a pattern different from that for the men, where it was noted that the youngest and oldest groups were of virtually the same size. The women's measurement as taken included relatively more fat.

When compared with various subpopulations of comparable age, the civilian American men in the general population tended to have slightly larger chests. Compared with a group of 25-34-year-old healthy veterans,[31] for example, the present men of the same age were 0.5 to 0.6 inch larger at each decade of age (table F). Air traffic controllers,[39] averaging 27 years of age, were smaller on the average by 0.9 inch than those 25-34 years of age from the present study. However, chest girths of a group of Spanish-American War veterans,[32] 72-91 years of age, were identical on the average to the oldest group of American men; while a group of former naval aviators[34] had substantially larger measurements, averaging 40.4 inches. The latter were, however, unusually large in overall body size and might be expected to have larger chests for that reason alone.

Compared with two groups of "Old Americans," Harvard fathers and sons,[38] measured for the most part between about 1904 and 1929, the present men had considerably larger chests. Those in the 18-24-year group averaged 3.6 inches larger than the Harvard fathers at age 19, and 2.0 inches larger than the Harvard sons at age 18. While part of the difference is attributable to the slightly older average age of the present 18-24-year age group, some of it also possibly reflects greater body size of American people today or of the general population when compared with that group.

When compared with U.S. military populations, men in the present study were again somewhat larger. Groups of Army men from the United States,[33] Army separatees,[43] Air Force flying personnel,[40] and Army aviators[44] were all smaller on the average than those of nearly comparable age in the entire American civilian population from the present study while "older" Air Force pilots[41] were about the same size.

American men in the present study also had higher values, on the average, than three European military populations.[35] They were larger than recently measured military groups of roughly comparable age in Turkey, Greece, and Italy by 1.9, 1.4, and 0.4 inches, respectively—all statistically significant differences.

The generally larger chest circumferences found for American men in the general population is difficult to explain, especially when compared with military populations who would not be expected to have small chests. However, the differences are not great, and could result from minor variations in measuring technique, more fat among the present civilians, or both.

Women in the United States have a chest girth which appears to be somewhat smaller than a large group of women measured in a previous clothing survey, though differences in the age distribution make direct comparisons difficult. In addition, the measurements were taken at a slightly lower anatomic level in the earlier study. This lack of standardization of the anatomic location for chest circumference among females makes other comparisons inadvisable where the measuring techniques are even more divergent.

Waist Girth

Waist girth, for men in the general civilian population of this country, averaged 35.0 inches, the middle 90 percent falling approximately between 28.4 and 42.9 inches, a range of 14.5 inches, and the middle 98 percent between 26.8 and 46.6 inches, a range of 19.8 inches. There was a marked increase with age in this dimension, as would be expected; the greatest increase—2.2 inches—occurring between the youngest men, 18-24 years, with the smallest waist circumferences, and the 25-34-year age group. The mean values were 31.9 and 34.1 inches, respectively. The dimension increased steadily with age to a maximum of 36.6 inches at 55-64 years. From that point there was a decline to 35.7 inches for the oldest men, 75-79 years (table 6 and fig. 6).

Women in the United States averaged 30.2 inches in waist girth, 4.8 inches less than men. About 90 percent of all women fell between 24.1 and 39.1 inches, a 15.0-inch range, and 98 per-

Table F. Chest girth in inches for selected groups

Sex and group	Number measured	Age			Chest girth	
		Mean	Standard deviation	Range in years	Mean	Standard deviation
Men						
Present study	3,091	---	---	18-79	39.2	---
	411	---	---	18-24	37.8	---
	675	---	---	25-34	39.1	---
	703	---	---	35-44	39.6	---
	547	---	---	45-54	39.8	---
	418	---	---	55-64	39.3	---
	265	---	---	65-74	38.9	---
	72	---	---	75-79	37.9	---
U.S. veterans (31)	144	---	---	25-34	38.5	2.86
	259	---	---	35-44	39.0	2.57
	157	---	---	45-54	39.3	2.50
Spanish-American War veterans(32)	133	81	3.5	72-91	37.9	3.0
Old Americans, fathers(38)	398	19.7	---	---	34.2	2.24
Old Americans, sons(38)	479	18.5	---	---	35.8	1.06
Air traffic control trainees(39)	681	27	6.2	25-50	38.2	2.6
Former naval aviators(34)	675	47	---	42-62	40.4	2.3
U.S. Air Force flying personnel(40)	4,063	27	4.2	18-54	38.8	2.5
U.S. Air Force older pilots(41)	398	---	---	30-54	39.7	2.4
U.S. Air Force basic trainees(42)	3,330	18	1.9	17-36	35.6	2.4
U.S. Army(43)	24,470	23	---	---	36.4	2.3
U.S. Army aviators(44)	500	30	4.6	20-47	37.7	2.1
Italians, military(35)	1,358	23	---	18-59	37.4	2.07
Greeks, military(35)	1,084	22	---	17-43	36.4	2.01
Turks, military(35)	915	22	---	17-45	35.9	1.98
U.S. Army(33)	514	24	---	17-51	37.7	2.83
Women						
Present study	3,581	---	---	18-79	34.7	---
	534	---	---	18-24	32.9	---
	746	---	---	25-34	33.7	---
	784	---	---	35-44	34.7	---
	705	---	---	45-54	35.3	---
	443	---	---	55-64	36.2	---
	299	---	---	65-74	35.7	---
	70	---	---	75-79	34.8	---
Clothing survey(45)	10,042	22.7	5.6	18-63	34.8	3.2

NOTE: Numbers in parentheses refer to source of data, see references.

cent between 22.9 and 44.3 inches, a 21.4-inch range. Women were more variable in this measurement than men with the largest waists almost twice as large as the smallest. At the upper end of the distribution, around the 99th percentiles, the difference between the sexes in this measurement was smallest, 2.3 inches.

For women, the pattern of changes with age in waist girth differed slightly from that of men. From the youngest group, 18-24 years, to the 25-34 group there was an increase of 1.1 inches, half that of the men. Thereafter the increase by decades was greater than for men -- 1.4, 1.4, 1.6, and finally a rise of only 0.4 inches to a maximum of 33.1 inches at 65-74 years, one decade later than the maximum value for men. Only with the last age group, age 75-79 years was there a very slight decline—namely 0.3 inch, to 32.8 inches (table 6 and fig. 6).

Comparisons of the waist circumference values from the present study, measured at the natural "waistline" or indentation, with the results of other studies are also only valid where the latter have been taken in a similar way. Civilian data on "Old American" fathers and sons measured at Harvard by D.A. Sargent during the first third of this century[38] show the present findings for American men aged 18-24 years to exceed the fathers at age 19 by 3.2 inches, and the sons at age 18 by 3.0 inches (table G). Some of this is attributable to the older average age for this group in the present study but some may also reflect overnutrition of a large segment of the contemporary population.

When compared with contemporary U.S. military populations, one would expect the men from the present study to have the larger waist circumferences, since civilians in general will be less physically fit, with more fat deposition, than service men. This proves to be the case. The sole exception from the present comparative data are the 18-24-year-old Army men from Fort Devens,[33] who were significantly larger (0.5 inch) in waist girth than the present civilians of comparable age. However, much of this difference probably stems from the preponderance in the military group of men in the upper part of the 18-24-year range. When Fort Devens men aged 25-34 years are compared with the present group, the latter have larger waists by 0.5 inch. When compared with

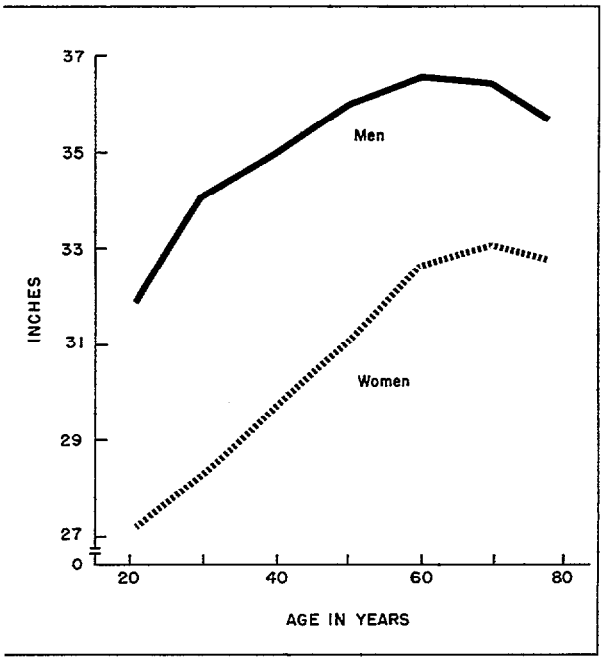

Figure 6. Average waist girth for adults, 18-79 years.

Air Force flyers,[40] averaging 27 years of age, the American civilian men aged 25-34 years from the present study are 2.1 inches larger. They are also 1.4 inches larger than Army aviators, with an average age of 30 years. The 18-24-year-old civilians are 1.6 inches larger than a group of Air Force basic trainees[42] with an average age of 18 years, though this might be expected because of the difference in the age distributions.

For women, where comparable data are available, the pattern is the same as that for men—that is, American women from the present study had larger waists. When compared with "Old American" mothers and daughters of Eastern women's colleges, measured over 50 years ago,[38] the American women from the present study aged 18-24 years averaged 2.9 inches larger than the mothers at age 19 and 1.5 inches larger than the daughters at age 18. As with the "Old American" males, part of this increase may be due to differences in the age distribution, and part to the difference in overall size. One hundred working women with an average age of 36 years[46] had a waist circumference of 28.8 inches which the present 35-44-year-old women exceeded substantially, by 0.9 inch. As for military compari-

Table G. Waist girth in inches for selected groups

Sex and group	Number measured	Age			Waist girth	
		Mean	Standard deviation	Range in years	Mean	Standard deviation
Men						
Present study	3,091	---	---	18-79	35.0	---
	411	---	---	18-24	31.9	---
	675	---	---	25-34	34.1	---
	703	---	---	35-44	35.0	---
	547	---	---	45-54	36.0	---
	418	---	---	55-64	36.6	---
	265	---	---	65-74	36.5	---
	72	---	---	75-79	35.7	---
U.S. Air Force flying personnel(40)	4,063	27	4.2	18-54	32.0	3.0
U.S. Air Force older pilots(41)	398	---	---	30-54	32.9	2.9
U.S. Air Force basic trainees(42)	3,330	18	1.9	17-36	30.3	2.7
U.S. Army aviators(44)	500	30	4.6	20-47	32.7	2.5
U.S. Army white (33)	347	---	---	18-24	32.4	3.23
	60	---	---	25-34	33.6	3.45
Old Americans, fathers(38)	397	19.7	---	---	28.7	2.12
Old Americans, sons(38)	478	18.5	---	---	28.9	1.94
Women						
Present study	3,581	---	---	18-79	30.2	---
	534	---	---	18-24	27.2	---
	746	---	---	25-34	28.3	---
	784	---	---	35-44	29.7	---
	705	---	---	45-54	31.1	---
	443	---	---	55-64	32.7	---
	299	---	---	65-74	33.1	---
	70	---	---	75-79	32.8	---
Working women(46)	100	36	---	20-59	28.8	2.8
WACS and Army nurses(47)	8,454	26	---	---	26.5	2.5
WAF basic trainees(48)	852	19	2.7	18-34	25.9	1.6
Old Americans, mothers(38)	413	18.8	1.25	---	24.3	1.61
Old Americans, daughters(38)	253	17.9	0.88	---	25.7	1.91

NOTE: Numbers in parentheses refer to source of data, see references.

sons, World War II WACS and Army nurses, with an average age of 26,[47] were 1.8 inches smaller than the most comparable age group of the present series. WAF basic trainees,[48] with an average age of 19 years, had a mean waist 1.3 inches smaller than the 18-24-year-old civilians in the general population.

In general, both American men and women as determined in the study had larger waists than almost all other groups in the civilian and military population available for comparison.

Biacromial Diameter

For men in the general civilian population of this country as indicated in the present study, biacromial diameter (shoulder breadth) averaged 15.6 inches. About 90 percent of all men ranged in this measurement between 14.3 and 17.0 inches, a difference of 2.7 inches, and approximately 98 percent varied between 13.5 and 17.5 inches, a difference of 4.0 inches.

The age-associated decline on the average in this measurement was slow until the fifties. The average value of 15.8 inches for the youngest group 18-24, remained constant for the 25-34 group, and dropped only 0.1 inch in each of the next two decades. From 45-54 there was a faster decline of 0.2 inch per decade to 15.2 inches at 65-74 years. The largest decrease here, as in most of the other measurements, occurred in the 75-79 year range, where the value fell to 14.7 inches (table 7 and fig. 7). Some of this apparent decrease with age undoubtedly reflects a long-term increase in body size. In addition, however, there is the possibility of actual changes in this dimension with age. Decreases in overlying fat or muscle are unlikely to influence this primarily skeletal measurement, but bone is lost late in life through osteoporosis. Differential survival could also effect such a decrease if relatively greater proportions of smaller persons, with smaller biacromial diameters, survive to old age—an uncertain point. Changes in the shape of the bony shoulder girdle with age could also be a factor.

Among women in the general civilian population biacromial diameter averaged 13.9 inches, or 1.7 inches less than the average for men. About 90 percent of all women varied between 12.8 and 15.2 inches, a 2.4-inch range, and approximately

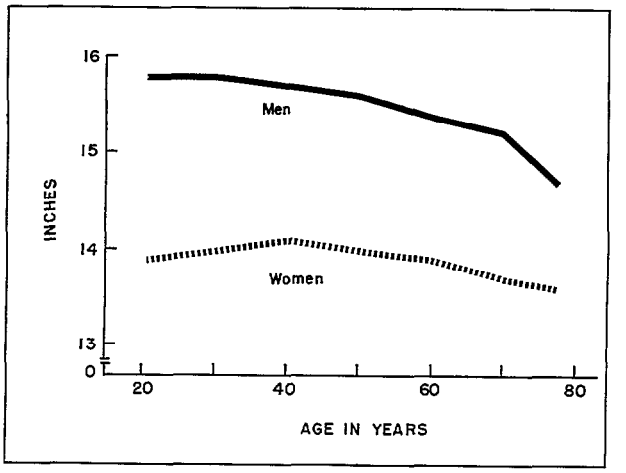

Figure 7. Average biacromial diameter for adults, 18-79 years.

98 percent between 12.3 inches and 15.7 inches, a 3.4-inch range. There was less of a sex difference at the lower end of the distribution than at the upper end, i.e., first percentile men are 1.2 inches larger than corresponding women, but 1.8 inches larger at the 99th percentiles, though in part the magnitude of these differences may result from the gross sizes of the persons being compared.

Age differences for women in this measurement were very slight and are less than for men. Here there was a slight increase with age from an average of 13.9 inches at 18-24 years to a maximum of 14.1 inches at 35-44 years. Then a slow decline begins to a low of 13.6 inches at 75-79 years. For women the oldest group had biacromial diameters only 0.3 inch smaller than the youngest group (table 7 and fig. 7), while for men the comparable figure was 1.1 inches.

The values for biacromial diameter from the present survey agree closely with those from special groups in the U.S. population (table H). Men in the 25-34-year age range, for example, had the same mean value, 15.8 inches, as a group of healthy veterans.[31] At 35-44 and 45-54 years, the present study group was negligibly smaller, 0.1 inch. Men in the oldest age category, 75-79 years of age, were 0.2 inch smaller in their mean biacromial diameter than a group of Spanish-American War veterans with an average age of 81 years.[32] Subjects in their twenties from the Tecumseh, Michigan Community Health Study[30] were

Table H. Biacromial diameter in inches for selected groups

Sex and group	Number measured	Age			Biacromial diameter	
		Mean	Standard deviation	Range in years	Mean	Standard deviation
Men						
Present study	3,091	---	---	18-79	15.6	---
	411	---	---	18-24	15.8	---
	675	---	---	25-34	15.8	---
	703	---	---	35-44	15.7	---
	547	---	---	45-54	15.6	---
	418	---	---	55-64	15.4	---
	265	---	---	65-74	15.2	---
	72	---	---	75-79	14.7	---
U.S. veterans (31)	144	---	---	25-34	15.8	0.69
	256	---	---	35-44	15.8	0.68
	158	---	---	45-54	15.7	0.71
Longitudinal growth study, Boston(36)	60	---	---	28-36	15.8	0.77
Spanish-American War veterans(32)	133	81	3.5	72-91	14.9	0.6
Tecumseh, Michigan Community Health Study(30)	418	---	---	20-29	16.0	0.85
Former naval aviators(34)	675	47	---	42-62	16.0	0.70
U.S. Air Force flying personnel(40)	4,063	27	4.2	18-54	15.8	0.74
U.S. Air Force older pilots(41)	398	---	---	30-54	15.9	---
U.S. Army(33)	344	---	---	18-24	15.7	0.76
	60	---	---	25-34	15.8	0.74
Italians, military(35)	1,358	23	---	18-59	15.7	0.72
Greeks, military(35)	1,084	22	---	17-43	15.3	0.78
Turks, military(35)	915	22	---	17-45	15.6	0.68
Irishmen(49)	8,955	---	---	20-94	15.2	---

See note at end of table.

Table H. Biacromial diameter in inches for selected groups—Con.

Sex and group	Number measured	Age			Biacromial diameter	
		Mean	Standard deviation	Range in years	Mean	Standard deviation
Women						
Present study	3,581	---	---	18-79	13.9	---
	534	---	---	18-24	13.9	---
	746	---	---	25-34	14.0	---
	784	---	---	35-44	14.1	---
	705	---	---	45-54	14.0	---
	443	---	---	55-64	13.9	---
	299	---	---	65-74	13.7	---
	70	---	---	75-79	13.6	---
Tecumseh, Michigan Community Health Study(30)	475	---	---	20-29	14.3	0.76
Working women(46)	100	36	---	20-59	14.0	0.54
"Normal women" Upstate New York(37)	94	---	---	16-30	14.7	0.69
	26	---	---	30-40	14.9	0.52
	27	---	---	40-50	14.9	0.55
	21	---	---	50-60	14.5	0.76
	14	---	---	60-70	14.6	0.57
Longitudinal growth study, Boston(36)	60	---	---	28-36	14.2	0.61
U.S. Army nurses(50)	152	---	---	---	13.4	---
Women pilots(50)	447	---	---	18-35	13.8	---

NOTE: Numbers in parentheses refer to source of data, see references.

0.2 inch larger than the roughly similar age ranges from the present study. Former naval aviators,[34] a group large in overall size, had mean biacromial diameters about 0.5 inch larger than the Health Examination Survey subjects, while those in a Boston longitudinal growth study[36] showed similar values to those in the present study for the comparable age range.

Compared with U.S. military populations, who are preselected for health and size, both extremes in height and weight being eliminated, males in the general civilian population were nevertheless very similar in biacromial diameter. At 18-24 years they were only 0.1 inch larger at the mean than a group of Army men,[33] and at 25-34 years the values were identical. Compared with a group of Air Force flyers[40] with an average age of 27 years, measured in 1950, the 50th percentile values for the 25-34-year-old group from the present study (those most comparable in terms of age), have identical values, 15.8 inches. At the upper end of the distribution, however, the present civilians have biacromial diameters broader than the Air Force flyers by 0.4 inch at the 99th percentile. The latter substantial difference may reflect the presence in the civilian population of men too large to be accepted into military service.

Compared with selected foreign populations, American civilian men appear slightly larger, 0.1 inch when compared with Italian military personnel of roughly comparable age. They were 0.2 inch larger than Turkish military personnel and 0.5 inch larger than Greek military personnel. In all three cases,[35] however, the American civilians were taller and heavier, hence broader shoulders might be expected. When compared with large groups of men measured in Ireland in the 1930's,[49] the American men from the present study were markedly more broad shouldered, by 0.4 inch for the younger age groups, on the average, dropping to about 0.2 inch for the older ages.

In general, findings for American civilian men from this study were quite comparable in biacromial diameter to special groups in this country which have been studied and, taking into account overall differences in body size, were also fairly comparable to representative European populations.

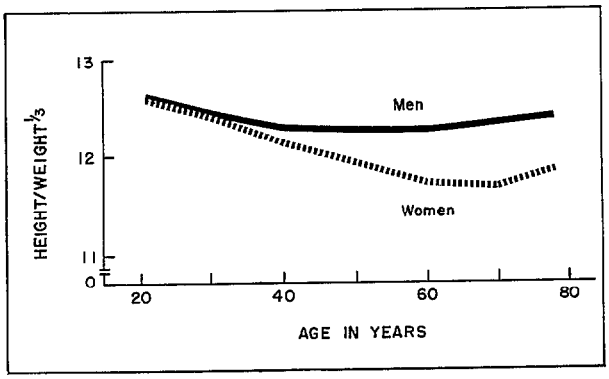

Figure 8. Average ponderal index, height/weight$^{1/3}$, for adults, 18-79 years.

For women, a large group of subjects in their twenties from the Tecumseh, Michigan Community Health Study[30] had mean biacromial diameters about 0.3 inch broader than the American women in this age range from the present study. Those in the Boston longitudinal growth study[36] were about 0.2 inch larger, whereas a group of working women measured in the 1930's[46] had a similar mean value. Both a group of Army nurses and women pilots[50] were smaller. The "normal women" from Upstate New York[37] had mean biacromial diameters almost an inch larger than the present series. Since they were also about an inch taller, larger shoulder breadths would be expected for this reason alone, though in the present case slight differences in measuring technique may also be involved.

Height / Weight $^{1/3}$

For American men in the general civilian population, the average ponderal index was found in this study to be 12.40. The middle 90 percent of this population fell between 11.31 and 13.44, a range of 2.13 index units. At the outer extremes, approximately 98 percent fell between 10.82 and 13.84, a range of 3.02.

Changes with age in mean values varied only between 12.30 and 12.67, the higher value being at the youngest age group and the lower for the two decades between 45 and 64 years. There was a steady decrease from 18-24 years to 45 years, then a slow rise from 64 years on (table 8 and fig. 8).

For women, height/weight$^{1/3}$ averaged 12.15, or 0.25 index units lower than the comparable value for men. About 90 percent of women in the United States ranged between 10.63 and 13.37, a range of 2.74, and 98 percent varied between 10.12 and 13.82, a range of 3.70. The 95th and 99th percentiles had fairly similar values for both men and women, but women were lower by about 0.70 units at both the 5th and 1st percentiles. Age changes in this index were more marked for women than for men, the values ranging from 11.72 to 12.66 for the former. There was a con-

Table J. Height/weight $^{1/3}$ for selected groups

Sex and group	Number measured	Age			Height/weight $^{1/3}$	
		Mean	Standard deviation	Range in years	Mean	Standard deviation
Men						
Present study	3,091	---	---	18-79	12.40	---
	411	---	---	18-24	12.67	---
	675	---	---	25-34	12.48	
	703	---	---	35-44	12.32	---
	547	---	---	45-54	12.30	---
	418	---	---	55-64	12.30	---
	265	---	---	65-74	12.35	---
	72	---	---	75-79	12.42	---
U.S. veterans (31)	137	---	---	25-34	12.58	0.58
	245	---	---	35-44	12.47	0.48
	160	---	---	45-54	12.40	0.43
Longitudinal growth study, Boston (36)	54	---	---	28-36	12.51	0.52
Former naval aviators (34)	675	47	---	42-62	12.48	0.44
Truck drivers (51)	269	37	8.2	---	12.48	0.64
U.S. Army (33)	527	24	5.4	17-51	12.73	0.63
Women						
Present study	3,581	---	---	18-79	12.15	---
	534	---	---	18-24	12.66	---
	746	---	---	25-34	12.45	---
	784	---	---	35-44	12.18	---
	705	---	---	45-54	11.97	---
	443	---	---	55-64	11.75	---
	299	---	---	65-74	11.72	---
	70	---	---	75-79	11.88	---
Longitudinal growth study, Boston (36)	49	---	---	28-36	12.86	0.63
Normal white women, New York City (52)	140	46	---	---	12.13	0.71
Normal Negro women, New York City (52)	103	37	---	---	12.10	0.81

NOTE: Numbers in parentheses refer to source of data, see references.

sistent decline in this index with age from the youngest age group to the oldest for women, except for a slight rise in the very oldest age group (table 8 and fig. 8).

Since women generally are less muscular and have less robust skeletons than men, their lower ponderal index is due entirely to their greater adiposity. The fall in middle adult life reflects weight increase, whereas the rise at age 75-79 shows that weight loss exceeds loss in stature.

Comparative data from other studies are shown in table J. Subjects in a Boston longitudinal growth study[36] had only slightly larger index values for the closest comparable age range. Healthy veterans[31] were 0.10 units higher at 25-34 years, about 0.15 units higher at 35-44 and again 0.10 units higher at 45-54 years. Former naval aviators[34] were higher by about 0.18 units, as were a group of commercial truck and bus drivers.[51] The highest value in this index occurred among the U.S. Army men,[33] as indicated, which might be expected because of their youth and their presumably better physical condition.

For women, subjects in a Boston longitudinal growth study[36] had a fairly high mean value in this index, 12.86, or about 0.41 units higher than the most closely comparable age subgroup from the present study. This difference may represent a greater concern for "weight-watching" in the former group. Two groups of normal New York City women, one white and one Negro,[52] showed fairly similar values with the present series when age is taken into account.

100 X Sitting Height / Stature

For men in the general civilian population, this index had an average value of 51.8. About 90 percent fell between values of 49.9 and 54.6, a range of 4.7 units, and 98 percent fell between 48.5 and 55.8, a range of 7.3 units. Age changes in this index ranged from a low of 51.4 for the oldest group to a high of 52.0 for the 35-44 group. There was a small increase up to middle age, followed by small decreases in succeeding decades (table 9 and fig. 9).

Women in the general civilian population had an average value in this index of 52.4, or 0.6 units larger than the comparable value for men. They thus had slightly longer trunks, relative

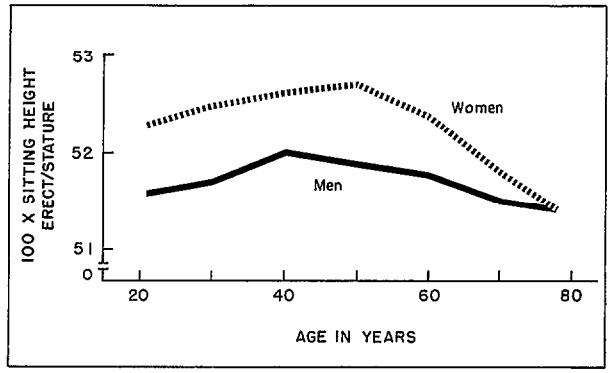

Figure 9. 100 x average sitting height erect/stature for adults, 18-79 years.

to their stature, than did men. About 90 percent varied between 50.3 and 55.2, a range of 4.9 units, and 98 percent between 49.0 and 56.2, a range of 7.2 units. Male-female differences in this ratio of the 1st, 5th, 95th, and 99th percentiles averaged about 0.5 units, with the women having consistently larger values. Age changes followed a pattern like that for men, though more marked; namely, slight increases to a high of 52.7 at 45-54 years, about 10 years later than for men, followed by small decreases to the lowest value of 51.4 at 75-79 years (table 9 and fig. 9).

The increase through early adult life reflects continuing bony growth of the vertebral bodies, whereas the decrease thereafter results from shrinkage of intervertebral discs.

Women had longer trunks relative to stature than men, but the amount of their excess was inflated by the greater gluteal fat of the women, which gives a longer trunk than skeletal measurements alone would indicate. Comparative values for other groups are presented in table K. Only among the two Negro groups is this index smaller than in the present study.

100 X Chest Circumference / Stature

The average value of this index for men in the general civilian population was 57.4. About 90 percent varied between 49.7 and 65.8, a difference of 16.1, and 98 percent ranged between 47.6 and 70.8, a difference of 23.2 units. In the youngest age group, 18-24 years, the value of this index was lowest, 55.1. From 25-44 years there was a

Table K. 100 x sitting height, erect/stature for selected groups

Sex and group	Number measured	Age			100 x sitting ht./ stature
		Mean	Standard deviation	Range in years	Mean
Men					
Present study	3,091	---	---	18-79	51.8
	411	---	---	18-24	51.6
	675	---	---	25-34	51.7
	703	---	---	35-44	52.0
	547	---	---	45-54	51.9
	418	---	---	55-64	51.8
	265	---	---	65-74	51.5
	72	---	---	75-79	51.4
Longitudinal growth study, Boston (36)	58	---	---	28-36	52.8
Air traffic control trainees (39)	678	27	6.2	21-50	52.0
Former naval aviators (34)	675	47	---	42-62	52.6
U.S. Army, white (53)	24,352	23	---	---	52.3
U.S. Army, Negro (53)	6,642	23	---	---	50.4
U.S. Army drivers, white (33)	431	24	---	---	51.9
U.S. Army drivers, Negro (33)	79	27	---	---	50.1
U.S. Air Force flying personnel (40)	4,061	27	---	18-54	52.0
U.S. Army aviators (44)	500	30	4.6	20-46	51.8
Italians, military (35)	1,358	22	---	18-59	52.6
Greeks, military (35)	1,084	22	---	17-43	52.9
Turks, military (35)	915	22	---	17-45	53.0
South Vietnamese, military (54)	2,129	27	5.7	18-53	53.0
Thailand, military (55)	2,950	24	4.0	17-52	52.9
Japanese, Tanushimaru (28)	499	---	---	40-59	54.6

See note at end of table.

Table K. 100 x sitting height, erect/stature for selected groups—Con.

Sex and group	Number measured	Age			100 x sitting ht./ stature
		Mean	Standard deviation	Range in years	Mean
Women					
Present study	3,581	---	---	18-79	52.4
	534	---	---	18-24	52.3
	746	---	---	25-34	52.5
	784	---	---	35-44	52.6
	705	---	---	45-54	52.7
	443	---	---	55-64	52.4
	299	---	---	65-74	51.8
	70	---	---	75-79	51.4
Longitudinal growth study, Boston (36)	60	---	---	28-36	53.0
"Normal women" Upstate New York (37)	94	---	---	16-30	53.0
	26	---	---	30-40	53.0
	27	---	---	40-50	53.2
	21	---	---	50-60	52.7
	14	---	---	60-70	53.3
"Normal working women" (46)	100	36	---	20-59	53.0
U.S. Army nurses (50)	152	---	---	---	53.1
Women pilots (50)	447	---	---	18-35	52.6

NOTE: Numbers in parentheses refer to source of data, see references.

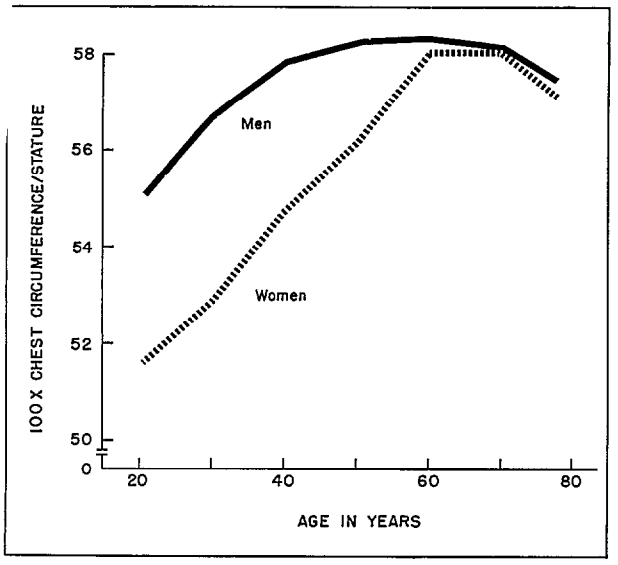

Figure 10. 100 x average chest circumference/stature for adults, 18-79 years.

marked increase to 57.9. Thereafter the value remained fairly constant, over the next three decades, i.e., 58.3, 58.4, and 58.2, declining to 57.5 at 75-79 years (table 10 and fig. 10).

For women, the chest circumference/stature ratio had an average value of 55.1 or 2.3 points less than that for men. However, these values are not comparable since chest circumference was measured at different anatomic locations for women and men. Ninety percent of the women varied between 47.4 and 65.1, a range of 17.7 while 98 percent varied between 45.1 and 69.9, a range of 24.8. The general pattern of changes with age in this index for women roughly paralleled that for the men. The lowest value, 51.6 occurred in the youngest group with steady increases over the following decades to a high of 58.1 at 55-74 years, followed by a slight drop to 57.1 for the oldest group, 75-79 years (table 10 and fig. 10). The rise in middle life corresponds to the increase in weight and fat; the fall at ages 75-79 years indicates that weight and fat are being lost more rapidly than height.

100 X Biacromial Diameter / Stature

American men in the general civilian population had an average value for this index of 22.5. The range from the 5th to 95th percentiles is from 20.0 to 24.0, a total of 4.0 units, and that from the 1st to 99th percentiles, from 19.1 to 25.0, a total of 5.9 units difference (table 11 and fig. 11). Age-related changes in this index were negligible, except for the very oldest group which was slightly more narrow-shouldered.

Women in the general civilian population had an average value in this index of 21.7, or 0.8 units less than men. Women were thus, as expected, more narrow-shouldered than men, relative to stature. About 90 percent of women were between 19.3 and 23.2, a range of 3.9 units, and 98 percent between 18.3 and 24.1, a range of 5.8 units. Age changes for women were likewise negligible (table 11 and fig. 11).

Relationship of Measures

The interrelation of these various physical measurements provides more definitive information on body build and compostion and on the extent of variation in them than do the previously mentioned indices.

Correlation coefficients showing the degree of rectilinear relationship of the various body measurements obtained in Cycle I of the Health Examination Survey with height, weight, and age are shown in table 12. Partial and multiple correlations and the linear regression equations for prediction of each of the other measures from height, weight, and age are given in tables 13 and 14. Since not all of these measures are normally distributed, prediction will be more precise in

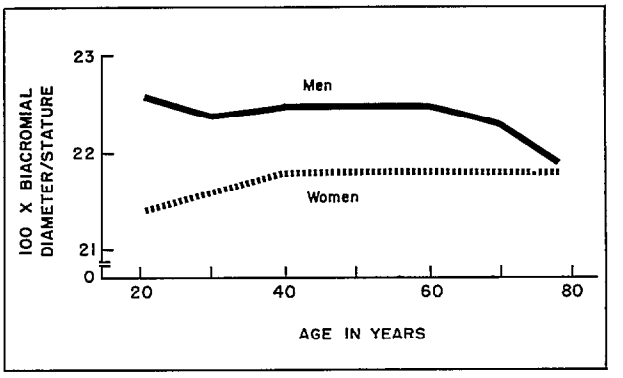

Figure 11. 100 x average biacromial diameter/stature for adults, 18-79 years.

the region of the means than at the extremes of the distributions.

As would be expected, body lengths among men are more closely associated with *height* while breadths, girths, skinfolds, and other measures involving adipose tissue show lower degrees of relationship. The association with body lengths ranges from +0.60 for buttock-popliteal length to +0.80 for knee height. Correlations with measures involving adipose tissue ranged from +0.39 for weight to 0.00 for the infrascapular skinfold. Correlations of less than +0.10 were found for elbow-to-elbow breadth, arm skinfold, sum of skinfolds, and waist girth.

Measures affected by adipose tissue are conversely more closely associated with *weight* in men than are the body lengths. The degree of relationship of the former ranges from +0.55 for buttock-knee length to +0.88 for chest girth. The correlation also equals or exceeds +0.80 for arm girth (+0.85), waist girth (+0.82), seat breadth (+0.81), and elbow-to-elbow breadth (+0.80). There tends to be a higher degree of association for all measures with weight than with height. The lowest order of association was found for popliteal height (+0.15).

In general among men the measurements show a low degree of association with *age*. The most closely associated with age are waist girth (+0.30), and elbow-to-elbow breadth (+0.16). All but these two measures, chest girth (+0.06), infrascapular skinfold (+0.04), and seat breadth (+0.04), show a negative association with age, ranging from a negligible -0.04 for arm skinfold to -0.27 for sitting height erect, reflecting the decrease in these measures with age.

When the effect of age and weight for men is removed, the six body lengths remain the most closely associated with height but the degree of relationship is reduced somewhat for each. The relation of the other measures with height is substantially reduced. Removing the effect of age and height increases the degree of association with weight for the girths, elbow-to-elbow breadth, arm skinfold, and infrascapular skinfold but reduces it somewhat for the rest. The relationship with age, when the effect of height and weight is removed, increases the association of this factor with waist girth (+0.30 to +0.57), elbow-to-elbow breadth (+0.16 to +0.26), chest girth (+0.06 to +0.16), and seat breadth (+ 0.04 to 0.16). The rest continue to show a low positive or negative relationship indicating no change or a decrease with age.

The association of each measure with height, weight, and age combined for men is increased over that for the highest corresponding simple and partial correlations as may be seen in tables 12 and 14 and appendix III. The improvement is statistically significant only for chest girth, elbow-to-elbow breadth, infrascapular skinfold, and biacromial diameter.

As is true for men, the body lengths among women are more closely associated with height than are measures involving breadths and adipose tissue. The range among the lengths is similar to that for men, from +0.51 for buttock-popliteal length to +0.78 for knee height. With the exception of biacromial diameter, elbow rest height and sitting height which are roughly similar for both sexes, the degree of association for all the measurements is lower for women than for men.

Measurements involving breadths and adipose tissue generally show a similar order of association to weight for women as was found for men. For women, these range from +0.62 for buttock-knee length to +0.88 for chest girth. With the exception of buttock-popliteal length, the length measurements are not as closely associated with weight in women as they were in men.

With age a higher degree of association was found among women than men for the girths, skinfolds, elbow-to-elbow breadth, and seat breadth. Height, with the effect of age and weight removed, shows a relationship to these measurements among women generally similar to that found for men, with the lengths remaining closely associated to stature while the degree of association of the others with weight is reduced substantially from that for the simple correlations.

Weight, with the effect of age and height removed, is less closely associated with buttock-popliteal length, sitting height erect and normal, knee height, and popliteal height while the relation to the remaining measures is not altered significantly among women in contrast to the findings for men.

When the effect of height and weight is removed, the association of age with length measures is increased or shows a smaller negative relationship while for the others the associations are reduced or show negligible changes.

The association with height, weight, and age of only five of the measures are increased significantly over that for the larger simple or partial correlations—waist girth, buttock-knee length, elbow rest height, biacromial diameter, and buttock-popliteal length.

Correlation coefficients showing the degree of linear association among all of the 18 measures are shown in appendix III. Since these are based on unweighted data they can be expected to differ slightly from the true linear association which could have been found had full use been made of the sample design.

These measures of the degree of association found in a highly representative sample of the population of the United States and the corresponding estimates for the population are included here for use in further studies of body size, its relation to various genetic and environmental factors, and for other purposes.

General Discussion

Men and women in the civilian, noninstitutional population of the United States were found to be larger and fatter than those groups from other countries for whom comparable data were available. Body size, shape, and composition are determined by both genetic and environmental factors. Disease and undernutrition can prevent persons from reaching their full genetic potential, as demonstrated by the rapid increases in stature and correlated body dimensions among migrant groups within a single generation after coming to the United States. The amount of such growth has been found by Shapiro[56] to be as much as 1.2 inches for groups of Japanese migrants to Hawaii, and by Damon[57], 2.1 inches for Italian-American factory workers near Boston, Massachusetts.[57] Once full genetic endowment has been achieved, further environmental amelioration will not increase height, but may increase weight according to findings of Bakwin and McLaughlin[58] and Damon.[59] Since skinfolds, a direct measure of fat, correlate negligibly with stature, greater height cannot explain the greater adiposity of men and women in the United States compared with other national populations. Overnutrition and sedentary habits with little physical exercise are probably responsible.

The importance of fat is that it constitutes a hazard to health, but it is the most labile body tissue and the most amenable to alteration. Obese persons have been found to have lower life expectancy, to be at greater risk during surgical procedures, and to be more subject to cardiovascular diseases, strokes, and diabetes than persons of lean or average physique.

SUMMARY

The seven body measurements and four indices reported here from the Health Examination Survey of adults in the civilian, noninstitutional population aged 18-79 years in 1960-62 showed the following characteristics:

1. Men had right arm skinfolds averaging 1.3 centimeters, with about 90 percent falling between 0.5 and 2.8 centimeters, and approximately 98 percent between 0.4 and 4.1 centimeters. This skinfold increased with age from 1.1 centimeters at 18-24 years to a high of 1.4 centimeters between 25-44 years, thereafter decelining to 1.1 centimeters at the oldest age range, 75-79 years.

   Women had right arm skinfold values consistently larger than those for men. Their average was 2.2 centimeters, with about 90 percent falling between 1.1 and 3.8 centimeters, and about 98 percent between 0.8 and 4.6 centimeters. Women had their lowest value, 1.8 centimeters, in the youngest age range, increasing consistently thereafter with age to a high of 2.5 centimeters at 55-64 years, then falling to 2.0 centimeters at 75-79 years.

2. Infrascapular skinfolds for men averaged 1.5 centimeters. About 90 percent fell between 0.7 and 3.0 centimeters, and 98 percent ranged between 0.6 and 4.1 centimeters. Changes with age were relatively small, ranging from 1.3 centimeters at 18-24 years to a high of 1.6 at 35-54 years, then falling to 1.3 centimeters again at the oldest ages.

   Women had infrascapular skinfold values larger than those for men though the differences were less marked than for the right arm. The average was 1.8 centimeters. About

90 percent ranged between 0.7 and 3.6 centimeters, and 98 percent between 0.6 and 4.5 centimeters. The lowest value was found in the youngest age group, after which there was a consistent increase to 2.2 centimeters at 55-64 years, and an ensuing decline to 1.7 centimeters at 75-79 years.

3. Men had a mean sum of skinfolds of 2.8 centimeters. Approximately 90 percent fell between 1.2 and 5.4 centimeters, and 98 percent between 1.0 and 7.1 centimeters. From 2.4 centimeters at 18-24 years, mean values increased to a high of 3.0 at 35-44, followed by a consistent decline to a low of 2.3 at 75-79 years. For men the infrascapular skinfold contributed the larger portion of the sum of skinfold value.

Women had a sum of skinfolds averaging 4.0 centimeters, with about 90 percent falling between 1.8 and 7.1 centimeters, and 98 percent between 1.4 and 8.6 centimeters. Women had their lowest value, 3.1 centimeters, at the youngest age, 18-24 years, and their highest, 4.7 centimeters, at 55-64 years. Thereafter there was a decline to 3.7 centimeters at 75-79 years. For women the right arm skinfold contributes the larger portion of the sum of skinfold value.

4. Right arm girth in men averaged 12.1 inches. About 90 percent varied between 10.1 and 14.2 inches, and 98 percent between 9.2 and 15.4 inches. At 18-24 years this measurement averaged 11.8 inches, at 35-44 years there was a high of 12.4 inches, and at 75-79 a low of 10.9 inches.

For women, right arm girth had a mean value of 11.2 inches. Approximately 90 percent fell between 9.0 and 14.4 inches, and about 98 percent varied between 8.3 and 15.8 inches. The lowest value, 10.2 inches, was found in the youngest group, followed by a consistent increase to a high of 11.9 inches at 55-64 years, and followed in turn by a decrease to 11.0 inches at 75-79 years.

5. For chest girth, men had an average value of 39.2 inches. About 90 percent of this population ranged between 34.3 and 44.9 inches, and 98 percent between 32.5 and 47.7 inches. The lowest value of chest girth, 37.8 inches, was found in the youngest age group, 18-24 years, the highest value, 39.8 inches, at 45-54 years. By 75-79 years, chest girth had dropped to 37.9 inches.

Women had an average chest girth (measured at a different anatomic location than for men) of 34.7 inches. Roughly 90 percent fell between 30.4 and 40.5 inches, and 98 percent between 29.0 and 43.5 inches. By age, the lowest value was found at 18-24 years, 32.9 inches, followed by a consistent increase to a maximum of 36.2 inches at 55-64 years, followed in turn by a decline to 34.8 inches at the oldest age group.

6. Waist girth for men averaged 35.0 inches, with about 90 percent varying between 28.4 and 42.9 inches, and 98 percent between 26.8 and 46.6 inches. By far the smallest value, 31.9 inches was found in the youngest age group. The largest waist girths, 36.6 inches, occurred at 55-64 years, followed by a small drop to 35.7 inches at 75-79 years.

Women had an average waist girth of 30.2 inches. Approximately 90 percent fell between 24.1 and 39.1 inches, and 98 percent between 22.9 and 44.3 inches. The lowest value again was found among the youngest subjects, 27.2 inches at 18-24 years, the highest value at 65-74 years, 33.1 inches.

7. Biacromial diameter (or bony shoulder breadth) had an average value for men of 15.6 inches. About 90 percent ranged between 14.3 and 17.0 inches, and 98 percent between 13.5 and 17.5 inches. There were relatively few age changes in this measurement until the older age groups were reached. There was an average value of 15.8 inches between 18-34 years followed by a small steady decline to 14.7 inches at 75-79 years.

For women, biacromial diameter averaged 13.9 inches, with about 90 percent falling between 12.8 and 15.2 inches, and 98 percent between 12.3 and 15.7 inches. Changes with

age were even smaller than for men. From 13.9 inches at 18-24 years, there was an increase to a maximum of 14.1 inches at ages 35-44, followed by a gradual decline to 13.6 inches at 75-79 years.

8. For men, height/weight[1,3] (or the ponderal index) had an average value of 12.40. The 5th percentile of this index was about 11.31, and the 95th percentile, 13.44. For the 1st and 99th percentiles, the approximate values were 10.82 and 13.84, respectively. The general age pattern was that of a decline in this index with increasing years, from 12.67 at 18-24 years, to 12.30 at 45-64 years, followed by a small rise to 12.42 at 75-79 years.

Women had an average value in this index of 12.15, with about 90 percent falling between a low of 10.63 and a high of 13.37, and about 98 percent between 10.12 and 13.82. The pattern of age changes was generally similar to that for men. The highest value, 12.66, was found at 18-24 years, the lowest value, 11.72, was found at 65-74 years after a series of gradual declines, followed by a small rise to 11.88 for the oldest age group.

9. For men, 100 x sitting height erect/stature has an average value of 51.8. Approximately 90 percent varied between 49.9 and 54.6 in this index, and 98 percent between 48.5 and 55.8. Age changes were fairly small: from a value of 51.6 at 18-24 years, there was an increase to a maximum of 52.0 at 35-44 years, followed by a gradual decline to a low of 51.4 at 75-79 years.

For women, the average value of this index was 52.4. About 90 percent ranged between 50.3 and 55.2, and 98 percent between values of 49.0 and 56.2. From an average value of 52.3 at 18-24 years, there were slight increases to a high of 52.7 at 45-54 years, followed by a decline to 51.4 at 75-79 years.

10. The 100 x chest circumference/stature index for men had an average value of 57.4. About 90 percent fell between 49.7 and 65.8, and about 98 percent between 47.6 and 70.8. There was a fairly marked increase with age in this index from a low of 55.1 at 18-24 years to a high of 58.4 at 55-64 years. Thereafter there was a decline to 57.5 at 75-79 years.

Women had an average value in this index of 55.1 (with chest circumference taken in a different anatomic location than for men). Approximately 90 percent fell between 47.4 and 65.1, and about 98 percent between 45.1 and 69.9. Age changes were even more marked for women than for men. From a low of 51.6 there was an increase to 58.1 at 55-74 years, followed by a slight drop to 57.1 at 75-79 years.

11. For men, the 100 x biacromial/stature index had an average value of 22.5. About 90 percent ranged between 20.0 and 24.0, and 98 percent between 19.1 and 25.0. Age changes were slight: the highest value, 22.6 occurred at 18-24 years, thereafter varying by small amounts to 22.3 at 65-74, and finally to a low of 21.9 at 75-79 years.

The average value of this index for women was 21.7, with 90 percent varying between 19.3 and 23.2 and 98 percent between 18.3 and 24.1. Age changes, as for men, were slight. From a low of 21.4 at 18-24 years, there was an increase to 21.6 at 25-34, thereafter stabilizing at 21.8 for 35 through 79 years.

Comparisons are made for each of the above measures and indices with other comparable domestic and foreign studies.

The linear interrelationships of these measures are considered and equations for the prediction of each from height, weight, and age are given.

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Table 1. Right arm skinfold, average, and selected percentiles for adults, by age and sex: United States, 1960-62

Sex, average, and percentile	Total, 18-79 years	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-79 years
	Measurement in centimeters							
MEN								
Average right arm skinfold	1.3	1.1	1.4	1.4	1.3	1.2	1.2	1.1
Percentile[1]								
99	4.1	3.7	4.5	4.0	3.8	3.3	3.2	3.0
95	2.8	2.6	3.3	2.9	2.8	2.4	2.7	2.0
90	2.3	2.4	2.6	2.4	2.2	2.0	2.2	1.7
80	1.8	1.7	2.0	1.9	1.8	1.6	1.7	1.5
70	1.5	1.3	1.6	1.6	1.5	1.4	1.4	1.3
60	1.3	1.1	1.4	1.4	1.3	1.3	1.3	1.1
50	1.1	0.9	1.2	1.2	1.1	1.2	1.1	1.0
40	1.0	0.8	1.0	1.1	1.0	1.0	1.0	0.9
30	0.8	0.7	0.8	1.0	0.9	0.9	0.8	0.8
20	0.7	0.6	0.7	0.8	0.7	0.8	0.7	0.7
10	0.6	0.5	0.5	0.6	0.6	0.6	0.6	0.6
5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4
WOMEN								
Average right arm skinfold	2.2	1.8	2.1	2.3	2.4	2.5	2.4	2.0
Percentile[1]								
99	4.6	4.3	4.7	4.6	4.8	4.7	4.7	3.9
95	3.8	3.2	3.7	3.9	4.0	4.0	3.6	3.3
90	3.4	2.8	3.2	3.5	3.6	3.7	3.4	3.1
80	3.0	2.4	2.8	3.0	3.2	3.2	3.0	2.7
70	2.6	2.1	2.4	2.7	2.8	2.9	2.7	2.5
60	2.4	2.0	2.2	2.5	2.6	2.7	2.5	2.3
50	2.2	1.7	2.0	2.3	2.4	2.5	2.4	2.2
40	2.0	1.6	1.9	2.1	2.2	2.3	2.2	2.0
30	1.8	1.5	1.7	1.8	2.0	2.1	2.0	1.7
20	1.6	1.3	1.5	1.6	1.8	1.9	1.7	1.4
10	1.3	1.1	1.2	1.4	1.5	1.6	1.5	1.0
5	1.1	0.9	1.0	1.2	1.2	1.4	1.2	0.7
1	0.8	0.6	0.7	1.0	0.8	1.0	0.8	0.3

[1] Measurement below which the indicated percent of persons in the given age group fall.

Table 2. Infrascapular skinfold, average, and selected percentiles for adults, by age and sex: United States, 1960-62

Sex, average, and percentile	Total, 18-79 years	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-79 years
	Measurement in centimeters							
MEN								
Average infrascapular skinfold---	1.5	1.3	1.5	1.6	1.6	1.5	1.5	1.3
Percentile[1]								
99	4.1	4.3	4.1	4.2	3.9	4.0	3.5	3.3
95	3.0	2.4	3.1	3.1	3.0	2.9	2.9	2.7
90	2.6	2.2	2.7	2.8	2.6	2.5	2.6	2.2
80	2.1	1.6	2.2	2.2	2.3	2.1	2.1	1.8
70	1.8	1.3	1.9	1.9	1.9	1.8	1.8	1.6
60	1.6	1.2	1.6	1.7	1.7	1.6	1.6	1.3
50	1.4	1.1	1.3	1.5	1.5	1.4	1.4	1.2
40	1.2	1.0	1.2	1.3	1.3	1.3	1.2	1.1
30	1.0	0.9	1.0	1.1	1.1	1.1	1.0	0.9
20	0.9	0.8	0.9	1.0	1.0	1.0	0.9	0.8
10	0.8	0.7	0.8	0.8	0.8	0.8	0.7	0.7
5	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6
1	0.6	0.6	0.5	0.6	0.6	0.6	0.5	0.5
WOMEN								
Average infrascapular skinfold---	1.8	1.3	1.5	1.8	2.0	2.2	2.0	1.7
Percentile[1]								
99	4.5	4.0	4.6	4.3	4.6	4.9	4.1	4.3
95	3.6	2.6	3.2	3.6	3.6	3.9	3.6	3.6
90	3.1	2.2	2.7	3.2	3.3	3.6	3.4	3.0
80	2.6	1.8	2.1	2.7	2.8	2.9	2.8	2.5
70	2.2	1.6	1.7	2.2	2.5	2.6	2.5	2.1
60	1.9	1.3	1.5	1.9	2.1	2.4	2.2	1.9
50	1.6	1.3	1.3	1.6	1.9	2.2	1.9	1.7
40	1.4	1.0	1.1	1.4	1.7	1.9	1.8	1.3
30	1.2	0.9	1.0	1.1	1.4	1.6	1.6	1.1
20	1.0	0.8	0.9	1.0	1.2	1.4	1.3	0.8
10	0.9	0.7	0.7	0.8	0.9	1.1	1.0	0.6
5	0.7	0.7	0.7	0.7	0.8	0.9	0.8	0.5
1	0.6	0.5	0.5	0.6	0.6	0.6	0.6	0.4

[1]Measurement below which the indicated percent of persons in the given age group fall.

Table 3. Sum of skinfolds, average, and selected percentiles for adults, by age and sex: United States, 1960-62

Sex, average, and percentile	Total, 18-79 years	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-79 years
	Measurement in centimeters							
MEN								
Average sum of skinfolds	2.8	2.4	2.9	3.0	2.8	2.7	2.7	2.3
Percentile[1]								
99	7.1	6.8	8.0	7.6	7.1	6.8	6.1	6.3
95	5.4	5.1	6.0	5.6	5.3	4.9	5.2	4.3
90	4.6	4.5	5.1	4.9	4.6	4.3	4.5	3.7
80	3.9	3.4	4.1	4.1	3.9	3.6	3.8	3.0
70	3.3	2.7	3.5	3.5	3.5	3.2	3.3	2.7
60	2.9	2.1	3.0	3.0	3.1	2.9	2.8	2.5
50	2.5	1.9	2.6	2.8	2.7	2.6	2.5	2.2
40	2.2	1.7	2.2	2.5	2.3	2.3	2.2	1.9
30	1.9	1.6	1.9	2.1	2.0	2.1	1.9	1.8
20	1.6	1.4	1.5	1.8	1.7	1.8	1.6	1.5
10	1.3	1.3	1.3	1.5	1.4	1.4	1.3	1.3
5	1.2	1.2	1.2	1.3	1.2	1.2	1.1	1.2
1	1.0	1.0	1.0	0.9	1.0	0.9	0.9	0.9
WOMEN								
Average sum of skinfolds	4.0	3.1	3.6	4.1	4.4	4.7	4.4	3.7
Percentile[1]								
99	8.6	7.9	9.1	8.6	9.2	9.3	7.9	7.5
95	7.1	5.5	6.7	7.3	7.3	7.6	6.9	7.3
90	6.3	4.8	5.7	6.6	6.6	7.1	6.5	5.7
80	5.4	4.2	4.7	5.6	5.8	6.0	5.7	5.1
70	4.8	3.6	4.2	4.8	5.2	5.4	5.2	4.7
60	4.3	3.2	3.6	4.3	4.7	5.0	4.7	4.0
50	3.9	2.9	3.3	3.9	4.3	4.6	4.3	3.8
40	3.4	2.6	3.0	3.5	3.9	4.2	4.0	3.3
30	3.0	2.4	2.7	3.1	3.5	3.8	3.7	2.7
20	2.6	2.1	2.3	2.6	3.0	3.4	3.1	2.4
10	2.2	1.8	2.0	2.2	2.5	2.9	2.5	1.7
5	1.8	1.6	1.7	2.0	2.0	2.4	2.2	1.3
1	1.4	1.3	1.2	1.6	1.4	1.7	1.3	0.6

[1]Measurement below which the indicated percent of persons in the given age group fall.

Table 4. Right arm girth, average, and selected percentiles for adults, by age and sex: United States, 1960-62

Sex, average, and percentile	Total, 18-79 years	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-79 years
	Measurement in inches							
MEN								
Average right arm girth	12.1	11.8	12.3	12.4	12.3	11.9	11.6	10.9
Percentile[1]								
99	15.4	15.0	15.6	15.6	15.3	15.0	14.5	13.5
95	14.2	14.3	14.5	14.5	14.2	14.0	13.7	12.7
90	13.8	13.8	14.0	13.8	13.9	13.5	13.2	12.5
80	13.2	12.9	13.4	13.3	13.3	13.1	12.6	11.8
70	12.8	12.5	12.9	13.0	13.0	12.6	12.4	11.7
60	12.5	12.1	12.6	12.7	12.6	12.3	12.0	11.4
50	12.1	11.7	12.3	12.5	12.3	12.0	11.7	11.1
40	11.8	11.4	12.0	12.2	12.0	11.6	11.4	10.7
30	11.4	11.1	11.7	11.9	11.7	11.2	11.0	10.3
20	11.1	10.8	11.2	11.5	11.3	10.9	10.6	9.9
10	10.6	10.4	10.7	10.9	10.9	10.5	10.0	9.6
5	10.1	10.2	10.3	10.6	10.5	10.0	9.3	9.1
1	9.2	9.4	9.6	9.8	9.5	9.0	8.0	8.0
WOMEN								
Average right arm girth	11.2	10.2	10.8	11.4	11.7	11.9	11.5	11.0
Percentile[1]								
99	15.8	15.2	15.5	16.0	16.4	16.3	15.3	14.6
95	14.4	12.8	13.7	14.6	14.7	14.8	14.0	13.8
90	13.5	11.9	13.0	13.7	13.8	14.0	13.5	13.3
80	12.5	11.3	11.8	12.6	12.9	13.2	12.7	12.5
70	11.9	10.7	11.2	12.1	12.4	12.5	12.4	12.1
60	11.5	10.4	10.9	11.5	11.9	12.2	11.8	11.4
50	11.1	10.1	10.6	11.2	11.5	11.8	11.5	11.0
40	10.7	9.8	10.4	10.8	11.2	11.4	11.2	10.6
30	10.4	9.5	10.1	10.5	10.9	11.1	10.9	10.1
20	9.9	9.2	9.7	10.1	10.5	10.7	10.5	9.5
10	9.4	8.9	9.2	9.6	9.9	10.3	9.8	8.9
5	9.0	8.6	8.9	9.4	9.3	9.7	9.2	8.4
1	8.3	8.1	8.4	8.7	8.5	8.3	8.2	7.9

[1]Measurement below which the indicated percent of persons in the given age group fall.

Table 5. Chest girth, average, and selected percentiles for adults, by age and sex: United States, 1960-62

Sex, average, and percentile	Total, 18-79 years	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-79 years
	Measurement in inches							
MEN								
Average chest girth	39.2	37.8	39.1	39.6	39.8	39.3	38.9	37.9
Percentile[1]								
99	47.7	48.1	47.8	47.0	47.5	49.2	47.2	45.4
95	44.9	44.2	44.9	45.2	45.0	44.8	44.4	44.1
90	43.5	42.2	43.5	43.5	44.1	43.7	43.0	41.9
80	41.8	40.3	41.7	42.1	42.5	42.2	41.7	39.4
70	40.8	39.1	40.9	41.1	41.5	41.2	40.9	38.8
60	39.9	38.2	39.9	40.3	40.4	40.1	39.8	38.5
50	39.0	37.5	39.0	39.4	39.6	39.2	38.7	38.1
40	38.2	36.6	38.2	38.7	38.7	38.3	38.1	36.9
30	37.4	35.8	37.4	38.0	37.9	37.3	37.1	36.6
20	36.4	35.3	36.4	37.3	37.0	36.4	36.0	36.0
10	35.2	34.1	35.0	36.1	35.8	35.4	34.6	34.3
5	34.3	33.5	34.0	35.1	34.9	34.7	33.8	33.0
1	32.5	31.9	32.5	33.2	33.3	32.6	32.3	29.8
WOMEN								
Average chest girth	34.7	32.9	33.7	34.7	35.3	36.2	35.7	34.8
Percentile[1]								
99	43.5	40.5	43.2	43.6	43.8	43.7	42.2	42.2
95	40.5	37.4	39.2	40.5	41.2	41.7	41.0	39.9
90	39.1	36.0	37.4	38.8	39.7	40.4	39.8	39.0
80	37.3	34.6	35.9	37.3	37.7	38.9	38.5	37.1
70	36.1	33.8	34.6	36.0	36.5	37.8	37.2	36.1
60	35.0	33.2	33.8	34.8	35.7	36.8	36.4	35.7
50	34.3	32.7	33.2	34.2	34.9	36.1	35.7	35.0
40	33.6	32.2	32.6	33.5	34.4	35.2	35.0	34.5
30	32.8	31.6	32.0	32.8	33.7	34.4	34.2	33.1
20	32.0	31.0	31.4	32.1	32.9	33.7	33.4	31.9
10	31.1	30.3	30.8	31.3	31.8	32.4	32.2	30.6
5	30.4	29.7	30.0	30.7	30.8	31.4	30.9	30.1
1	29.0	28.6	28.9	29.4	29.5	30.1	29.0	29.6

[1]Measurement below which the indicated percent of persons in the given age group fall.

Table 6. Waist girth, average, and selected percentiles for adults, by age and sex: United States, 1960-62

Sex, average, and percentile	Total, 18-79 years	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-79 years
	Measurement in inches							
MEN								
Average waist girth	35.0	31.9	34.1	35.0	36.0	36.6	36.5	35.7
Percentile[1]								
99	46.6	42.4	45.8	46.3	46.7	47.6	47.7	46.2
95	42.9	39.3	41.6	42.4	43.5	43.9	44.4	42.6
90	40.8	37.7	39.6	39.8	41.6	42.2	42.5	41.3
80	38.8	35.0	37.5	38.2	39.4	40.6	40.0	38.7
70	37.3	33.6	36.0	36.9	38.3	39.1	38.7	37.2
60	36.0	32.0	35.0	35.8	37.1	37.7	37.6	36.6
50	34.8	31.2	33.7	34.6	35.9	36.5	36.8	35.8
40	33.6	30.4	32.6	33.6	34.9	35.2	35.3	35.0
30	32.3	29.5	31.4	32.7	33.5	34.1	33.9	33.7
20	31.1	28.8	30.6	31.6	32.3	32.8	32.7	32.6
10	29.5	27.8	29.3	30.5	30.6	30.9	30.8	30.8
5	28.4	27.1	28.6	29.3	29.6	29.8	28.8	28.3
1	26.8	26.0	26.6	27.3	27.9	27.5	26.9	25.8
WOMEN								
Average waist girth	30.2	27.2	28.3	29.7	31.1	32.7	33.1	32.8
Percentile[1]								
99	44.3	39.1	41.0	44.6	44.9	47.2	43.5	42.0
95	39.1	34.7	35.5	38.5	40.1	42.1	40.7	39.9
90	36.9	32.1	33.7	35.8	37.3	38.8	39.3	38.8
80	34.1	29.7	31.0	33.1	34.7	36.2	37.4	36.7
70	32.2	28.1	29.3	31.0	32.7	34.5	35.3	35.2
60	30.6	27.2	28.3	29.5	31.2	33.5	34.0	34.1
50	29.2	26.3	27.5	28.7	30.2	32.3	32.9	33.2
40	28.2	25.7	26.8	27.8	29.3	31.4	31.7	31.6
30	27.2	25.1	26.0	27.0	28.4	29.8	30.2	30.7
20	26.1	24.4	25.4	26.2	27.5	28.7	28.9	28.0
10	25.0	23.6	24.5	25.3	26.2	27.2	27.7	26.6
5	24.1	23.0	23.6	24.6	25.1	25.8	26.3	25.9
1	22.9	22.1	22.5	23.6	23.5	24.5	24.4	23.9

[1]Measurement below which the indicated percent of persons in the given age group fall.

Table 7. Biacromial diameter, average, and selected percentiles for adults, by age and sex: United States, 1960-62

Sex, average, and percentile	Total, 18-79 years	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-79 years
	Measurement in inches							
MEN								
Average biacromial diameter	15.6	15.8	15.8	15.7	15.6	15.4	15.2	14.7
Percentile[1]								
99	17.5	17.7	17.8	17.5	17.3	17.7	16.7	16.2
95	17.0	17.1	17.1	17.1	16.9	16.7	16.4	15.8
90	16.7	16.9	16.9	16.8	16.6	16.5	16.1	15.7
80	16.2	16.5	16.5	16.4	16.3	16.2	15.9	15.5
70	16.1	16.2	16.3	16.2	16.1	15.9	15.6	15.3
60	15.9	16.0	16.0	16.0	15.9	15.7	15.4	15.0
50	15.7	15.8	15.8	15.8	15.7	15.5	15.2	14.8
40	15.5	15.7	15.6	15.6	15.5	15.3	15.1	14.7
30	15.3	15.5	15.4	15.4	15.3	15.1	14.9	14.3
20	15.0	15.2	15.2	15.1	15.0	14.8	14.7	14.2
10	14.7	14.8	14.8	14.8	14.7	14.5	14.4	13.8
5	14.3	14.5	14.5	14.5	14.4	14.1	14.1	13.4
1	13.5	13.9	13.8	13.6	13.8	13.5	13.4	12.4
WOMEN								
Average biacromial diameter	13.9	13.9	14.0	14.1	14.0	13.9	13.7	13.6
Percentile[1]								
99	15.7	15.7	15.6	15.8	15.8	15.6	15.7	14.9
95	15.2	15.1	15.2	15.2	15.3	15.1	15.0	14.7
90	14.9	14.9	15.0	15.0	14.9	14.8	14.7	14.6
80	14.6	14.6	14.7	14.7	14.6	14.6	14.3	14.2
70	14.4	14.3	14.5	14.5	14.4	14.4	14.0	14.0
60	14.2	14.1	14.3	14.3	14.2	14.2	13.8	13.8
50	14.0	14.0	14.1	14.1	14.0	13.9	13.7	13.6
40	13.8	13.8	13.9	13.9	13.9	13.8	13.5	13.4
30	13.6	13.6	13.7	13.7	13.7	13.6	13.3	13.3
20	13.4	13.4	13.5	13.5	13.4	13.4	12.8	13.0
10	13.1	13.1	13.1	13.2	13.1	13.0	12.8	12.8
5	12.8	12.9	12.9	13.0	12.9	12.7	12.5	12.5
1	12.3	12.3	12.3	12.3	12.4	12.3	12.2	12.1

[1]Measurement below which the indicated percent of persons in the given age group fall.

Table 8. Ponderal index—height/weight $^{1/3}$ —, average, and selected percentiles for adults, by age and sex: United States, 1960-62

Sex, average, and percentile	Total, 18-79 years	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-79 years
	Measurement in ponderal index units							
MEN								
Average of height/weight$^{1/3}$	12.40	12.67	12.48	12.32	12.30	12.30	12.35	12.42
Percentile[1]								
99	13.84	13.89	13.83	13.76	13.71	13.93	13.96	13.74
95	13.44	13.58	13.45	13.28	13.28	13.41	13.63	13.45
90	13.19	13.43	13.24	13.03	13.05	13.11	13.28	13.22
80	12.90	13.27	13.00	12.75	12.80	12.80	12.91	12.78
70	12.69	13.01	12.81	12.58	12.60	12.59	12.68	12.60
60	12.53	12.84	12.60	12.42	12.40	12.39	12.47	12.51
50	12.34	12.67	12.45	12.30	12.23	12.20	12.25	12.40
40	12.17	12.53	12.25	12.14	12.07	12.04	12.06	12.25
30	12.00	12.32	12.06	11.99	11.90	11.84	11.87	12.01
20	11.77	12.12	11.86	11.77	11.69	11.69	11.68	11.78
10	11.52	11.73	11.59	11.50	11.47	11.49	11.35	11.53
5	11.31	11.42	11.41	11.31	11.26	11.32	11.15	11.42
1	10.82	10.73	10.78	10.75	10.90	10.64	10.86	*
WOMEN								
Average height/weight$^{1/3}$	12.15	12.66	12.45	12.18	11.97	11.75	11.72	11.88
Percentile[1]								
99	13.82	14.08	13.92	13.70	13.61	13.55	13.37	13.54
95	13.37	13.71	13.51	13.32	13.10	12.88	12.96	13.15
90	13.11	13.46	13.28	13.06	12.87	12.71	12.69	13.03
80	12.81	13.17	13.02	12.78	12.60	12.42	12.33	12.60
70	12.61	12.98	12.83	12.63	12.37	12.10	12.03	12.26
60	12.40	12.84	12.66	12.44	12.13	11.92	11.87	12.07
50	12.16	12.67	12.52	12.25	11.95	11.69	11.66	11.77
40	11.92	12.53	12.34	12.03	11.77	11.48	11.43	11.54
30	11.66	12.34	12.07	11.76	11.54	11.29	11.24	11.26
20	11.35	12.07	11.71	11.47	11.24	11.02	11.02	10.96
10	10.96	11.66	11.35	11.05	10.88	10.69	10.71	10.70
5	10.63	11.27	10.99	10.57	10.59	10.44	10.45	10.57
1	10.12	10.45	10.43	10.00	9.87	9.81	10.21	*

[1] Measure below which the indicated percent of persons in the given age group fall.

Table 9. 100 x sitting height erect/stature, average, and selected percentiles for adults, by age and sex: United States, 1960-62

Sex, average, and percentile	Total, 18-79 years	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-79 years
	Measurement in index units							
MEN								
Average ratio	51.8	51.6	51.7	52.0	51.9	51.8	51.5	51.4
Percentile[1]								
99	55.8	55.5	55.6	56.1	55.8	56.7	54.9	55.3
95	54.6	54.5	54.5	54.8	54.7	54.7	54.3	54.0
90	54.0	53.9	53.9	54.1	54.2	54.2	53.8	53.7
80	53.5	53.4	53.4	53.6	53.6	53.6	53.3	53.2
70	53.0	52.9	52.9	53.1	53.2	53.2	52.8	52.7
60	52.7	52.6	52.6	52.8	52.8	52.7	52.4	52.3
50	52.3	52.2	52.3	52.4	52.5	52.3	51.9	51.9
40	51.9	51.8	51.9	52.1	52.1	52.0	51.6	51.5
30	51.5	51.4	51.6	51.7	51.7	51.5	51.3	51.1
20	51.1	50.9	51.2	51.3	51.2	51.1	50.9	50.6
10	50.4	50.2	50.5	50.8	50.5	50.4	50.2	50.1
5	49.9	49.5	49.8	50.2	50.1	50.0	49.6	49.5
1	48.5	47.7	48.6	49.1	48.9	48.2	48.4	47.7
WOMEN								
Average ratio	52.4	52.3	52.5	52.6	52.7	52.4	51.8	51.4
Percentile[1]								
99	56.2	55.9	56.3	56.4	56.4	55.8	55.0	66.4
95	55.2	54.9	55.1	55.4	55.5	55.1	54.7	54.7
90	54.8	54.6	54.8	54.9	55.0	54.7	54.2	53.8
80	54.2	54.0	54.2	54.4	54.4	54.2	53.6	53.3
70	53.7	53.6	53.8	53.9	53.9	53.7	53.1	52.9
60	53.4	53.2	53.5	53.6	53.6	53.3	52.7	52.5
50	53.0	52.9	53.2	53.2	53.2	53.0	52.4	52.1
40	52.6	52.5	52.8	52.9	52.9	52.6	52.0	51.6
30	52.2	52.2	52.4	52.4	52.4	52.2	51.5	51.0
20	51.7	51.6	52.0	52.0	52.0	51.7	51.0	50.4
10	51.0	51.0	51.2	51.2	51.3	51.1	50.3	49.4
5	50.3	50.3	50.5	50.5	50.8	50.5	49.6	47.8
1	49.0	48.8	49.2	49.2	49.8	49.3	48.1	37.8

[1]Value below which the indicated percent of persons in the given age group fall.

Table 10. 100 x chest circumference/stature, average, and selected percentiles for adults, by age and sex: United States, 1960-62

Sex, average, and percentile	Total, 18-79 years	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-79 years
	Measurement in index units							
MEN								
Average ratio	57.4	55.1	56.7	57.9	58.3	58.4	58.2	57.5
Percentile[1]								
99	70.8	71.1	68.3	69.9	71.2	72.1	70.3	66.1
95	65.8	64.4	65.1	65.9	66.6	66.8	66.6	64.9
90	63.7	61.0	62.9	63.4	64.4	64.2	65.0	62.7
80	61.4	58.5	60.4	61.8	62.4	62.2	62.7	61.4
70	59.8	56.6	58.9	59.7	60.8	60.8	60.6	59.5
60	58.4	55.5	57.4	58.6	59.0	59.8	59.7	58.6
50	57.0	54.3	56.4	57.5	58.0	58.4	58.4	57.2
40	55.8	53.2	55.1	56.5	56.6	56.7	56.3	55.7
30	54.5	52.2	53.9	55.4	55.1	55.4	55.0	54.8
20	53.2	51.2	52.6	54.1	54.1	54.1	53.6	54.3
10	51.4	49.3	50.8	52.5	52.5	52.2	51.3	53.4
5	49.7	48.5	49.4	51.2	51.2	51.0	50.1	48.7
1	47.6	46.2	47.1	48.4	48.3	48.1	48.2	46.8
WOMEN								
Average ratio	55.1	51.6	52.9	54.7	56.2	58.1	58.1	57.1
Percentile[1]								
99	69.9	64.1	66.3	71.1	69.9	71.0	70.7	68.1
95	65.1	59.6	61.9	64.4	66.2	67.3	66.7	66.4
90	62.6	56.7	59.2	61.5	63.4	64.8	65.1	65.1
80	59.6	54.4	56.1	58.7	60.3	62.4	62.3	61.3
70	57.4	52.9	54.2	56.6	58.2	60.7	60.7	59.9
60	55.7	52.2	53.1	55.0	56.6	59.1	59.2	57.1
50	54.2	51.1	52.0	53.7	55.2	57.7	57.6	56.0
40	52.9	50.3	51.2	52.5	54.2	56.6	56.4	55.4
30	51.7	49.4	50.4	51.5	53.4	55.2	55.3	54.3
20	50.4	48.4	49.1	50.4	51.9	53.4	53.7	52.1
10	48.7	47.0	47.6	48.9	50.0	51.5	51.5	50.1
5	47.4	45.5	47.0	47.6	48.8	49.7	50.5	49.0
1	45.1	44.0	45.1	45.6	45.7	46.8	47.0	48.2

[1]Value below which the indicated percent of persons in the given age group fall.

Table 11. 100 x biacromial diameter/stature, average, and selected percentiles for adults, by age and sex: United States, 1960-62

Sex, average, and percentile	Total, 18-79 years	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-79 years
	Measurement in index units							
MEN								
Average ratio	22.5	22.6	22.4	22.5	22.5	22.5	22.3	21.9
Percentile[1]								
99	25.0	26.3	25.2	24.9	24.8	25.5	25.0	23.9
95	24.0	24.3	23.9	24.0	23.9	24.3	23.9	23.4
90	23.6	23.8	23.6	23.7	23.5	23.7	23.6	22.9
80	22.9	23.0	22.9	23.0	22.9	22.9	23.0	22.5
70	22.6	22.7	22.6	22.7	22.6	22.6	22.6	22.0
60	22.3	22.4	22.3	22.3	22.3	22.3	22.2	21.7
50	22.0	22.1	21.9	22.0	21.9	22.0	21.8	21.4
40	21.6	21.7	21.6	21.7	21.7	21.6	21.5	21.1
30	21.3	21.4	21.3	21.4	21.4	21.3	21.1	20.8
20	21.0	21.0	20.9	21.1	21.1	20.9	20.6	20.4
10	20.3	20.3	20.2	20.5	20.4	20.2	20.2	20.0
5	20.0	20.0	19.8	20.1	20.1	19.8	19.8	19.5
1	19.1	19.1	19.0	19.1	19.1	19.1	19.1	19.0
WOMEN								
Average ratio	21.7	21.4	21.6	21.8	21.8	21.8	21.8	21.8
Percentile[1]								
99	24.1	23.8	23.8	24.2	24.6	23.9	24.8	25.2
95	23.2	22.8	23.0	23.3	23.5	23.2	23.6	23.7
90	22.8	22.4	23.7	22.8	22.9	22.8	22.9	23.0
80	22.2	21.9	22.0	22.2	22.3	22.4	22.4	22.4
70	21.8	21.5	21.7	21.8	21.9	22.0	21.9	21.9
60	21.5	21.2	21.4	21.5	21.6	21.7	21.5	21.6
50	21.2	20.9	21.1	21.2	21.3	21.4	21.2	21.2
40	20.9	20.6	20.8	20.9	21.0	21.1	20.9	20.9
30	20.5	20.4	20.5	20.6	20.6	20.7	20.5	20.5
20	20.2	20.1	20.2	20.3	20.3	20.3	20.2	20.2
10	19.7	19.5	19.6	19.8	19.7	19.9	19.7	19.6
5	19.3	19.1	19.2	19.3	19.4	19.3	19.3	19.2
1	18.3	18.0	18.3	18.4	18.7	18.5	*	*

[1] Value below which the indicated percent of persons in the given age group fall.

Table 12. Correlation coefficients of body measurements with height, weight, and age for men and women: United States, 1960-62

Body measurement	Height		Weight		Age	
	Men	Women	Men	Women	Men	Women
Age	-.270	-.289	-.058	+.204	-	-
Height	-	-	+.394	+.189	-.270	-.289
Weight	+.394	+.189	-	-	-.058	+.204
Sitting height, erect	+.770	+.772	+.403	+.197	-.272	-.339
Sitting height, normal	+.717	+.729	+.433	+.165	-.183	-.300
Knee height	+.802	+.782	+.404	+.322	-.172	-.128
Popliteal height	+.767	+.723	+.153	-.035	-.215	-.196
Elbow rest height	+.212	+.258	+.324	+.253	-.192	-.177
Thigh clearance height	+.210	+.137	+.684	+.693	-.190	-.026
Buttock-knee length	+.751	+.609	+.551	+.620	-.151	-.036
Buttock-popliteal length	+.600	+.514	+.379	+.490	-.108	-.005
Elbow-to-elbow breadth	+.069	-.070	+.804	+.844	+.156	+.393
Seat breadth	+.309	+.137	+.813	+.805	+.043	+.187
Biacromial diameter	+.381	+.407	+.474	+.443	-.261	-.116
Chest girth	+.189	+.016	+.885	+.882	+.062	+.317
Waist girth	+.054	-.090	+.821	+.844	+.299	+.432
Right arm girth	+.139	-.026	+.849	+.888	-.115	+.272
Right arm skinfold	+.060	-.022	+.562	+.641	-.039	+.203
Infrascapular skinfold	-.003	-.136	+.709	+.729	+.045	+.278
Sum of skinfolds	+.032	-.088	+.705	+.738	+.021	+.260

Table 13. Multiple regression equations for measurements as a function of height, weight, and age[1] for men and women: United States, 1960-62

Measurement and sex	Regression equation[2]
Sitting height, erect	
Men	= + 9.382 + 0.374 (ht.) + 0.006 (wt.) - 0.007 (age)
Women	= + 8.229 + 0.397 (ht.) + 0.005 (wt.) - 0.014 (age)
Sitting height, normal	
Men	= + 8.835 + 0.347 (ht.) + 0.009 (wt.) + 0.0001 (age)
Women	= + 6.684 + 0.405 (ht.) + 0.003 (wt.) - 0.011 (age)
Knee height	
Men	= - 1.872 + 0.328 (ht.) + 0.004 (wt.) + 0.003 (age)
Women	= - 1.442 + 0.317 (ht.) + 0.006 (wt.) + 0.004 (age)
Popliteal height	
Men	= - 3.927 + 0.328 (ht.) - 0.007 (wt.) + 0.00003(age)
Women	= - 2.890 + 0.305 (ht.) - 0.007 (wt.) + 0.004(age)
Elbow rest height	
Men	= + 6.392 + 0.023 (ht.) + 0.013 (wt.) - 0.012 (age)
Women	= + 3.970 + 0.068 (ht.) + 0.010 (wt.) - 0.013 (age)
Thigh clearance height	
Men	= + 5.165 - 0.030 (ht.) + 0.018 (wt.) - 0.008 (age)
Women	= + 3.550 - 0.017 (ht.) + 0.018 (wt.) - 0.009 (age)
Buttock-knee length	
Men	= + 2.464 + 0.273 (ht.) + 0.013 (wt.) + 0.003 (age)
Women	= + 4.211 + 0.240 (ht.) + 0.021 (wt.) - 0.0004 (age)
Buttock-popliteal length	
Men	= + 1.434 + 0.244 (ht.) + 0.007 (wt.) + 0.004 (age)
Women	= + 3.356 + 0.208 (ht.) + 0.016 (wt.) + 0.003 (age)
Elbow-to-elbow breadth	
Men	= + 17.283 - 0.169 (ht.) + 0.061 (wt.) + 0.017 (age)
Women	= + 14.060 - 0.148 (ht.) + 0.060 (wt.) + 0.022 (age)
Seat breadth	
Men	= + 8.054 + 0.005 (ht.) + 0.032 (wt.) + 0.006 (age)
Women	= + 9.189 - 0.005 (ht.) + 0.039 (wt.) + 0.002 (age)
Biacromial diameter	
Men	= + 10.527 + 0.052 (ht.) + 0.012 (wt.) - 0.010 (age)
Women	= + 7.212 + 0.086 (ht.) + 0.010 (wt.) - 0.005 (age)
Chest girth	
Men	= + 33.206 - 0.201 (ht.) + 0.114 (wt.) + 0.015 (age)
Women	= + 30.321 - 0.150 (ht.) + 0.094 (wt.) + 0.020 (age)
Waist girth	
Men	= + 32.407 - 0.382 (ht.) + 0.150 (wt.) + 0.082 (age)
Women	= + 31.810 - 0.348 (ht.) + 0.134 (wt.) + 0.061 (age)
Right arm girth	
Men	= + 13.869 - 0.126 (ht.) + 0.044 (wt.) - 0.011 (age)
Women	= + 11.597 - 0.121 (ht.) + 0.051 (wt.) + 0.003 (age)
Right arm skinfold	
Men	= + 2.386 - 0.058 (ht.) + 0.018 (wt.) - 0.003 (age)
Women	= + 2.389 - 0.045 (ht.) + 0.019 (wt.) + 0.001 (age)
Infrascapular skinfold	
Men	= + 3.929 - 0.092 (ht.) + 0.023 (wt.) + 0.0002 (age)
Women	= + 3.654 - 0.097 (ht.) + 0.024 (wt.) + 0.002 (age)
Sum of skinfolds	
Men	= + 6.208 - 0.149 (ht.) + 0.041 (wt.) - 0.002 (age)
Women	= + 6.758 - 0.142 (ht.) + 0.043 (wt.) + 0.004 (age)

[1] Measurement in inches; weight in pounds; and age in years. [2] See appendix III.

Table 14. Partial and multiple correlation coefficients and standard errors of estimate around the corresponding multiple linear regression lines (table 13) for adults: United States, 1960-62

Variable(y)[1]	Partial correlations			Multiple correlation	Standard error of estimate
	$r_{y\ 1.23}$	$r_{y\ 2.13}$	$r_{y\ 3.12}$	$r_{y\ .123}$	$S_{y\ .123}$
Men					
Sitting height, erect	0.705	0.177	-0.116	0.781	0.911
Sitting height, normal	0.646	0.235	0.002	0.735	0.982
Knee height	0.758	0.157	0.069	0.809	0.675
Popliteal height	0.766	-0.253	0.001	0.784	0.661
Elbow rest height	0.051	0.278	-0.163	0.369	1.104
Thigh clearance height	-0.152	0.684	-0.239	0.708	0.459
Buttock-knee length	0.689	0.417	0.063	0.801	0.701
Buttock-popliteal length	0.526	0.191	0.060	0.621	0.905
Elbow-to-elbow breadth	-0.399	0.853	0.257	0.859	0.931
Seat breadth	0.021	0.791	0.155	0.817	0.630
Biacromial diameter	0.181	0.397	-0.215	0.550	0.700
Chest girth	-0.327	0.899	0.163	0.904	1.407
Waist girth	-0.457	0.904	0.568	0.915	1.810
Right arm girth	-0.455	0.881	-0.263	0.884	0.594
Right arm skinfold	-0.222	0.589	-0.069	0.591	0.570
Infrascapular skinfold	-0.421	0.772	0.007	0.773	0.480
Women					
Sitting height, erect	0.728	0.142	-0.222	0.787	0.901
Sitting height, normal	0.683	0.081	-0.153	0.737	1.038
Knee height	0.766	0.251	0.093	0.804	0.632
Popliteal height	0.735	-0.270	0.096	0.747	0.681
Elbow rest height	0.153	0.257	-0.181	0.373	1.071
Thigh clearance height	-0.079	0.709	-0.250	0.716	0.498
Buttock-knee length	0.615	0.633	0.007	0.797	0.728
Buttock-popliteal length	0.482	0.441	0.054	0.652	0.905
Elbow-to-elbow breadth	-0.344	0.867	0.320	0.889	0.948
Seat breadth	-0.014	0.787	0.032	0.805	0.859
Biacromial diameter	0.314	0.424	-0.126	0.562	0.627
Chest girth	-0.251	0.886	0.208	0.900	1.389
Waist girth	-0.375	0.878	0.402	0.902	2.035
Right arm girth	-0.393	0.903	0.064	0.911	0.679
Right arm skinfold	-0.169	0.639	0.033	0.658	0.604
Infrascapular skinfold	-0.371	0.760	0.062	0.782	0.569

[1] y is the dependent variable in the indicated correlation coefficients (r) and standard errors of estimate(s), x_1 is height x_2 is weight and x_3 is age—the latter three designated by the subscripts 1, 2, and 3 above.

APPENDIX I

RECORDING FORMS AND DIAGRAMS OF DIAMETER, GIRTH, AND SKINFOLD MEASUREMENTS IN THIS REPORT

RECORDING FORMS USED

Health Examination Survey

PHYSICAL MEASUREMENTS

HES-207

IF ✓ NO REPORT	REASON FOR NO REPORT	PROCEDURE	RECORDING	CODE
		2. **Biacromial Diameter**	___ ___ . ___ cm.	
		Girths 3. Right Arm	___ cm.	
		4. Chest	___ cm.	
	Male ☐	5. Waist 6. Female wearing girdle	___ cm. YES ☐ NO ☐	
		Skinfolds 7. Right Arm	☐ 1. ___ cm. 2. ___ cm.	
		8. Right Infrascapular	☐ 1. ___ cm. 2. ___ cm.	
		9. **Height** Height decreased by	☐ cm. Curved Spine ☐ NO ☐ Deformed Legs ☐	
		10. **Weight**	☐ LBS.	

PHYSICAL MEASUREMENTS

HES-207

HUMAN ENGINEERING MEASUREMENTS

Observer _____ Anthropometer No. _____ Base (Cm.) _____ Recorder _____

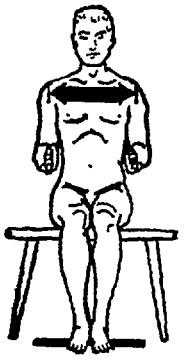
IF ✓ NO REPORT	REASON FOR NO REPORT	MEASUREMENT	RECORDING IN Cm.	FOR OFFICE USE	CODE
		11. Sitting height normal	___ ___ ___ . ___		
		12. Sitting height erect	___ ___ ___ . ___		
		13. Knee height*	___ ___ ___ . ___		
		14. Popliteal height	___ ___ ___ . ___		
		15. Thigh clearance height	___ ___ ___ . ___		
		16. Buttock-knee length	___ ___ . ___	X	
		17. Buttock-popliteal length	___ ___ . ___	X	
		18. Seat breadth (across hips)	___ ___ . ___	X	
		19. Elbow-to-elbow breadth	___ ___ . ___	X	
		20. Elbow rest height	___ ___ ___ . ___		

*Note: Items 13, 14, 15, 16, 17, and 20 are to be measured on examinee's right side. If measured on left side, indicate reason.

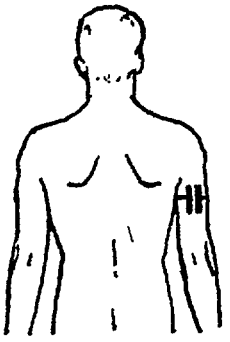
DIAGRAMS OF MEASUREMENTS

(girths, skinfolds, biacromial diameter)

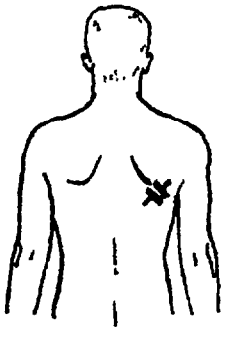
Biacromial diameter



Skinfold: back of upper arm

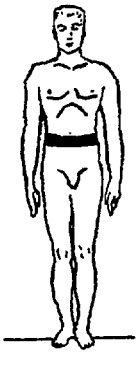


Skinfold: subscapular



Chest circumference

Waist circumference – omphalion



Biceps circumference, extended

APPENDIX II

GENERAL STATISTICAL NOTES

Survey Design

The sampling plan of the first cycle of the Health Examination Survey followed a highly stratified multistage probability design in which a sample of the civilian, noninstitutional population of the conterminous United States, 18-79 years of age, was selected. In the first stage of this plan a sample of 42 primary sampling units (PSU's) was drawn from among the 1,900 geographic units into which the United States was divided. In this report a PSU is defined as a standard metropolitan statistical area or one to three contiguous counties. Later stages result in the random selection of clusters of typically about four persons from a small neighborhood within the PSU. The total sampling included some 7,700 persons in 29 different States. The detailed structure of the design and the conduct of the survey are described in references 1 and 2.

Reliability

Measurement processes employed in the survey were highly standardized and closely controlled. This does not mean, of course, that the correspondence between the real world and the survey results is exact. Data from the survey are imperfect for three major reasons: (1) results are subject to sampling error, (2) the actual conduct of a survey never agrees perfectly with the design; and (3) the measurement processes themselves are inexact, even though standardized and controlled.

A first-stage evaluation of the survey is reported in reference 2, which deals largely with an analysis of the faithfulness with which the sampling design was carried out. This study notes that out of the 7,700 sample persons, the 6,672 who were examined—a response rate of over 86 percent—gave evidence that they were a highly representative sample of the civilian, noninstitutional population of the United States.

Imputation for the nonrespondents was accomplished by attributing to the unexamined persons the characteristics of comparable examined persons as described in reference 2. The specific procedure used amounted to inflating the sampling weight for each examined person to compensate for sample persons at that stand of the same age-sex group who were not examined. This inflation procedure would be expected to introduce little, if any, distortion, judging from the data obtained in the physician followup. Here the height and weight data for the subsample of examined and unexamined sample persons were found to be in good agreement. Measuring techniques used for these two measurements by the physicians and in the examination were also apparently comparable, since physicians' reports showed, on the average, good agreement with the examination findings on height and weight.

In addition to persons not examined at all, there were some whose examination was incomplete in one procedure or another. Age, sex, and race were known for every examined person, but for a number of examinees one or more of the anthropometric measurements were not available. The extent of these missing measurements is indicated in table I.

There were, in addition to these 158 examinees, 21 for whom one of the recorded measurements was obviously in error—for example, popliteal height the same as or only one-half inch shorter than knee height, and a few similar discrepancies.

Estimates for missing (and erroneous) data were generally made subjectively on the basis of a multiple regression-type decision, substituting for the missing measurement those for an individual who was of the same age, sex, and race, and who had other dimensions similar to the ones available for the examinee with incomplete data. The findings were essentially unaffected by the few deviations that had to be made in standard measurement techniques for amputees and others.

For those with no measurements available, a respondent of the same age-sex-race group was selected at random, and his measurements were assigned to the unexamined person.

Sampling and Measuring Error

In the present report, reference has been made to minimizing bias and variability of the measurement techniques.

The probability design of the survey makes possible the calculation of sampling errors. Traditionally, the sampling error is used to determine how imprecise

Table I. Number of examinees with one or more missing anthropometric measurements: Health Examination Survey, 1960-62

Measurement missing	Number of examinees
Total examinees	158
All measurements	2
Height	18
Weight	20
Sitting height normal	35
Sitting height erect	32
Knee height	32
Popliteal height	24
Thigh clearance height	20
Buttock-knee length	46
Buttock-popliteal length	43
Seat breadth	14
Elbow-to-elbow breadth	20
Elbow rest height	18
Biacromial diameter	13
Right arm girth	13
Chest girth	28
Waist girth	19
Right arm skinfold	11
Infrascapular skinfold	12

the survey results may be because they come from a sample rather than from the measurements of all elements in the universe.

The presentation of sampling errors for a study of the type of the Health Examination Survey is difficult for at least three reasons: (1) Measurement error and "pure" sampling error are confounded in the data -- it is not easy to find a procedure which will either completely include both or treat one or the other separately; (2) the survey design and the estimation procedure are complex and accordingly require computationally involved techniques for the calculation of variances; and (3) from the survey come thousands of statistics, many for subclasses of the population for which there are a small number of sample cases. Estimates of sampling error are obtained from the sample data and are themselves subject to sampling error, which may be large when the number of cases in the cell is small or, even occasionally, when the number of cases is substantial.

Estimates of approximate sampling variability for selected statistics used in this report are presented in table II for the averages and in table III for percentages. These estimates have been prepared by a replication technique, which yields overall variability through observation of variability among random subsamples of the total sample. The method reflects both "pure" sampling variance and a part of the measurement variance.

In accordance with usual practice, the interval estimate for any statistic may be considered to be the range within one standard error of the tabulated statistic, with 68 percent confidence; or the range within two standard errors of the tabulated statistic, with 95 percent confidence.

An overestimate of the standard error of difference $\underline{d} = \underline{x} - \underline{y}$ of two statistics $\underline{x}$ and $\underline{y}$ is generally given by the formula

$$\underline{s}_{\underline{d}} = (\underline{x}^2 \underline{v}_{\underline{x}}^2 + \underline{y}^2 \underline{v}_{\underline{y}}^2)^{1/2},$$ where $\underline{v}_{\underline{x}}$ and $\underline{v}_{\underline{y}}$ are the relative sampling errors, respectively, of $\underline{x}$ and $\underline{y}$.

Small Categories

In some tables magnitudes are shown for cells in which the sample size is so small that the sampling error may be several times as great as the statistic itself. Obviously, in such instances the statistic has no meaning in itself except to indicate that the true quantity is small. Such numbers, if shown, have been included in the belief that they help to convey an impression of the overall story of the table.

Table II. Standard errors of estimates, for averages of selected body measurements and indices: United States, 1960-62

Sex and body measurement	Total, 18-79 years	Age						
		18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-79 years
Men								
Right arm skinfold	0.02	0.06	0.03	0.03	0.05	0.03	0.05	0.10
Infrascapular skinfold	0.02	0.07	0.03	0.03	0.04	0.05	0.04	0.11
Sum of skinfolds	0.04	0.12	0.05	0.05	0.07	0.07	0.08	0.18
Right arm girth	0.04	0.11	0.04	0.05	0.05	0.05	0.12	0.24
Chest girth	0.08	0.26	0.08	0.12	0.16	0.12	0.23	0.49
Waist girth	0.07	0.13	0.14	0.14	0.18	0.22	0.33	0.64
Biacromial diameter	0.03	0.06	0.03	0.05	0.02	0.06	0.06	0.12
Height/weight$^{1/3}$	0.01	0.05	0.04	0.04	0.04	0.02	0.07	0.11
100 x sitting height erect/stature	0.04	0.12	0.05	0.07	0.09	0.09	0.08	0.16
100 x chest circumference/stature	0.12	0.44	0.17	0.17	0.29	0.23	0.52	0.52
100 x biacromial diameter/stature	0.04	0.11	0.07	0.07	0.07	0.09	0.16	0.11
Women								
Right arm skinfold	0.04	0.07	0.06	0.04	0.03	0.07	0.07	0.09
Infrascapular skinfold	0.02	0.05	0.03	0.03	0.03	0.06	0.06	0.08
Sum of skinfolds	0.05	0.11	0.08	0.06	0.04	0.12	0.13	0.14
Right arm girth	0.03	0.05	0.03	0.06	0.07	0.08	0.09	0.18
Chest girth	0.07	0.10	0.10	0.10	0.14	0.11	0.18	0.17
Waist girth	0.09	0.19	0.11	0.15	0.19	0.30	0.26	0.39
Biacromial diameter	0.01	0.04	0.04	0.01	0.01	0.04	0.04	0.05
Height/weight$^{1/3}$	0.01	0.04	0.02	0.04	0.04	0.05	0.04	0.07
100 x sitting height erect/stature	0.04	0.07	0.05	0.06	0.04	0.07	0.11	0.35
100 x chest circumference/stature	0.16	0.16	0.16	0.22	0.22	0.23	0.23	0.51
100 x biacromial diameter/stature	0.02	0.06	0.02	0.02	0.02	0.07	0.07	0.17

Table III. Standard errors of estimates for 5th and 95th percentiles of selected body measurements and indices: United States, 1960-62

Sex and body measurement	Total, 18-79 years	Age						
		18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-79 years
Men								
Group a	0.04	0.12	0.06	0.06	0.08	0.08	0.10	0.22
Group b	0.08	0.22	0.10	0.10	0.14	0.14	0.16	0.32
Group c	0.14	0.38	0.22	0.25	0.34	0.34	0.50	0.85
Group d	0.27	0.60	0.34	0.37	0.50	0.52	0.76	1.20
Women								
Group e	0.04	0.10	0.06	0.06	0.06	0.12	0.12	0.18
Group f	0.08	0.14	0.12	0.12	0.12	0.16	0.22	0.36
Group c	0.14	0.38	0.22	0.25	0.34	0.34	0.50	0.85
Group d	0.27	0.60	0.34	0.37	0.50	0.52	0.76	1.20

Group a: Infrascapular and arm skinfold, height/weight$^{1/3}$
Group b: Sum of skinfolds, arm girth, biacromial diameter, 100 x sitting height erect/stature, 100 x biacromial diameter/stature.
Group c: Chest and waist girth.
Group d: 100 x chest circumference/stature.
Group e: Infrascapular skinfold, height/weight$^{1/3}$, biacromial diameter, 100 x biacromial diameter/stature.
Group f: Arm skinfold, sum of skinfolds, arm girth, 100 x sitting height erect/stature.

APPENDIX III

CORRELATION AND REGRESSION ESTIMATES

Measures of the mutual relationship between each pair of the physical measurements, and between each of the physical measurements and height, weight, and age are given in terms of linear regression equations and correlation coefficients. It is recognized that the relationship among at least some of these variables is not linear. For these the actual degree of relationship among them will be somewhat understated. However, the determination of the precise type of relationship would be extremely complex; consequently for expediency only the linear relationships are shown here.

For the simple correlation coefficients determinations of the mutual relationship between two variables were made by the usual formula:

$$r_{x_y} = \left(\frac{\Sigma xy}{n} - \bar{x}\bar{y}\right) / s_x s_y$$

where x and y are the two variables in question.

The relationship of each physical measurement (other than height and weight) with either height, weight, or age but holding constant the effect of the other two of these latter variables was determined by the partial correlation coefficients which may be expressed as:

$$r_{y1.23} = \frac{r_{y1.3} - r_{y2.3}\, r_{12.3}}{(1-r^2_{y2.3})^{1/2}\,(1-r^2_{12.3})^{1/2}}$$

where

$$r_{y1.3} = \frac{r_{y1} - r_{y3}\, r_{13}}{(1-r^2_{13})^{1/2}\,(1-r^2_{y3})^{1/2}}, \text{ etc.}$$

with the dependent (physical) measure designated as y and the independent measures by the subscripts for the x's -- height (x_1), weight (x_2), and age (x_3).

The degree of linear association between the dependent measure, y, and independent measures -- height (x_1), weight (x_2), and age (x_3) is given by the multiple correlation coefficient of the form

$$R_{y.123} = \left[(1) - (1-r^2_{y1})(1-r^2_{y2.1})(1-r^2_{y3.12})\right]^{1/2}$$

The multiple regression equations of the form

$$Y = a_{y.123} + b_{y1.23} X_1 + b_{y2.13} X_2 + b_{y3.12} X_3$$

were fitted by the method of least squares again with X_1 denoting the height; X_2 weight; X_3 age; and Y the dependent variable (physical measurement). The constants—regression coefficients (b) and Y-intercept (a)--in the regression equation are of the form:

$$b_{y1.23} = r_{y1.23}\,\frac{s_{y.123}}{s_{1.y23}}$$

and

$$a_{y.123} = \bar{Y} - b_{y1.23}\,\bar{X}_1 - b_{y2.13}\,\bar{X}_2 - b_{y3.12}\,\bar{X}_3$$

The goodness of fit of the multiple linear regression equation to the observed data is determined by the usual formula:

$$S_{y.123} = \left[\frac{n\Sigma(y-Y)^2}{n-m}\right]^{1/2}$$

where n is the number of sets of observations in the sample and m is the number of constants in the regression equation, including the a's and b's. This value of $S_{y.123}$ indicates how nearly the estimated values from the regression equation, Y, actually agree with the observed values, Y, and is a measure of the extent of variability in the population from this average relationship. It is assumed that the actual y-values are uniformly normally distributed about the regression line and hence that a band $Y \pm 2\,S_{y.123}$ will include 95 percent of the Y-values. Since these measurements, particularly weight and girth or girth related measurements are known *not* to be normally distributed, the fit around the regression lines and the predictions possible from them will be more accurate around the mean values than the extremes of the distributions.

The simple correlation coefficients for each measurement with height, weight, or age (table 12); the partial and multiple correlation coefficients and the standard errors of estimate around the multiple linear

regression lines (table 14); and the multiple linear regression equations for the prediction of each of the other measurements from height, weight, and age (table 13) are population estimates obtained by making full use of the complex probability sample design used in the survey. For this reason the usual errors of estimate derived from simple random sampling theory are not applicable. The logarithmic transformations for these statistics together with their appropriate standard errors of estimate are shown for men in table IV. The standard errors of estimate were based on values derived using a pseudoreplication procedure, called balanced half-sample replication, which has been described more fully in a previous *Vital and Health Statistics* publication.[60] This method uses the results from the multistage sample design of the survey in which the individual observations have been subjected to various kinds of ratio and poststratification adjustments.

It can be assumed that these estimates of the standard errors of the transformation values of the correlation coefficients would apply approximately for women also where the correlation coefficients are of roughly the same size as those of men.

The simple correlation coefficients based on unweighted data for each pair of the physical measurements for men and women are given in tables V and VI. The determinations here have been made for convenience using unweighted data from the sample of examinees and do not take into account the differential weighting and adjustment for nonresponse needed to obtain estimates for the entire civilian noninstitutional population of the United States. These values will differ slightly from the National estimates.[60]

Table IV. Z transformation and the corresponding standard errors of estimate for men: Health Examination Survey, 1960-62[1]

Y	Z_{y1}	$SE_{z_{y1}}$	Z_{y2}	$SE_{z_{y2}}$	Z_{y3}	$SE_{z_{y3}}$	$Z_{y1.23}$	$SE_{z_{y1.23}}$	$Z_{y2.13}$	$SE_{z_{y2.13}}$	$Z_{y3.12}$	$SE_{z_{y3.12}}$	$Z_{y.123}$	$SE_{z_{y.123}}$
Sitting height erect	1.021	0.029	0.427	0.021	-0.279	0.018	0.877	0.027	0.179	0.026	-0.117	0.024	1.048	0.030
Sitting height normal	0.902	0.031	0.464	0.026	-0.185	0.019	0.768	0.029	0.240	0.030	0.002	0.022	0.940	0.031
Knee height	1.104	0.036	0.429	0.017	-0.174	0.023	0.992	0.037	0.159	0.021	0.069	0.025	1.123	0.036
Popliteal height	1.013	0.027	0.154	0.022	-0.218	0.028	1.011	0.030	-0.258	0.029	0.001	0.024	1.055	0.029
Elbow rest height	0.216	0.024	0.336	0.024	-0.194	0.018	0.051	0.022	0.285	0.026	-0.165	0.021	0.387	0.023
Thigh clearance height	0.214	0.020	0.836	0.032	-0.192	0.026	-0.153	0.027	0.837	0.035	-0.244	0.028	0.884	0.034
Buttock-knee length	0.975	0.029	0.619	0.022	-0.153	0.020	0.847	0.027	0.444	0.025	0.064	0.018	1.102	0.027
Buttock-popliteal length	0.693	0.021	0.399	0.019	-0.109	0.023	0.585	0.021	0.193	0.022	0.060	0.022	0.727	0.021
Elbow-to-elbow breadth	0.069	0.019	1.111	0.012	0.158	0.023	-0.422	0.029	1.267	0.018	0.263	0.027	1.289	0.017
Seat breadth	0.319	0.022	1.134	0.035	0.043	0.023	0.021	0.022	1.075	0.037	0.156	0.028	1.149	0.037
Biacromial diameter	0.401	0.024	0.515	0.018	-0.267	0.020	0.183	0.020	0.420	0.016	-0.218	0.019	0.618	0.022
Chest girth	0.192	0.020	1.397	0.013	0.063	0.023	-0.340	0.031	1.466	0.018	0.164	0.023	1.495	0.015
Waist girth	0.054	0.015	1.159	0.023	0.308	0.017	-0.494	0.026	1.493	0.025	0.645	0.025	1.557	0.024
Right arm girth	0.140	0.019	1.253	0.017	-0.115	0.023	-0.492	0.028	1.380	0.017	-0.269	0.027	1.395	0.017
Right arm skinfold	0.060	0.020	0.636	0.024	-0.039	0.019	-0.226	0.028	0.676	0.028	-0.069	0.020	0.679	0.028
Infrascapular skinfold	-0.003	0.018	0.886	0.036	0.045	0.023	-0.449	0.020	1.026	0.032	0.007	0.024	1.023	0.032

[1] Y represents the measure indicated to the left, 1 is height, 2 is weight, and 3 is age. The z-values are the logarithmic equivalents, to the base 10, of the respective simple, partial, and multiple correlation coefficients. The SE's are the standard errors for the respective logarithms of the correlation coefficients as estimated by the pseudoreplication procedure, called balanced half sample replication, for the complex probability sample design used in the Health Examination Survey.

Table V. Simple correlation coefficients for the 16 body measurements, excluding height and weight among men: Health Examination Survey, 1960-62

Body measurement	Sitting height erect	Sitting height normal	Knee height	Popliteal height	Elbow rest height	Thigh clearance height
Sitting height, erect	-	0.873	0.446	0.410	0.544	0.238
Sitting height, normal	-	-	0.443	0.382	0.454	0.284
Knee height	-	-	-	0.798	-0.029	0.228
Popliteal height	-	-	-	-	-0.062	-0.029
Elbow rest height	-	-	-	-	-	0.217
Thigh clearance height	-	-	-	-	-	-
Buttock-knee length	-	-	-	-	-	-
Buttock-popliteal length	-	-	-	-	-	-
Elbow-to-elbow breadth	-	-	-	-	-	-
Seat breadth	-	-	-	-	-	-
Biacromial diameter	-	-	-	-	-	-
Chest girth	-	-	-	-	-	-
Waist girth	-	-	-	-	-	-
Right arm girth	-	-	-	-	-	-
Right arm skinfold	-	-	-	-	-	-
Infrascapular skinfold	-	-	-	-	-	-

Table VI. Simple correlation coefficients for the 16 body measurements, excluding height and weight, among women: Health Examination Survey, 1960-62

Body measurement	Sitting height erect	Sitting height normal	Knee height	Popliteal height	Elbow rest height	Thigh clearance height
Sitting height, erect	-	0.907	0.440	0.364	0.585	0.209
Sitting height, normal	-	-	0.420	0.352	0.533	0.199
Knee height	-	-	-	0.747	0.023	0.196
Popliteal height	-	-	-	-	-0.095	-0.141
Elbow rest height	-	-	-	-	-	0.293
Thigh clearance height	-	-	-	-	-	-
Buttock-knee length	-	-	-	-	-	-
Buttock-popliteal length	-	-	-	-	-	-
Elbow to-elbow breadth	-	-	-	-	-	-
Seat breadth	-	-	-	-	-	-
Biacromial diameter	-	-	-	-	-	-
Chest girth	-	-	-	-	-	-
Waist girth	-	-	-	-	-	-
Right arm girth	-	-	-	-	-	-
Right arm skinfold	-	-	-	-	-	-
Infrascapular skinfold	-	-	-	-	-	-

Table V. Simple correlation coefficients for the 16 body measurements, excluding height and weight, among men: Health Examination Survey 1960-62—Con.

Buttock-knee length	Buttock-popliteal length	Elbow-elbow breadth	Seat breadth	Biacromial diameter	Chest girth	Waist girth	Right arm girth	Right arm skinfold	Infra-scapular skinfold
0.418	0.227	0.139	0.365	0.365	0.238	0.106	0.221	0.133	0.096
0.429	0.274	0.212	0.422	0.335	0.298	0.184	0.265	0.191	0.152
0.743	0.626	0.139	0.311	0.352	0.229	0.138	0.194	0.081	0.038
0.619	0.524	-0.114	0.050	0.275	0.000	-0.097	-0.059	-0.097	-0.166
0.005	-0.145	0.231	0.286	0.127	0.258	0.191	0.269	0.216	0.247
0.348	0.237	0.603	0.579	0.303	0.605	0.537	0.663	0.480	0.503
-	0.736	0.299	0.449	0.365	0.386	0.323	0.342	0.240	0.212
-	-	0.193	0.265	0.252	0.252	0.216	0.224	0.128	0.106
-	-	-	0.707	0.311	0.833	0.820	0.755	0.524	0.674
-	-	-	-	0.343	0.732	0.717	0.675	0.546	0.610
-	-	-	-	-	0.418	0.249	0.379	0.183	0.242
-	-	-	-	-	-	0.837	0.784	0.558	0.710
-	-	-	-	-	-	-	0.712	0.552	0.727
-	-	-	-	-	-	-	-	0.570	0.667
-	-	-	-	-	-	-	-	-	0.697
-	-	-	-	-	-	-	-	-	-

Table VI. Simple correlation coefficients for the 16 body measurements, excluding height and weight, among women: Health Examination Survey, 1960-62—Con.

Buttock-knee length	Buttock-popliteal length	Elbow-elbow breadth	Seat breadth	Biacromial diameter	Chest girth	Waist girth	Right arm girth	Right arm skinfold	Infra-scapular skinfold
0.347	0.231	-0.032	0.204	0.350	0.059	-0.076	0.052	0.057	-0.063
0.327	0.230	-0.029	0.197	0.317	0.045	-0.091	0.034	0.064	-0.063
0.689	0.585	0.106	0.254	0.406	0.180	0.121	0.128	0.100	0.041
0.429	0.387	-0.200	-0.101	0.255	-0.126	-0.166	-0.219	-0.193	-0.248
0.051	-0.045	0.143	0.275	0.094	0.179	0.111	0.222	0.191	0.150
0.465	0.352	0.597	0.609	0.370	0.594	0.523	0.641	0.539	0.541
-	0.786	0.413	0.552	0.426	0.441	0.410	0.450	0.343	0.296
-	-	0.328	0.390	0.341	0.371	0.333	0.355	0.269	0.243
-	-	-	0.696	0.331	0.878	0.870	0.835	0.619	0.751
-	-	-	-	0.327	0.680	0.666	0.746	0.614	0.596
-	-	-	-	-	0.433	0.301	0.331	0.209	0.243
-	-	-	-	-	-	0.862	0.843	0.615	0.762
-	-	-	-	-	-	-	0.803	0.589	0.747
-	-	-	-	-	-	-	-	0.740	0.774
-	-	-	-	-	-	-	-	-	0.755
-	-	-	-	-	-	-	-	-	-

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