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ANTHROPOMETRIC AND MASS DISTRIBUTION CHARACTERISTICS OF THE ADULT FEMALE

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16. Abstract

This study of 46 living adult females is part of a long-range research program designed to establish valid analytical relationships between readily measured body dimensions and mass distribution characteristics of living populations. Presented in this report are data describing the mass distribution characteristics of primary and composite body segments. The report also contains sets of regression equations which can be used to predict segmental volumes and moments of inertia from anthropometric data. The data base is derived from both classical anthropometric measurements and from stereophotogrammetric techniques. Subjects were representative of a general United States population as defined by the 1971-74 Public Health Service, Health and Nutrition Examination Survey (HANES). The data obtained describe segment and segment composite volumes, centers of volume, intersegment cut centroids, principal inertial axes, and surface anatomical landmarks with respect to anatomical axes developed for each segment. Experiments designed to test the validity of research techniques and controls, and to measure the differences between stereophotometrically derived values and values obtained by direct measurement techniques are also described here.

It is anticipated that these data will be useful as design criteria for anthropomorphic test devices used in safety research, design and performance evaluation of safety restraint systems, and development of body prostheses.

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ANTHROPOMETRIC AND MASS DISTRIBUTION CHARACTERISTICS OF THE ADULT FEMALE

INTRODUCTION

The research reported here is part of a series of studies designed to obtain information about mass distribution characteristics of the living human body and its segments, and to establish a reliable means for estimating these properties from easily measured body dimensions.

Over the years investigators have developed a number of laborious methods for determining total body mass and moments of inertia of individuals (Ignazi et al. 1972, Santchi et al. 1963); comparable data for segments of the body have been available only through the study of cadavers (Braune and Fischer 1892, Dempster 1955). The use of stereophotogrammetry (Herron et al. 1976) now makes possible the mathematical segmentation of living subjects, and provides a means for measuring mass distribution properties on body segments as well as on the total body.

A convenient and accurate method for obtaining mass distribution data for living populations would be of great value in the construction of human body analogues used in auto crash research, the design of aircraft ejection seats, the construction of artificial limbs and in many other related endeavors.

Thus, the goals of this series of mass distribution studies are not just to add to the available data, but to pursue still simpler and more readily accessible means of obtaining such data on a larger scale than is offered by stereophotogrammetry, a sophisticated, highly complex and very expensive technology. To this end, stereophotogrammetry has been used in this study of women, as it was used in the companion men's study (McConville et al. 1980), to develop and validate a series of regression equations for predicting mass distribution characteristics of the total body and its segments from anthropometric body measurements -- which can be obtained by equipment no more complicated than a set of calipers and a tape measure.

In the earlier experimental phases of the program, the use of human cadaver subjects by Chandler et al. (1975), provided verifiable comparisons of derived photometric values and directly measured values. On the basis of these comparative relationships, a series of predictive reqression equations was developed and confirmed by a later study of living children (Chandler et al. 1978) and the more recent adult male study by McConville et al. (1980). The specific research described in this report is based on 46 adult female subjects, selected to approximate the range of stature and weight combinations found in the general United States female population.

Detailed descriptions of the subject selection, anthropometric and stereophoto data collection, and data analysis procedures are given in sections I and II. Section III contains results of the study, including summary statistics on selected body measurements, location of center of volume, principal moments and principal axes of inertia,* and a series of regression equations for predicting volume and moments. Data are given for the total body and for 24 segments and segment combinations. A discussion of the findings appears in section IV.

Descriptions of all 92 anthropometric measurements and of the landmarks used to obtain them are given in Appendix A. Appendix B describes a series of duplicate and alternative testing procedures which were undertaken to validate the measuring techniques used in this series of studies.

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* The term "moments of inertia" is used throughout this report; however, the computed moments are based on an assessment of volume and an assumption of constant density.

I DATA COLLECTION

The Subjects

The primary intent of the sampling strategy was to select a minimum number of subjects who could reasonably represent the U.S. adult female population in stature and weight. The sampling plan for this study was to achieve a stature and weight distribution comparable to that found in the civilian female population as reported in the National Health and Nutrition Examination Survey (HANES) of 1971-1974 by Abraham et al. (1979). The HANES survey provides the most current and appropriate general population model available for adult U.S. females.

Limits for this study were established for an age range of 21 years through 45 years and 5th through 95th percentile values for stature and weight. In view of the limitations of locally available subjects, it was reasoned that an age range limit of 45 years would reduce the potential physical and physiological factors not compatible with the experimental procedures. The total sample of 46 subjects was divided into two age groups, 21 through 32 years and 33 through 45 years, with matching distribution of percentile rankings in stature and weight. Within the limits of subject availability and designated size-weight categories, attempts were made to select those subjects who demonstrated the greatest range of composite segment variations in volume and dimensional proportions.

The primary selection criteria of stature and weight for test subjects compare with the HANES data base values as follows:

	Sample (n=46)		HANES (n=5507)	
	$\bar{X}$	SD	$\bar{X}$	SD
Stature (cm)	161.20	6.00	162.60	6.33
Weight (kg)	63.90	12.50	64.64	15.52

The distribution of the sample with regard to the HANES 21-45 population is graphically portrayed on the bivariate distribution table in Figure 1.

Anthropometry

A total of 83 landmarks were located and marked on each subject, following which 92 dimensions were measured. The landmarks later served to define planes of segmentation and to establish all anatomical axis systems.

WEIGHT (KG)

HEIGHT (CM)	35.0	40.0	45.0	50.0	55.0	60.0	65.0	70.0	75.0	80.0	85.0	90.0	95.0	100.0
188.0									1					
186.0									1					
184.0						1	1	1	1	1				
182.0						3	1		2		1			
180.0					2	5	4	2	2	2				2
178.0					2	4	7	7	4	3	6			2
176.0				1	4	12	19	9	6	5	6		3	1
174.0				2	11	26	30	28	21	13	3	3	5	2
172.0				9	22	47	36	27	17	15	13	6	6	6
170.0			1	9	53	79	53	35	39	19	6	5	6	4
168.0			6	32	85	108	65	58	22	32	18	13	9	7
166.0		1	11	64	101	13[illegible]	70	66	39	41	29	17	17	10
164.0		4	16	82	132	133	87	60	39	39	34	20	19	6
162.0		2	23	104	129	134	84	61	32	25	25	20	12	14
160.0		5	38	91	138	115	86	36	38	30	16	12	11	7
158.0	1	5	39	102	126	105	70	33	31	22	20	10	4	5
156.0	2	6	48	84	82	56	35	27	25	12	6	6	3	1
154.0		4	27	43	56	33	19	21	7	10	5	3	1	1
152.0	1	9	17	26	27	19	21	8	4	3	5	2	1	
150.0	3	4	16	20	17	13	9	6	6	2		2		2
148.0		6	7	8	8	6	7	3	4		1			1
146.0	1	5	2	6	3	2	3		2	3				
144.0		1	1	4										
142.0		1	1	1	2		1							
140.0														
138.0						1								
136.0				1										
134.0				1										
TOTAL	8	53	253	690	1000	1040	708	488	343	277	194	119	97	71

HEIGHT (CM)	105.0	110.0	115.0	120.0	125.0	130.0	135.0	140.0	145.0	150.0	155.0	160.0	165.0	170.0	175.0	180.0	TOTAL
188.0																	1
186.0																	1
184.0																	5
182.0	1																8
180.0			1														20
178.0	1	3			1												40
176.0		2				1			1								70
174.0	2	1	1	1	1	1		1						1			153
172.0	4	5	1		1	1	1			1							218
170.0	5	5	1	4		1		1	1	1							328
168.0	10	1		3	1		1							1			472
166.0	6	6	4	2	2	1	1	1			1						628
164.0	7	3	1		2				1								686
162.0	5	6	2	1							1		1				681
160.0	3	2	3	1		1		1									634
158.0	5	1	1	2	2	1	2									1	588
156.0	5	1	1	1			2										403
154.0	1	1			1	1											234
152.0	2																145
150.0																	100
148.0																	51
146.0																	27
144.0																	6
142.0																	6
140.0																	
138.0																	1
136.0																	1
134.0																	1
TOTAL	57	37	16	15	11	8	7	4	3	2	2		1	2		1	5507

HANES ANTHROPOMETRY	MEAN	ST DEV	R	REGRESSION EQUATIONS	STD ERROR
WEIGHT	64.64	15.52	0.256	= (0.627)*HEIGHT(CM) + (−37.31)	15.01
HEIGHT	162.60	6.33	0.256	= (0.104)*WEIGHT(KG) + (155.88)	6.12

Figure 1. A bivariate frequency table for weight and height—HANES women aged 21–45. Height and weight of subjects in this study are designated by stars.

The basic anthropometry done in this study is consistent with measurements made in the 1980 adult male study, although certain minor changes were made for this study (see Appendix A).

The anthropometric survey team was trained by members of the survey team who conducted the original male survey to assure reasonable duplication of techniques for locating anatomical landmarks and measuring the same dimensions.

A detailed description of all landmarks and measurements, as well as summary statistics, appear in Appendix A.

Stereophotogrammetry

After the anthropometric measurements were taken, each subject was prepared for stereophotogrammetry. Landmarks, originally marked in pencil, were covered with round stick-on markers. Those landmarks located on the side of the body or body segment, or otherwise not visible to the cameras, were marked with offset targets.

When the markers were in place, two pairs of stereoplates, front and back, were made on each subject and immediately developed before the subject was released to assure that the plates were of usable quality. If not, the subject was re-photographed.

The stereophotographic and optical analyzer systems used in this study were the same as those used throughout the earlier program studies and are described in detail by Herron (1974) and Herron et al. (1976) at the Texas Institute for Rehabilitation and Research.

Validation Studies

Because of the innovative nature of the combined measurement techniques used in these studies, and some unexplained data relationships revealed in the earlier phases of this long range program, this study included additional tests to validate the measurement procedures. Selected anthropometric and stereophoto measurements were duplicated to test the variability of human perception and operational functions. Twelve subjects were selected for a variety of experimental control tests; four of the 12 became the control subjects participating in all experimental testing and duplication procedures. The remaining eight subjects of this group participated in a series of direct measurements to determine (1) total body density, (2) total body inertia, and (3) partial body volumes for comparison with those determined stereometrically. In addition, a comparison of stereometrically derived linear body dimensions with those measured anthropometrically was made on 32 variables for the entire study sample. The detailed protocol and results of these experimental procedures are presented in Appendix B of this report.

II DATA PROCESSING AND ANALYSIS

The data obtained from the stereophoto plates, through use of an optical analyzer system, yielded contour points for horizontal and parallel cross sections approximately normal to the long axis of each segment. As in the male study, the distance between points along the perimeter of each cross section averaged approximately 0.7 cm. The vertical interval between cross sections was 2.54 cm except for the head, hand, foot and abdomen segments where the interval was 1.27.

Using the cross sectional data to define three-dimensional body surface, an analytic body segmentation scheme (defined later in this section) and an assumption of constant density (established as 1.0 in this study), the volume, center of volume, principal moments and axes of inertia were calculated for each segment and for the total body of each subject. The analytic procedures used for segmentation and the calculations of volume and moment properties are described by Baughman (1982).

The final step in this study was the calculation of series of regression equations for predicting volumes and principal moments of inertia from various anthropometric dimensions. One set of equations was obtained by using only stature and weight as predictor values--not because they necessarily provide the best estimates but because they are easily obtainable for most populations of interest. A second series of multi-step regression equations using stature, weight and other segmental variables as predictors was obtained by using a standard type of BMD stepwise regression computer program which selects the body dimensions having maximum power to predict volume or principal moments of inertia for a given segment. The body size variables considered in the development of these equations were restricted to those measured directly on the segment involved, plus stature and weight which were included because as measures of overall mass distribution they may be better predictors than any other single variable.

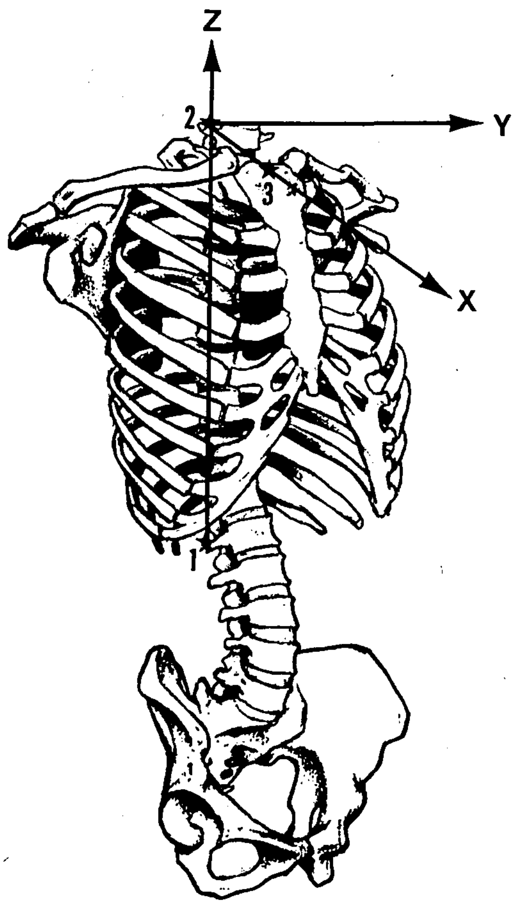
Axis Systems

Anatomical axis systems for the total body and for each segment were created in both the male and female studies as reference systems from which centers of volume and principal axes of inertia could be located regardless of body segment position. This permits duplication of measurements on other subject populations and represents a major step forward from past studies in which principal axes were located with reference to fixed points in the laboratory.

The unique specification of anatomical coordinate systems requires a minimum of three noncolinear points which were defined with respect to surface landmarks associated with each segment. The general procedure used was to define the direction of one axis (or vector) to extend from one point to another and then to take the normal projection from the third point to this axis to form another coordinate axis. The third coordinate axis was generated by forming the cross or vector product between these two axes in a prescribed order.

The cross product yields a third vector which is perpendicular to both the first and second vectors. In order to correctly calculate the cross product, the positive direction of the first two vectors must be defined and the prescribed order of a x b = c, b x c = a, c x a = b, must be followed. In this study, the positive direction of each axis (denoted by X, Y, or Z) is defined in reference to the standard anatomical position: +X extends from posterior to anterior, +Y extends from the subject's right to left, and +Z extends from distal to proximal (or towards the head in the case of the torso). Whenever possible, the first axis is selected with the goal of maximizing the distance between the two anthropometric landmarks defining the vector. This minimizes the rotational effects that slight differences in identifying landmarks on different subjects would have on the entire axis system. Figure 2 illustrates the anatomical axis system of the thorax. The three noncolinear points used for axes construction are (1) 10th rib midspine, (2) cervicale, and (3) suprasternale. The first vector (Z) extends from 10th rib midspine to cervicale (this also establishes the positive direction). The second vector (X) is normal to the first and passes through the suprasternale landmark (note that the second vector does not necessarily originate at the cervicale landmark as the illustration indicates). The third axis is calculated as the cross product $\hat{Z} \times \hat{X} = \hat{Y}$. Once the relationship of the axes has been set, the origin can be placed at any landmark. In this case, it was translated to the 10th rib midspine landmark to avoid duplication of the neck segment origin.

In some cases more than three points were used. For some of these, the same basic approach to calculating the coordinate system as described above was used and an extra (fourth) point provided for origin placement. A few segments required a relatively complex scheme for coordinate calculation. This was especially true of the feet, where several projections had to be taken. In all cases, however, the methodology described below for obtaining unique coordinate systems for each segment is based on construction of two orthogonal axes from landmarks, and the generation of the third by use of the cross (or vector) product calculated in the order listed in the definition.



1 = 10th rib midspine (origin)
2 = cervicale
3 = suprasternale

Z axis - vector from 10th Rib Midspine to Cervicale
X axis - normal from Z axis to Suprasternale
Y axis - $\hat{Z} \times \hat{X}$

Figure 2. Anatomical axis system for the thorax segment.

An illustration of both principal and anatomical axis systems on a three-dimensional model of the thorax segment is pictured in Figure 3.

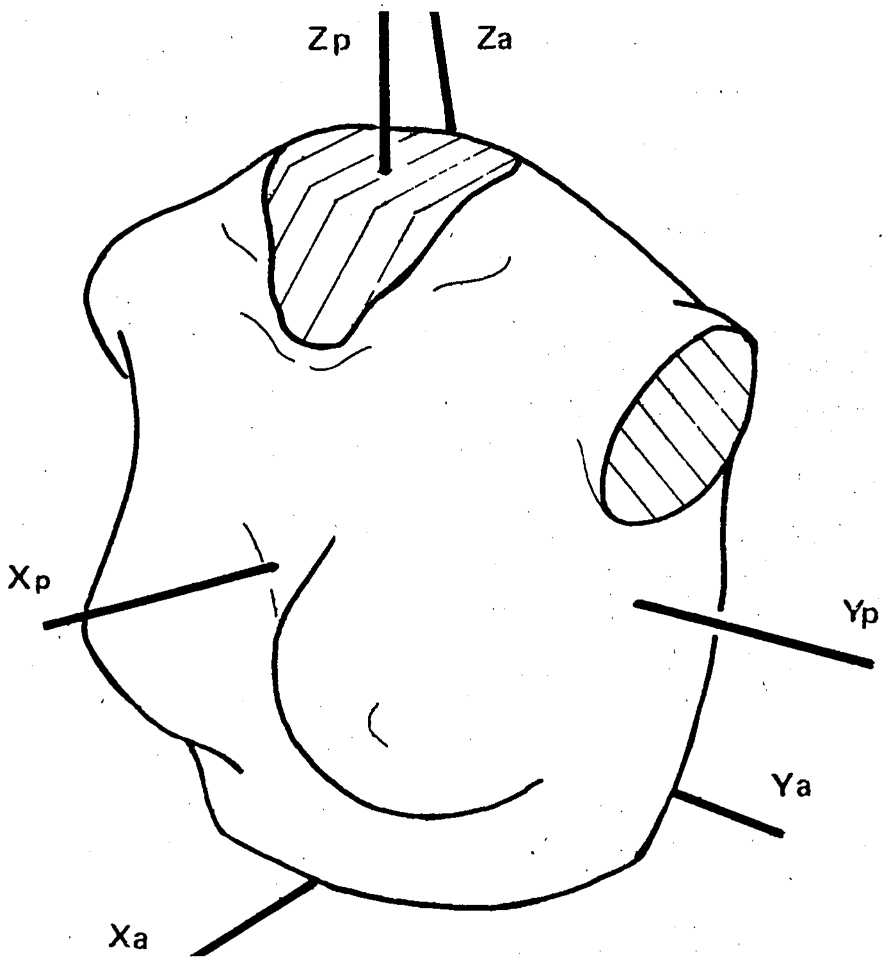


Figure 3. Three-dimensional model of the thorax. A=anatomical axis system; P=principal axis system.

The original anatomical axis system for each segment and segment composite is as follows:

<u>HEAD</u>

Y axis - vector from right tragion to left tragion.
X axis - normal from Y axis to right infraorbitale.
Z axis - $\hat{X} \times \hat{Y}$.
Origin - intersection of Y axis and a normal passing through sellion.

NECK

Y axis - normal vector to the subject's left from the plane formed by cricoid cartilage, cervicale, and suprasternale.
X axis - normal from Y axis through the mid-point of a line between left and and right clavicales.
Z axis - $\hat{X} \times \hat{Y}$.
Origin - at cervicale.

THORAX

Z axis - vector from 10th rib midspine to cervicale.
X axis - normal from Z axis to suprasternale.
Y axis - $\hat{Z} \times \hat{X}$
Origin - at 10th rib midspine.

ABDOMEN

Y axis - vector from right 10th rib to left 10th rib.
X axis - normal from 10th rib midspine to Y axis.
Z axis - $\hat{X} \times \hat{Y}$.
Origin - at intersection of X and Y vectors.

PELVIS, TORSO, and TOTAL BODY

Y axis - vector from right anterior superior iliac spine to left anterior superior iliac spine.
Z axis - normal from symphysion to Y axis.
X axis - $\hat{Y} \times \hat{Z}$.
Origin - at intersection of Y axis and the normal to it passing through a point midway between the posterior superior iliac spines.

RIGHT UPPER ARM

Z axis - vector from lateral humeral epicondyle to acromion.
Y axis - normal from Z axis to medial humeral epicondyle.
X axis - $\hat{Y} \times \hat{Z}$.
Origin - at acromion.

RIGHT FOREARM, and RIGHT FOREARM PLUS HAND

Z axis - vector from ulnar styloid to radiale.
Y axis - normal from radial styloid to Z axis.
X axis - $\hat{Y} \times \hat{Z}$.
Origin - at radiale.

RIGHT HAND

Y axis - vector from metacarpale II to metacarpale V.
Z axis - normal from dactylion to Y axis.
X axis - $\hat{Y} \times \hat{Z}$.
Origin - at intersection of Y axis and the normal passing through metacarpale III.

LEFT UPPER ARM

Z axis - vector from lateral humeral epicondyle to acromion.
Y axis - normal from medial humeral epicondyle to Z axis.
X axis - $\hat{Y} \times \hat{Z}$.
Origin - at acromion.

LEFT FOREARM, and LEFT FOREARM PLUS HAND

Z axis - vector from ulnar styloid to radiale.
Y axis - normal from Z axis to radial styloid.
X axis - $\hat{Y} \times \hat{Z}$.
Origin - at radiale.

LEFT HAND

Y axis - vector from metacarpale V to metacarpale II.
Z axis - normal from dactylion to Y axis.
X axis - $\hat{Y} \times \hat{Z}$.
Origin - at intersection of Y axis and the normal passing through metacarpale III.

RIGHT THIGH, RIGHT THIGH MINUS FLAP, and RIGHT HIP FLAP

Z axis - vector from lateral femoral epicondyle to trochanterion.
Y axis - normal from Z axis to medial femoral epicondyle.
X axis - $\hat{Y} \times \hat{Z}$.
Origin - at trochanterion.

RIGHT CALF

Z axis - vector from sphyrion to tibiale.
Y axis - normal from lateral malleolus to Z axis.
X axis - $\hat{Y} \times \hat{Z}$.
Origin - at tibiale.

RIGHT FOOT

Z axis - superiorly directed vector normal to the X-Y plane formed by metatarsal I, metatarsal V, and posterior calcaneous.
X axis - vector from posterior calcaneous to normally projected position of toe 2 on X-Y plane.
Y axis - $\hat{Z} \times \hat{X}$.
Origin - at the intersection of the X axis and the normal passing through metatarsal phalange I.

LEFT THIGH, LEFT THIGH MINUS FLAP, and LEFT HIP FLAP

Z axis - vector from lateral femoral epicondyle to trochanterion.
Y axis - normal from medial femoral epicondyle to Z axis.
X axis - $\hat{Y} \times \hat{Z}$.
Origin - at trochanterion.

LEFT CALF

Z axis - vector from sphyrion to tibiale.
Y axis - normal from Z axis to lateral malleolus.
X axis - $\hat{Y} \times \hat{Z}$.
Origin - at tibiale.

LEFT FOOT

Z axis - superiorly directed vector normal to the X-Y plane formed by metatarsal I, metatarsal V, and posterior calcaneous.
X axis - vector from posterior calcaneous to normally projected position of toe 2 on X-Y plane.
Y axis - $\hat{Z} \times \hat{X}$.
Origin - at the intersection of the X axis and the normal passing through metatarsal-phalange I.

Segmentation

The plan for segmenting the body into the seventeen primary segments and subdividing the thighs into separate proximal flaps was identical to that used in the adult male reference study. Added in this study was the computation of centroids on each segment to facilitate reassembly of the body. These points were established at the center of the cross-sectional area on the plane of segmentation.

The segments and segment combinations are the head, neck, thorax, abdomen, pelvis, right and left upper arms, right and left forearms, right and left hands, right and left thighs, right and left flaps, right and left thighs minus flaps, right and left calves, right and left feet, right and left forearms plus hands, torso, and the total body. Computer programs used to segment the parts were developed by Baughman (1982) and are described by the author in that publication. The planes of segmentation, which define the segments, are illustrated in Figure 4. The location and orientation of these segmentation planes are described in reference to established anatomical landmarks with the body standing erect in the classical anatomical position. Specific definitions of the segmentation planes are described as follows:

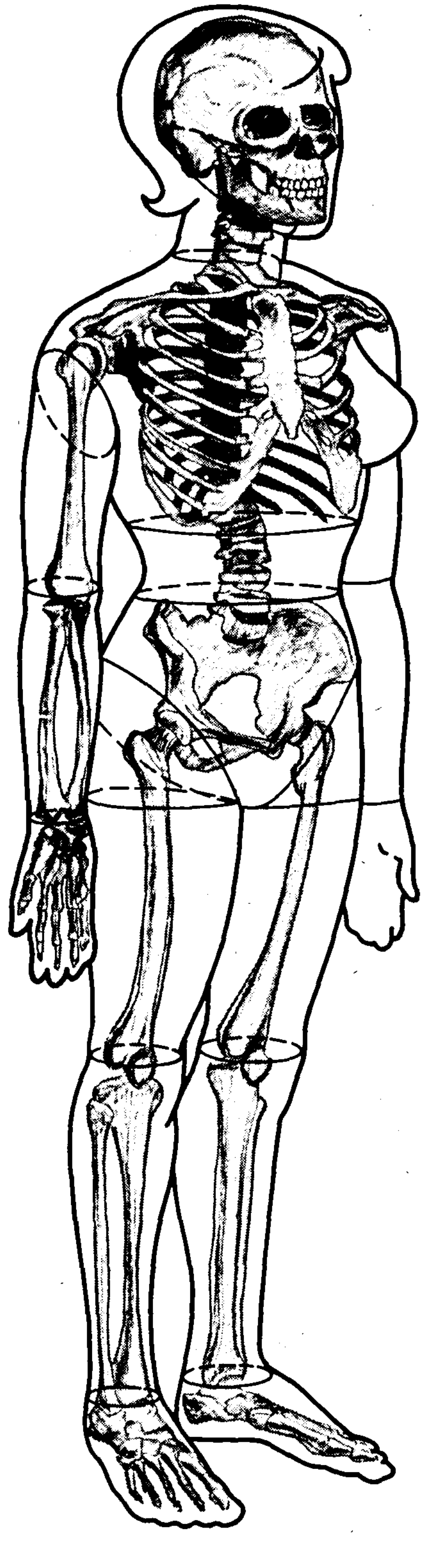


Figure 4. Planes of segmentation for the total body.

Head plane: A simple plane that passes through the right and left gonion points and nuchale.

Neck plane: A compound plane in which a horizontal plane originates at cervicale and passes anteriorly to intersect with the second plane. The second plane originates at the lower of the two clavicale landmarks and passes superiorly at a 45 degree angle to intersect the horizontal plane.

Thorax plane: A simple transverse plane that originates at the 10th rib midspine landmark and passes horizontally through the torso.

Abdominal plane: A simple transverse plane originating at the higher of the two iliocristale landmarks and continuing horizontally through the torso.

Hip plane: A simple plane originating midsagittally on the perineal surface and passing superiorly and laterally midway between the anterior superior iliac spine and trochanterion landmarks, parallelling the right and left inguinal ligaments.

Thigh flap plane: A simple plane originating at the gluteal furrow landmark and passing horizontally through the thigh.

Knee plane: A simple plane originating at the lateral femoral epicondyle and passing horizontally through the knee.

Ankle plane: A simple plane originating at the sphyrion landmark and passing horizontally through the ankle.

Shoulder plane: A simple plane originating at the acromion landmark and passing inferiorly and medially through the anterior and posterior scye point marks at the axillary level.

Elbow plane: A simple plane originating at the olecranon landmark and passing through the medial and lateral humeral epicondyle landmarks.

Wrist plane: A simple plane originating at the ulnar and radial styloid landmarks and passing through the wrist perpendicular to the long axis of the forearm.

III RESULTS

Data analysis in this study provided information on (1) the locations of landmarks relative to the anatomical axis origin, (2) principal axes of inertia with respect to the anatomical axes, (3) principal moments of inertia, (4) segment volumes, and (5) regression equations to predict volume and moments from standard anthropometry. These data are defined and described in Tables 1-25.

The axis systems illustrated in the perspective drawings accompanying each table are identified by directional labels. The set labelled X_a, Y_a, and Z_a, designates the anatomical axis system. The set labelled X_p, Y_p, and Z_p, designates the principal axis system. The standard error of estimate (SE EST) accompanying the regression equations in these tables is expressed as a percentage of the mean value. All other values are expressed as follows:

Principal moments in gram centimeters squared (gm cm^2),
Volumes in cubic centimeters (cc)
Weights in pounds (lbs)*
Skinfolds in millimeters (mm)
Other dimensional values in centimeters (cm)

The cut planes associated with each segment or segment composite are identified by the shaded areas in the illustrations.

Results of the validation studies can be found in Appendix B.

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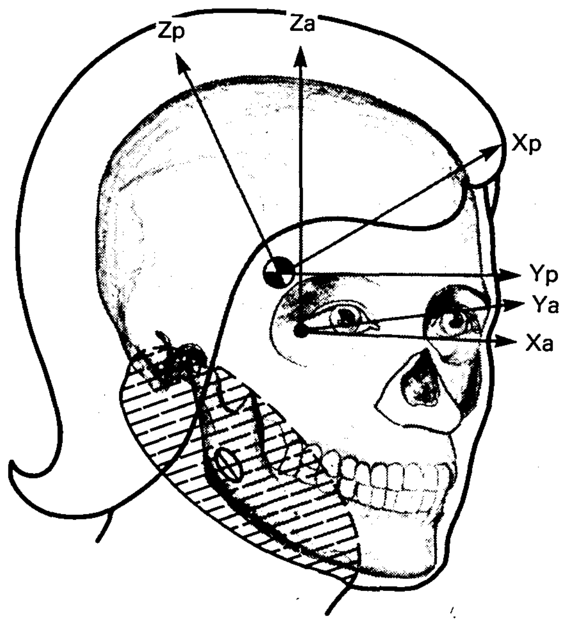
* Unit pounds are used to maintain consistency with the earlier report (McConville et al. 1980). If the subject's mass is given in kg, the regression coefficient for weight in these tables should be multiplied by 2.205.

TABLE 1

HEAD

ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
HEAD HT	13.6- 17.9	15.59	.78
HEAD LTH	17.3- 19.9	18.69	.64
HEAD BR	13.7- 15.7	14.58	.44
BITRAGION BR	11.8- 14.3	13.16	.48
SAGITTAL ARC	33.5- 40.7	37.33	1.31
BITRAG-CORON ARC	31.0- 37.0	33.91	1.31
HEAD CIRC	52.1- 56.6	54.78	1.20



HEAD RANGE	VOLUME MEAN	S.D.
3,386 - 4,514	3,894	267

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	-2.43 - .05	-1.08	.53
Y-AXIS	-.60 - .84	.01	.35
Z-AXIS	2.24 - 4.79	3.42	.45

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
NUCHALE	-8.96	.87	.09	.59	-2.56	1.20
SELLION	8.48	.48	0.00	0.00	1.91	.39
LEFT TRAGION	0.00	0.00	6.87	.41	0.00	0.00
RIGHT TRAGION	0.00	0.00	-6.80	.39	0.00	0.00
R INFRAORBITALE	6.98	.39	-.17	1.41	0.00	0.00

LOCATION OF THE CUT CENTROID FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
HEAD	-2.87	.64	.30	1.15	-4.66	.58

HEAD: REGRESSION EQUATIONS

HEAD VOLUME AND MOMENTS FROM STATURE AND WEIGHT

		STATURE		WEIGHT		CONSTANT	R	SE EST
VOLUME	=	-1.25	+	4.45	+	3,469	.450	6.3%
X MOMENT	=	-95	+	322	+	141,316	.415	11.3%
Y MOMENT	=	-25	+	357	+	143,627	.409	11.8%
Z MOMENT	=	-69	+	243	+	106,468	.462	9.9%

HEAD VOLUME FROM:

HEAD CIRC		HEAD HT		STATURE		CONSTANT	R	SE EST
147.05					-	4,161.23	.661	5.2%
108.73	+	137.28			-	4,202.24	.754	4.6%
132.85	+	163.75	-	13.73	-	3,722.51	.799	4.3%

HEAD X MOMENT FROM:

HEAD CIRC		HEAD HT		STATURE		CONSTANT	R	SE EST
10,655					-	412,600	.613	9.7%
8,156	+	8,953			-	415,236	.685	9.1%
9,857	+	10,819	-	968	-	381,416	.725	8.7%

HEAD Y MOMENT FROM:

HEAD CIRC		HEAD HT		STATURE		CONSTANT	R	SE EST
12,702					-	505,983	.635	9.9%
9,784	+	10,461			-	509,109	.706	9.2%
11,702	+	12,566	-	1,092	-	470,950	.743	8.8%

HEAD Z MOMENT FROM:

HEAD CIRC		HEAD BR		STATURE		CONSTANT	R	SE EST
7,967					-	306,977	.673	8.2%
5,586	-	8,531			-	309,488	.797	6.8%
6,959	-	10,038	-	782	-	282,183	.845	6.1%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE			MEAN	S.D.
X-AXIS	135,088	-	221,662	171,144	20,829
Y-AXIS	143,550	-	250,341	189,917	23,994
Z-AXIS	103,816	-	160,653	129,503	14,181

PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	42.19	91.23	47.83	STD. DEV. OF ROT. X = 3.22
Y	88.84	1.32	89.37	STD. DEV. OF ROT. Y = 8.22
Z	132.17	89.69	42.17	STD. DEV. OF ROT. Z = 3.61

HEAD: REGRESSION EQUATIONS

HEAD VOLUME AND MOMENTS FROM STATURE AND WEIGHT

		STATURE	WEIGHT	CONSTANT	R	SE EST
VOLUME	=	-1.25 +	4.45 +	3,469	.450	6.3%
X MOMENT	=	-384 +	476 +	155,137	.419	17.1%
Y MOMENT	=	-25 +	357 +	143,627	.409	11.8%
Z MOMENT	=	220 +	88 +	92,585	.154	15.0%

HEAD VOLUME FROM:

HEAD CIRC	HEAD HT	STATURE	CONSTANT	R	SE EST
147.05		-	4,161.23	.661	5.2%
108.73 +	137.28	-	4,202.24	.754	4.6%
132.85 +	163.75 -	13.73 -	3,722.51	.799	4.3%

HEAD X MOMENT FROM:

HEAD HT	HEAD BR	STATURE	CONSTANT	R	SE EST
21,364		-	172,855	.567	15.4%
16,909 +	17,129	-	353,147	.609	14.9%
19,132 +	17,142 -	723 -	271,345	.624	14.9%

HEAD Y MOMENT FROM:

HEAD CIRC	HEAD HT	STATURE	CONSTANT	R	SE EST
12,704		-	505,983	.635	9.9%
9,784 +	10,461	-	509,109	.706	9.2%
11,702 +	12,566 -	1,092 -	470,950	.743	8.8%

HEAD Z MOMENT FROM:

HEAD CIRC	HEAD BR	STATURE	CONSTANT	R	SE EST
8,746		-	338,641	.503	13.0%
9,985 -	9,252	-	271,640	.534	12.8%
11,158 -	9,089 -	521 -	254,325	.550	12.8%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE		MEAN	S.D.
X-AXIS	103,816 -	221,662	160,208	29,519
Y-AXIS	143,550 -	250,341	189,917	23,994
Z-AXIS	109,241 -	205,082	140,438	20,861

PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES

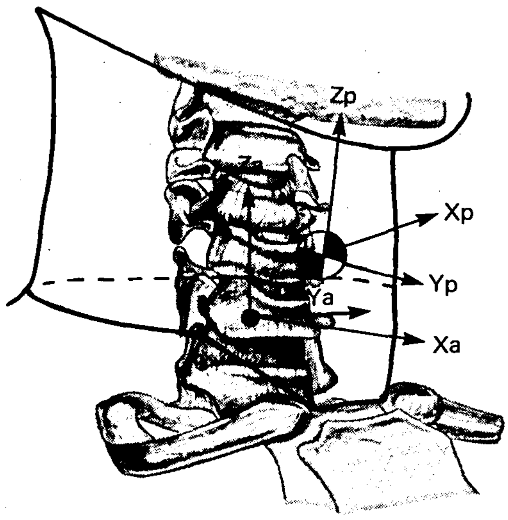
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	42.19	91.28	47.83	STD. DEV. OF ROT. X = 3.22
Y	88.84	1.32	89.37	STD. DEV. OF ROT. Y = 8.22
Z	132.17	89.69	42.17	STD. DEV. OF ROT. Z = 3.61

TABLE 2

NECK

ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
NECK LTH	4.3- 9.3	6.98	1.16
NECK BR	9.2- 12.5	10.46	.70
NECK CIRC	29.6- 39.1	32.86	2.21



NECK VOLUME RANGE	MEAN	S.D.
500 - 991	737	122

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	3.41 - 8.16	5.27	.86
Y-AXIS	-.56 - .97	.05	.27
Z-AXIS	2.93 - 5.79	4.51	.61

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
CERVICALE	0.00	0.00	0.00	0.00	0.00	0.00
MID THYROID CART	10.20	1.01	0.00	0.00	3.65	.87
LEFT CLAVICALE	11.54	.88	1.98	.31	-.05	.16
RIGHT CLAVICALE	11.46	.93	-2.12	.33	.05	.16
SUPRASTERNALE	12.68	.91	0.00	0.00	-.87	.23

LOCATION OF THE CUT CENTROID FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
HEAD	2.48	1.13	.33	1.00	7.16	.90
NECK	1.82	.91	-.07	1.06	.94	.32

NECK: REGRESSION EQUATIONS

NECK VOLUME AND MOMENTS FROM STATURE AND WEIGHT

		STATURE		WEIGHT		CONSTANT	R	SE EST
VOLUME	=	10.01	+	1.21	-	1,047	.650	12.9%
X MOMENT	=	220	+	36	-	30,357	.645	23.2%
Y MOMENT	=	260	+	37	-	33,955	.611	22.0%
Z MOMENT	=	111	+	89	-	16,002	.694	20.6%

NECK VOLUME FROM:

STATURE	NECK CIRC	NECK LTH	CONSTANT	R	SE EST
12.34		-	1,252.24	.601	13.4%
10.25 +	19.10	-	1,543.33	.685	12.4%
9.44 +	23.57 +	14.26 -	1,658.86	.694	12.4%

NECK X MOMENT FROM:

STATURE	NECK CIRC	NECK BR	CONSTANT	R	SE EST
292		-	36,745	.566	24.7%
233 +	542	-	45,005	.678	22.3%
230 +	309 +	877 -	46,070	.686	22.3%

NECK Y MOMENT FROM:

STATURE	NECK CIRC	NECK LTH	CONSTANT	R	SE EST
330		-	40,181	.553	22.9%
272 +	529	-	48,234	.636	21.5%
247 +	671 +	455 -	51,922	.648	21.5%

NECK Z MOMENT FROM:

NECK CIRC	STATURE	NECK LTH	CONSTANT	R	SE EST
1,368		-	30,499	.748	18.8%
1,252 +	146	-	50,236	.776	18.1%
1,380 +	123 +	410 -	53,554	.781	18.1%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE		MEAN	S.D.
X-AXIS	5,545 -	18,731	10,380	3,075
Y-AXIS	6,196 -	21,923	13,064	3,557
Z-AXIS	7,441 -	25,010	14,443	4,049

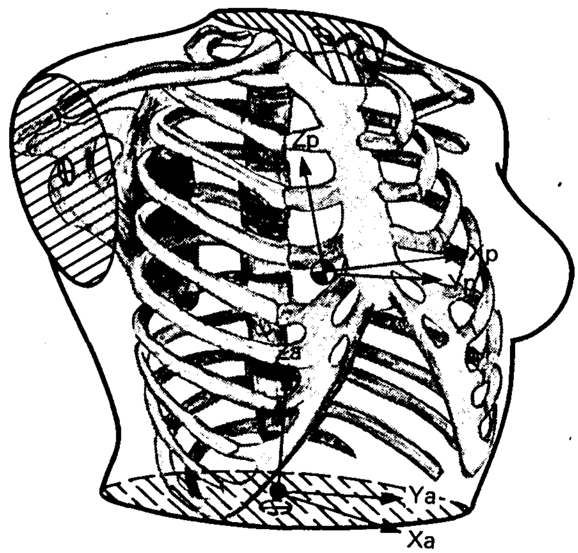
PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	8.38	89.60	81.63	STD. DEV. OF ROT. X = 16.07
Y	89.98	2.94	92.94	STD. DEV. OF ROT. Y = 15.75
Z	98.36	87.09	8.88	STD. DEV. OF ROT. Z = 10.36

TABLE 3

THORAX

ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
THORAX LTH	29.4- 40.6	36.16	2.18
MIDSAG CHEST DPTH	13.5- 23.0	17.81	1.71
BIACROMIAL BR	33.5- 40.2	36.79	1.63
CHEST BR	25.2- 36.8	28.64	2.29
BUSTPT-BUSTPT	13.9- 22.2	18.02	1.72
TENTH RIB BR	21.0- 33.3	25.67	2.99
TENTH RIB CIRC	62.0-106.2	75.94	10.43
SUBSCAPULAR SKFLD	.6- 4.2	1.52	.78
BUST CIRC	82.0-122.8	95.41	8.15



THORAX VOLUME

RANGE	MEAN	S.D.
12,718 - 30,724	18,175	3,567

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	3.76 - 9.24	6.11	1.04
Y-AXIS	-.81 - .56	-.02	.29
Z-AXIS	13.43 - 18.69	16.51	1.13

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
CERVICALE	0.00	0.00	0.00	0.00	36.05	2.30
LEFT ACROMIALE	2.63	1.57	17.79	1.00	29.78	2.30
RIGHT ACROMIALE	2.48	1.61	-17.84	1.03	29.50	2.12
10TH RIBMIDSPINE	0.00	0.00	0.00	0.00	0.00	0.00
SUPRASTERNALE	10.75	.95	0.00	0.00	29.39	1.94

LOCATION OF THE CUT CENTROID FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
NECK	2.04	.93	-.08	1.08	36.10	2.27
THORAX	8.84	1.29	.12	.84	.43	.51
RIGHT SHOULDER	2.99	2.35	-16.03	1.88	22.70	1.93
LEFT SHOULDER	4.31	2.33	16.70	1.48	22.92	2.04

THORAX: REGRESSION EQUATIONS

THORAX VOLUME AND MOMENTS FROM STATURE AND WEIGHT

		STATURE		WEIGHT		CONSTANT	R	SE EST
VOLUME	=	-1.32	+	120.37	+	1,428	.932	7.3%
X MOMENT	=	7,231	+	27,698	-	2,278,454	.893	14.5%
Y MOMENT	=	10,639	+	21,608	-	2,619,378	.896	14.8%
Z MOMENT	=	-13,444	+	23,963	+	650,051	.923	14.5%

THORAX VOLUME FROM:

WEIGHT		BUST CIRC		THORAX LTH		CONSTANT	R	SE EST
120.25					+	1,231.08	.932	7.2%
68.95	+	192.41			-	9,899.31	.951	6.2%
33.08	+	285.77	+	422.96	-	29,046.39	.977	4.3%

THORAX X MOMENT FROM:

WEIGHT		THORAX LTH		BUST CIRC		CONSTANT	R	SE EST
28,345					-	1,203,646	.892	14.4%
25,840	+	96,484			-	4,339,515	.920	12.7%
5,058	+	142,976	+	73,425	-	10,097,971	.958	9.3%

THORAX Y MOMENT FROM:

WEIGHT		THORAX LTH		BUST CIRC		CONSTANT	R	SE EST
22,560					-	1,038, 26	.892	14.9%
19,997	+	98,707			-	4,246,157	.938	11.6%
5,697	+	130,698	+	50,523	-	8,208,450	.967	8.7%

THORAX Z MOMENT FROM:

BUST CIRC		TENTH RIB BR		THORAX LTH		CONSTANT	R	SE EST
79,756					-	5,750,761	.947	12.0%
48,970	+	92,952			-	5,199,478	.963	10.2%
50,167	+	83,946	+	45,298	-	6,720,519	.973	8.8%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE	MEAN	S.D.
X-AXIS	1,642,023 - 6,381,834	2,790,171	879,151
Y-AXIS	1,199,403 - 4,800,768	2,140,627	699,245
Z-AXIS	1,000,656 - 4,561,545	1,858,781	686,351

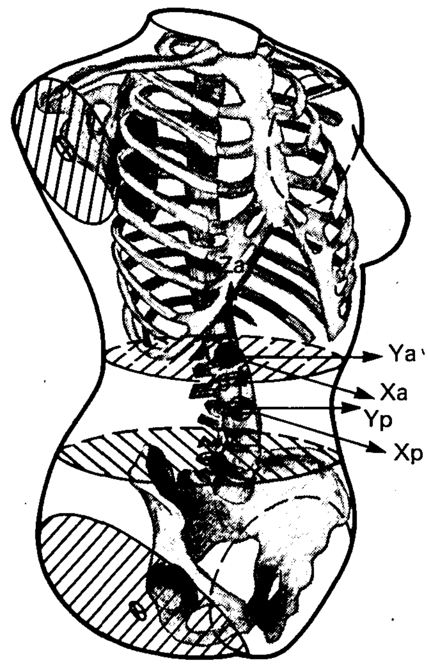
PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	19.19	91.53	70.87	STD. DEV. OF ROT. X = 4.71
Y	88.20	1.88	90.53	STD. DEV. OF ROT. Y = 6.39
Z	109.10	86.91	19.14	STD. DEV. OF ROT. Z = 3.02

TABLE 4

ABDOMEN

ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
ABDOMEN LTH	1.2- 11.2	4.94	1.84
TENTH RIB BR	21.0- 33.3	25.67	2.99
WAIST BR	24.5- 40.6	31.05	4.12
BICRISTAL BR	24.6- 31.9	27.91	1.86
WAIST CIRC	68.7-118.8	86.70	13.22
TENTH RIB CIRC	62.0-106.2	75.94	10.43
SUPRAILIAC SKFLD	.6- 4.2	1.65	.80



ABDOMEN VOLUME

RANGE	MEAN	S.D.
809 - 9,203	2,817	1,465

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	-1.48 - 3.97	.55	1.09
Y-AXIS	-1.65 - .84	-.06	.53
Z-AXIS	-4.85 - -1.12	-2.84	.81

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
L ILIOCRISTALE	.72	1.65	15.09	1.72	-5.82	1.62
R ILIOCRISTALE	.06	1.25	-15.27	1.88	-5.52	1.49
LEFT 10TH RIB	0.00	0.00	13.57	1.50	0.00	0.00
RIGHT 10TH RIB	0.00	0.00	-13.45	1.75	0.00	0.00
POS SUP ILIAC MS	-11.24	1.51	-.14	.40	-9.69	1.80

LOCATION OF THE CUT CENTROID FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
THORAX	.14	.89	.29	.96	-.05	.67
ABDOMEN	.44	1.21	.12	.90	-5.46	1.52

ABDOMEN: REGRESSION EQUATIONS

ABDOMEN VOLUME AND MOMENTS FROM STATURE AND WEIGHT

		STATURE	WEIGHT	CONSTANT	R	SE EST
VOLUME	=	-113.70 +	32.80 +	16,526	.600	42.6%
X MOMENT	=	-11,364 +	3,940 +	1,456,180	.687	61.4%
Y MOMENT	=	-10,928 +	3,364 +	1,407,621	.705	76.2%
Z MOMENT	=	-19,503 +	6,878 +	2,446,594	.723	63.4%

ABDOMEN VOLUME FROM:

ABDOMEN LTH	TENTH RIB CIRC	TENTH RIB BR	CONSTANT	R	SE EST
542.03		+	139.21	.680	38.5%
586.41 +	94.84	-	7,282.10	.957	15.4%
572.45 +	184.72 -	323.75 -	5,727.80	.969	13.2%

ABDOMEN X MOMENT FROM

TENTH RIB CIRC	ABDOMEN LTH	TENTH RIB BR	CONSTANT	R	SE EST
10,373		-	608,719	.732	57.0%
11,072 +	48,074	-	899,306	.943	28.0%
19,635 +	46,744 -	30,843 -	751,231	.955	25.5%

ABDOMEN Y MOMENT FROM

TENTH RIB CIRC	ABDOMEN LTH	TENTH RIB BR	CONSTANT	R	SE EST
8,665		-	538,302	.719	73.9%
9,247 +	40,007	-	780,126	.925	40.8%
19,437 +	38,424 -	36,704 -	603,911	.947	34.8%

ABDOMEN Z MOMENT FROM

TENTH RIB CIRC	ABDOMEN LTH	TENTH RIB BR	CONSTANT	R	SE EST
17,838		-	1,081,332	.760	58.9%
18,900 +	72,980	-	1,522,462	.936	32.4%
34,919 +	70,491 -	57,702 -	1,245,440	.950	29.0%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE	MEAN	S.D.
X-AXIS	41,754 - 784,110	179,010	147,912
Y-AXIS	23,441 - 682,676	119,717	125,792
Z-AXIS	64,332 - 1,287,145	273,309	244,943

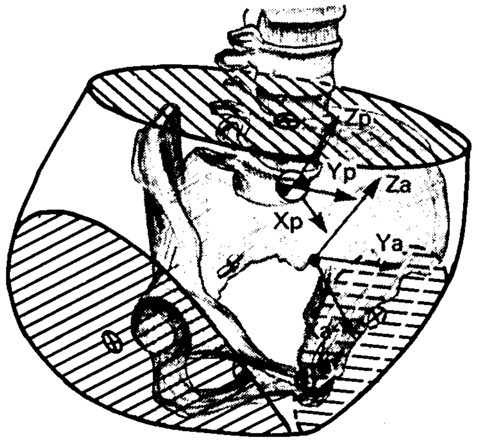
PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	.45	90.13	90.43	STD. DEV. OF ROT. X = 1.51
Y	89.87	.34	89.69	STD. DEV. OF ROT. Y = 4.25
Z	89.57	90.31	.53	STD. DEV. OF ROT. Z = 2.61

TABLE 5

PELVIS

ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
BUTTOCK DEPTH	18.1- 35.7	24.12	3.49
BICRISTAL BR	24.6- 31.9	27.91	1.86
BISPINOUS BR	18.1- 33.2	23.25	2.96
BITROCH BR	27.1- 36.8	31.63	1.99
HIP BR	30.9- 45.4	37.25	3.34
BUTTOCK CIRC	83.5-130.2	100.08	9.69
SUPRAILIAC SKFLD	.6- 4.2	1.85	.80
PELVIC LTH	21.8- 31.9	25.82	2.08



PELVIS RANGE	VOLUME MEAN	S.D.
5,835 - 20,392	10,128	3,250

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	-12.16 - -5.59	-8.61	1.24
Y-AXIS	-1.32 - .95	-.07	.45
Z-AXIS	-.76 - 5.26	2.30	1.39

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
LEFT ASIS	0.00	0.00	11.84	1.55	0.00	0.00
RIGHT ASIS	0.00	0.00	-11.93	1.59	0.00	0.00
POS SUP ILIAC MS	-18.04	2.34	0.00	0.00	7.54	2.71
SYMPHYSION	0.00	0.00	-.02	.72	-9.12	1.58

LOCATION OF THE CUT CENTROID FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
ABDOMEN	-5.86	1.73	.31	1.07	9.27	1.40
RIGHT HIP	-1.29	.87	-10.92	1.48	-5.95	1.27
LEFT HIP	-1.35	.93	10.76	1.64	-6.23	1.60

PELVIS: REGRESSION EQUATIONS

PELVIS VOLUME AND MOMENTS FROM STATURE AND WEIGHT

		STATURE	WEIGHT	CONSTANT	R	SE EST
VOLUME	=	-97.57 +	118.96 +	9,097	.952	10.1%
X MOMENT	=	-10,829 +	16,383 +	338,759	.953	15.6%
Y MOMENT	=	-19,910 +	17,024 +	1,538,661	.946	21.1%
Z MOMENT	=	-27,129 +	26,546 +	1,875,223	.958	16.9%

PELVIS VOLUME FROM:

WEIGHT	STATURE	SUPRAILIAC SKINFOLD	CONSTANT	R	SE EST
110.24		-	5,403.95	.938	11.3%
118.96 -	97.57	+	9,097.30	.952	10.1%
107.20 -	84.30 +	528.80 +	7,637.48	.956	9.7%

PELVIS X MOMENT FROM:

WEIGHT	BISPINOUS BR	BUTTOCK DEPTH	CONSTANT	R	SE EST
15,415		-	1,270,824	.944	16.7%
13,279 +	28,174	-	1,624,847	.953	15.5%
8,686 +	28,527 +	38,817 -	1,922,238	.959	14.7%

PELVIS Y MOMENT FROM:

BUTTOCK DEPTH	WEIGHT	STATURE	CONSTANT	R	SE EST
122,194		-	2,220,067	.926	24.2%
72,424 +	6,725	-	1,967,133	.937	22.6%
43,119 +	11,563 -	15,564 +	567,274	.951	20.2%

PELVIS Z MOMENT FROM:

WEIGHT	STATURE	SUPRAILIAC SKINFOLD	CONSTANT	R	SE EST
24,120		-	2,156,947	.935	20.5%
26,546 -	27,129	+	1,875,223	.958	16.9%
23,811 -	24,044 +	122,921 +	1,535,882	.963	16.1%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE	MEAN	S.D.
X-AXIS	363,285 - 2,338,946	901,158	451,582
Y-AXIS	253,450 - 2,473,799	727,256	460,134
Z-AXIS	434,686 - 3,574,031	1,241,623	713,023

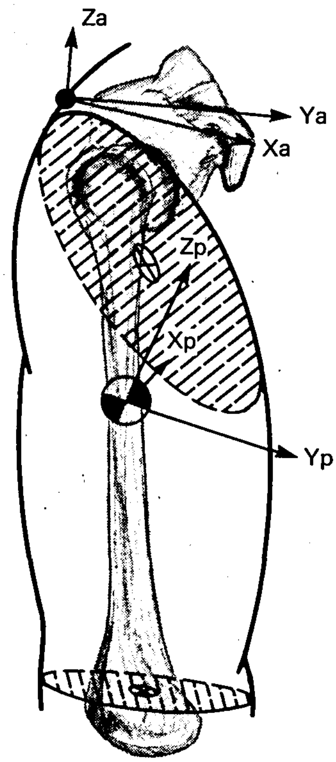
PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	2.77	90.37	92.74	STD. DEV. OF ROT. X = 1.86
Y	89.63	.37	90.00	STD. DEV. OF ROT. Y = 10.47
Z	87.26	90.01	2.74	STD. DEV. OF ROT. Z = 5.27

TABLE 6

RIGHT UPPER ARM

ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
ACROM-RAD LTH	25.6- 32.8	29.74	1.65
AXILLARY ARM CIRC	24.8- 40.1	30.24	3.74
BICEPS CR RLXD RT	22.5- 38.6	27.82	3.67
BICEPS CR FLXD RT	22.8- 40.3	28.84	3.65
ELBOW CR	20.3- 29.2	24.42	1.94
AXILLARY ARM DEPTH	8.2- 15.4	11.36	1.59
BICEPS DPTH RLXD	7.1- 12.9	9.26	1.27
ELBOW BR RT	5.1- 6.9	5.94	.42
TRICEPS SKINFOLD	.9- 4.4	2.00	.68
BICEPS SKINFOLD	.3- 2.8	1.17	.54



RU ARM RANGE	VOLUME MEAN	S.D.
965 - 2,580	1,557	351

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE		MEAN	S.D.
X-AXIS	-.72	- 1.33	-.09	.48
Y-AXIS	1.85	- 3.96	2.81	.43
Z-AXIS	-18.59	- -13.15	-15.87	1.03

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
RIGHT ACROMIALE	0.00	0.00	0.00	0.00	0.00	0.00
RIGHT OLECRANON	-2.30	.43	4.00	.39	-28.70	1.57
R MED HUM EPICON	0.00	0.00	7.04	.67	-29.00	1.66
R LAT HUM EPICON	0.00	0.00	0.00	0.00	-28.02	1.54
RIGHT RADIALE	.01	.36	.82	.46	-29.82	1.54

LOCATION OF THE CUT CENTROID FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
RIGHT SHOULDER	-1.75	2.47	2.74	.81	-6.20	.98
RIGHT ELBOW	-1.48	2.60	3.62	.68	-28.47	1.69

RIGHT UPPER ARM: REGRESSION EQUATIONS

RIGHT UPPER ARM VOLUME AND MOMENTS FROM STATURE AND WEIGHT

		STATURE		WEIGHT		CONSTANT	R	SE EST
VOLUME	=	2.45	+	11.91	-	518	.957	6.7%
X MOMENT	=	1,386	+	671	-	230,521	.919	11.6%
Y MOMENT	=	1,162	+	805	-	208,801	.931	11.3%
Z MOMENT	=	-139	+	319	-	3,337	.953	14.5%

RIGHT UPPER ARM VOLUME FROM:

WEIGHT		ELBOW CIRC		ACROM-RAD LTH		CONSTANT	R	SE EST
12.13					-	152.87	.956	6.7%
8.24	+	61.26			-	1,100.28	.967	5.9%
7.33	+	67.89	+	19.49	-	1,714.08	.970	5.7%

RIGHT UPPER ARM X MOMENT FROM:

WEIGHT		ACROM-RAD LTH		BICEPS CR FLXD RT		CONSTANT	R	SE EST
795					-	24,571	.870	14.4%
640	+	6,232			-	188,046	.945	9.6%
193	+	8,110	+	3,285	-	275,694	.956	8.7%

RIGHT UPPER ARM Y MOMENT FROM:

WEIGHT		ACROM-RAD LTH		BICEPS CR FLXD RT		CONSTANT	R	SE EST
909					-	36,156	.903	13.2%
774	+	5,431			-	178,606	.949	9.7%
254	+	7,618	+	3,826	-	280,694	.962	8.6%

RIGHT UPPER ARM Z MOMENT FROM:

BICEPS CR FLXD RT		WEIGHT		BICEPS CR RLXD RT		CONSTANT	R	SE EST
2,338					-	48,280	.956	13.8%
1,326	+	145			-	39,484	.972	11.2%
2,813	+	152	-	1,546	-	40,380	.976	10.4%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE		MEAN	S.D.
X-AXIS	40,756 -	156,889	87,471	25,278
Y-AXIS	42,687 -	175,200	91,966	27,845
Z-AXIS	7,769 -	49,158	19,153	8,920

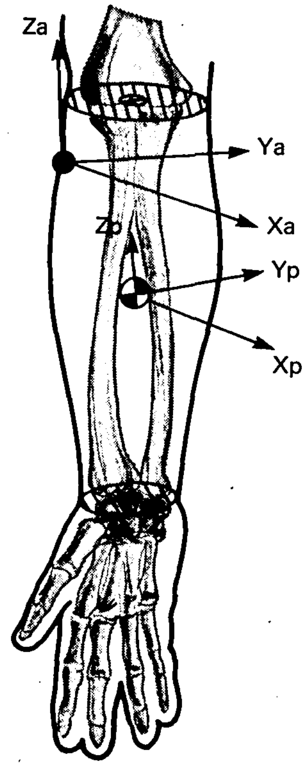
PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	28.64	62.14	83.86	STD. DEV. OF ROT. X = 2.84
Y	118.51	29.27	83.94	STD. DEV. OF ROT. Y = 2.44
Z	92.52	98.26	8.64	STD. DEV. OF ROT. Z = 12.70

TABLE 7

RIGHT FOREARM

ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
RAD-STYLION LTH	20.4- 25.7	23.07	1.26
ELBOW CIRC	20.3- 29.2	24.42	1.94
MIDFOREARM CIRC	17.7- 27.0	21.22	2.29
WRIST CIRC	13.8- 19.0	15.72	1.16
MIDFOREARM BR	5.7- 9.2	7.13	.76
WRIST BR	3.8- 5.9	4.75	.34
ELBOW BR RT	5.1- 6.9	5.94	.42



RF ARM RANGE	VOLUME MEAN	S.D.
593 - 1,484	935	194

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	1.01 - 2.96	1.77	.40
Y-AXIS	-2.11 - .69	-.74	.57
Z-AXIS	-9.85 - -7.07	-8.61	.67

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
RIGHT OLECRANON	.93	.93	3.39	.65	1.88	.48
R MED HUM EPICON	4.50	1.19	3.88	1.43	.99	.51
R RADIAL STYLOID	0.00	0.00	-5.43	.43	-22.98	1.24
R ULNAR STYLOID	0.00	0.00	0.00	0.00	-22.85	1.23
RIGHT RADIALE	0.00	0.00	0.00	0.00	0.00	0.00

LOCATION OF THE CUT CENTROID FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
RIGHT ELBOW	1.28	1.92	2.59	1.45	1.82	1.16
RIGHT WRIST	-.91	3.46	-2.12	1.63	-22.53	1.66

RIGHT FOREARM: REGRESSION EQUATIONS

RIGHT FOREARM VOLUME AND MOMENTS FROM STATURE AND WEIGHT

	STATURE		WEIGHT		CONSTANT	R	SE EST
VOLUME =	.89	+	5.94	-	45	.860	10.8%
X MOMENT =	426	+	289	-	68,105	.801	17.3%
Y MOMENT =	437	+	267	-	68,262	.787	17.7%
Z MOMENT =	-54	+	96	+	2,687	.863	20.2%

RIGHT FOREARM VOLUME FROM:

ELBOW CIRC		WRIST CIRC		RAD-STYLION LTH		CONSTANT	R	SE EST
93.26					-	1,342.41	.934	7.5%
68.25	+	47.70			-	1,481.53	.944	7.0%
61.12	+	53.42	+	18.99	-	1,835.29	.952	6.6%

RIGHT FOREARM X MOMENT FROM:

ELBOW CIRC		RAD-STYLION LTH		WRIST CIRC		CONSTANT	R	SE EST
5,040					-	81,687	.838	15.5%
4,362	+	3,111			-	136,893	.896	12.8%
3,124	+	3,268	+	2,296	-	146,381	.903	12.5%

RIGHT FOREARM Y MOMENT FROM:

ELBOW CIRC		RAD-STYLION LTH		WRIST CIRC		CONSTANT	R	SE EST
4,705					-	75,134	.819	16.3%
4,001	+	3,229			-	132,450	.888	13.2%
2,772	+	3,386	+	2,279	-	141,867	.896	12.9%

RIGHT FOREARM Z MOMENT FROM:

MIDFOREARM CIRC		ELBOW CIRC		WRIST CIRC		CONSTANT	R	SE EST
1,212					-	18,186	.940	13.5%
655	+	706			-	23,594	.955	11.9%
499	+	663	+	406	-	25,640	.957	11.7%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE			MEAN	S.D.
X-AXIS	19,966	-	78,318	41,394	11,666
Y-AXIS	19,096	-	75,205	39,760	11,147
Z-AXIS	3,445	-	16,553	7,529	2,948

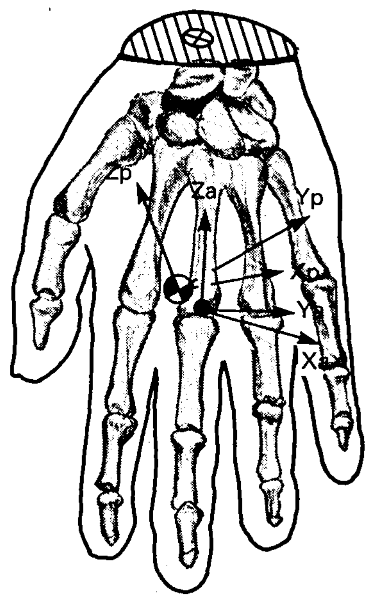
PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	25.52	115.06	94.53	STD. DEV. OF ROT. X = 2.72
Y	65.83	25.84	98.59	STD. DEV. OF ROT. Y = 2.35
Z	82.28	84.12	9.73	STD. DEV. OF ROT. Z = 12.81

TABLE 8

RIGHT HAND

ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
WRIST CIRC	13.8- 19.0	15.72	1.16
HAND CIRC	16.5- 20.6	18.86	.92
HAND BR	6.7- 8.5	7.76	.40
META III-DACT LTH	7.6- 10.2	8.99	.51
HAND LTH	15.0- 19.2	17.08	.84



R HAND RANGE	VOLUME MEAN	S.D.
241 - 466	344	48

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	-.54 - 1.56	.79	.46
Y-AXIS	.43 - 1.67	.90	.28
Z-AXIS	.71 - 2.89	1.59	.45

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
R RADIAL STYLOID	2.16	1.50	-.03	.51	7.33	.60
R ULNAR STYLOID	-.10	1.26	4.74	.58	6.47	.60
R METACARPALE V	0.00	0.00	4.75	.37	0.00	0.00
R METACARPALE II	0.00	0.00	-2.95	.23	0.00	0.00
RIGHT DACTYLION	0.00	0.00	.27	5.35	-9.65	.65

LOCATION OF THE CUT CENTROID FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
RIGHT WRIST	-.06	3.77	2.55	1.03	7.26	1.10

RIGHT HAND: REGRESSION EQUATIONS

RIGHT HAND VOLUME AND MOMENTS FROM STATURE AND WEIGHT

	STATURE	WEIGHT	CONSTANT	R	SE EST
VOLUME =	1.87 +	1.05 -	105	.735	9.6%
X MOMENT =	94 +	36 -	12,623	.748	15.8%
Y MOMENT =	90 +	30 -	12,185	.760	15.6%
Z MOMENT =	10 +	11 -	1,062	.666	17.6%

RIGHT HAND VOLUME FROM:

WRIST CIRC	HAND BR	META III-DACT LTH	CONSTANT	R	SE EST
35.29		-	210.93	.861	7.2%
26.19 +	44.33	-	411.94	.909	5.9%
25.14 +	36.37 +	16.83 -	484.95	.923	5.5%

RIGHT HAND X MOMENT FROM:

WRIST CIRC	HAND LTH	HAND BR	CONSTANT	R	SE EST
1,243		-	11,827	.809	13.8%
910 +	923	-	22,356	.890	10.8%
762 +	778 +	976 -	25,126	.905	10.2%

RIGHT HAND Y MOMENT FROM:

WRIST CIRC	HAND LTH	HAND BR	CONSTANT	R	SE EST
1,031		-	9,717	.791	14.5%
720 +	859	-	19,513	.890	10.9%
625 +	765 +	632 -	21,306	.899	10.6%

RIGHT HAND Z MOMENT FROM:

WRIST CIRC	HAND BR	META III-DACT LTH	CONSTANT	R	SE EST
354		-	3,453	.846	12.5%
244 +	532	-	5,867	.914	9.6%
240 +	498 +	72 -	6,180	.916	9.6%

THE PRINCIPAL MOMENTS OF INERTIA

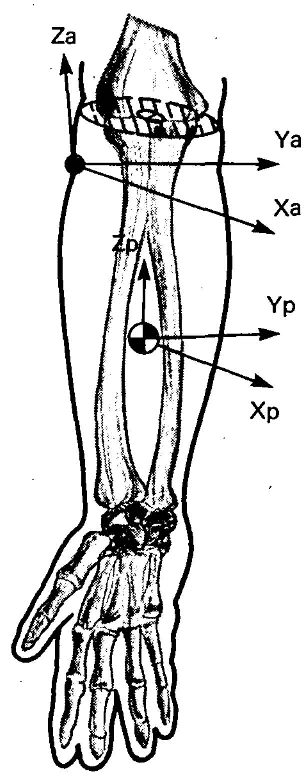
	RANGE		MEAN	S.D.
X-AXIS	4,474 -	12,646	7,714	1,791
Y-AXIS	3,790 -	10,367	6,483	1,518
Z-AXIS	1,180 -	3,679	2,106	487

PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	17.17	77.02	101.04	STD. DEV. OF ROT. X = 3.15
Y	105.12	18.88	101.04	STD. DEV. OF ROT. Y = 7.49
Z	82.06	76.53	15.71	STD. DEV. OF ROT. Z = 4.49

TABLE 9

RIGHT FOREARM PLUS HAND



ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
FOREARM + HAND LTH	35.4- 43.3	40.15	1.90
ELBOW CIRC	20.3- 29.2	24.42	1.94
MIDFOREARM CIRC	17.7- 27.0	21.22	2.29
WRIST CIRC	13.8- 19.0	15.72	1.16
MIDFOREARM BR	5.7- 9.2	7.13	.76
WRIST BR	3.8- 5.9	4.75	.34
HAND CIRC	16.5- 20.6	18.86	.92
ELBOW BR RT	5.1- 6.9	5.94	.42
HAND BR	6.7- 8.5	7.76	.40
META III-DACT LTH	7.6- 10.2	8.99	.51
HAND LTH	15.0- 19.2	17.08	.84

R FARM+H VOLUME

RANGE	MEAN	S.D.
834 - 1,843	1,279	233

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	.44 - 2.09	1.13	.41
Y-AXIS	-2.28 - -.51	-1.34	.37
Z-AXIS	-15.55 - -11.11	-13.97	.90

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
RIGHT OLECRANON	.93	.93	3.39	.65	1.88	.48
R RADIAL STYLOID	0.00	0.00	-5.43	.43	-22.98	1.24
R ULNAR STYLOID	0.00	0.00	0.00	0.00	-22.85	1.23
RIGHT RADIALE	0.00	0.00	0.00	0.00	0.00	0.00
RIGHT DACTYLION	-1.21	2.32	-1.04	5.63	-39.46	2.17

LOCATION OF THE CUT CENTROID FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
RIGHT ELBOW	1.28	1.92	2.59	1.45	1.82	1.16
RIGHT WRIST	-.91	3.46	-2.12	1.63	-22.53	1.66

RIGHT FOREARM PLUS HAND: REGRESSION EQUATIONS

RIGHT FOREARM PLUS HAND VOLUME AND MOMENTS FROM STATURE AND WEIGHT

		STATURE		WEIGHT		CONSTANT	R	SE EST
VOLUME	=	2.76	+	6.99	-	150	.862	9.4%
X MOMENT	=	1,822	+	795	-	254,637	.843	12.2%
Y MOMENT	=	1,834	+	767	-	255,501	.841	12.2%
Z MOMENT	=	-45	+	107	+	2,058	.856	17.9%

RIGHT FOREARM PLUS HAND VOLUME FROM:

ELBOW CIRC		WRIST CIRC		FOREARM + HAND LTH		CONSTANT	R	SE EST
112.00					-	1,456.10	.934	6.6%
69.23	+	81.56			-	1,693.96	.955	5.5%
64.59	+	77.53	+	17.77	-	2,230.82	.964	5.0%

RIGHT FOREARM PLUS HAND X MOMENT FROM:

ELBOW CIRC		FOREARM + HAND LTH		WRIST CIRC		CONSTANT	R	SE EST
14,401					-	200,479	.833	12.4%
11,322	+	8,100			-	450,525	.934	8.1%
7,553	+	7,926	+	7,314	-	466,464	.942	7.7%

RIGHT FOREARM PLUS HAND Y MOMENT FROM:

ELBOW CIRC		FOREARM + HAND LTH		WRIST CIRC		CONSTANT	R	SE EST
13,971					-	192,913	.826	12.6%
10,887	+	8,115			-	443,406	.932	8.2%
7,222	+	7,945	+	7,112	-	458,905	.940	7.8%

RIGHT FOREARM PLUS HAND Z MOMENT FROM:

MIDFOREARM CIRC		ELBOW CIRC		WRIST CIRC		CONSTANT	R	SE EST
1,376					-	19,357	.944	11.3%
770	+	767			-	25,236	.958	9.9%
457	+	681	+	821	-	29,375	.965	9.2%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE		MEAN	S.D.
X-AXIS	82,256 -	232,531	151,181	33,536
Y-AXIS	80,572 -	227,429	148,259	32,820
Z-AXIS	4,678 -	19,299	9,843	3,333

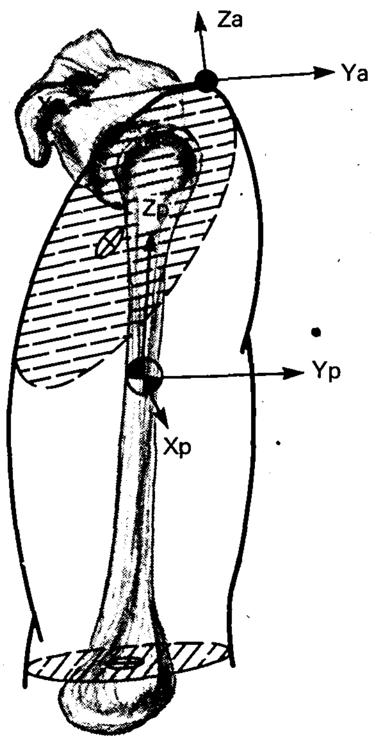
PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	17.36	106.49	95.29	STD. DEV. OF ROT. X = 1.79
Y	74.33	17.65	97.91	STD. DEV. OF ROT. Y = 2.58
Z	82.71	83.89	9.54	STD. DEV. OF ROT. Z = 10.94

TABLE 10

LEFT UPPER ARM

ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
ACROM-RAD LTH	25.6- 32.8	29.74	1.65
AXILLARY ARM CIRC	24.8- 40.1	30.24	3.74
BICEPS CR RLXD LT	22.0- 40.9	27.71	3.85
BICEPS CR FLXD LT	22.4- 42.3	28.60	3.83
ELBOW CR	20.3- 29.2	24.42	1.94
AXILLARY ARM DEPTH	8.2- 15.4	11.38	1.59
BICEPS DPTH RLXD	7.1- 12.9	9.26	1.27
ELBOW BR LT	5.1- 6.5	5.92	.37
TRICEPS SKINFOLD	.9- 4.4	2.00	.68
BICEPS SKINFOLD	.3- 2.8	1.17	.54



LU ARM RANGE	VOLUME MEAN	S.D.
920 - 2,903	1,556	380

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	-.64 - 1.25	.09	.45
Y-AXIS	-3.69 - -1.77	-2.70	.42
Z-AXIS	-18.73 - -13.25	-15.84	1.09

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
LEFT ACROMIALE	0.00	0.00	0.00	0.00	0.00	0.00
LEFT OLECRANON	-2.28	.39	-3.76	.59	-28.60	1.66
L MED HUM EPICON	0.00	0.00	-7.17	.90	-28.85	1.78
L LAT HUM EPICON	0.00	0.00	0.00	0.00	-28.05	1.62
LEFT RADIALE	.02	.40	-.87	.55	-29.93	1.67

LOCATION OF THE CUT CENTROID FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
LEFT SHOULDER	-.41	2.03	-2.99	.80	-6.52	.73
LEFT ELBOW	-.07	2.50	-4.13	.99	-28.50	1.62

LEFT UPPER ARM: REGRESSION EQUATIONS

LEFT UPPER ARM VOLUME AND MOMENTS FROM STATURE AND WEIGHT

	STATURE		WEIGHT		CONSTANT	R	SE EST
VOLUME =	.91	+	13.06	-	431	.957	7.2%
X MOMENT =	1,052	+	782	-	192,530	.907	13.6%
Y MOMENT =	1,010	+	894	-	196,666	.909	14.1%
Z MOMENT =	-196	+	359	+	409	.946	17.2%

LEFT UPPER ARM VOLUME FROM:

WEIGHT		BICEPS CR FLXD LT		ACROM-RAD LTH		CONSTANT	R	SE EST
13.15					-	295.74	.957	7.2%
8.25	+	36.48			-	706.49	.969	6.1%
3.64	+	65.37	+	47.57	-	2,241.29	.981	4.8%

LEFT UPPER ARM X MOMENT FROM:

WEIGHT		ACROM-RAD LTH		BICEPS CR RLXD LT		CONSTANT	R	SE EST
876					-	36,212	.883	14.9%
747	+	5,188			-	172,288	.927	12.0%
92	+	8,151	+	4,567	-	294,725	.949	10.2%

LEFT UPPER ARM Y MOMENT FROM:

WEIGHT		ACROM-RAD LTH		BICEPS CR RLXD LT		CONSTANT	R	SE EST
984					-	46,583	.892	15.2%
854	+	4,827			-	173,200	.923	13.1%
103	+	8,273	+	5,310	-	315,565	.947	11.1%

LEFT UPPER ARM Z MOMENT FROM:

BICEPS CR FLXD LT		WEIGHT		ACROM-RAD LTH		CONSTANT	R	SE EST
2,510					-	52,395	.956	15.3%
1,553	+	143			-	45,422	.969	13.1%
1,887	+	87	+	574	-	63,925	.971	12.7%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE			MEAN	S.D.
X-AXIS	39,507	-	184,721	87,189	27,431
Y-AXIS	41,377	-	205,210	92,124	30,532
Z-AXIS	7,089	-	59,214	19,378	10,047

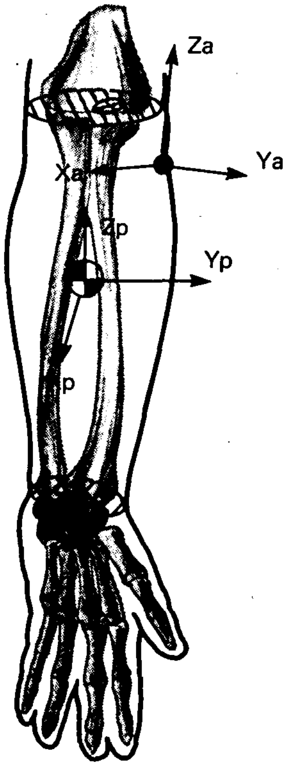
PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	25.42	114.69	84.33	STD. DEV. OF ROT. X = 2.68
Y	64.72	26.17	96.32	STD. DEV. OF ROT. Y = 2.21
Z	92.45	81.86	8.51	STD. DEV. OF ROT. Z = 11.86

TABLE 11

LEFT FOREARM

ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
RAD-STYLION LTH	20.4- 25.7	23.07	1.26
ELBOW CIRC	20.3- 29.2	24.42	1.94
MIDFOPEARM CIRC	17.7- 27.0	21.22	2.29
WRIST CIRC	13.8- 19.0	15.72	1.16
MIDFOREARM BR	5.7- 9.2	7.13	.76
WRIST BR	3.8- 5.9	4.75	.34
ELBOW BR LT	5.1- 6.5	5.92	.37



LF ARM RANGE	VOLUME MEAN	S.D.
552 - 1,386	923	195

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	1.17 - 2.93	1.81	.33
Y-AXIS	-.23 - 2.16	.79	.55
Z-AXIS	-9.86 - -6.87	-8.53	.65

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
LEFT OLECRANON	.83	.83	-3.21	.61	1.93	.44
L MED HUM EPICON	4.64	1.12	-3.91	1.46	1.05	.60
L RADIAL STYLOID	0.00	0.00	5.50	.42	-22.82	1.27
L ULNAR STYLOID	0.00	0.00	0.00	0.00	-22.95	1.13
LEFT RADIALE	0.00	0.00	0.00	0.00	0.00	0.00

LOCATION OF THE CUT CENTROID FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
LEFT ELBOW	2.47	2.23	-1.82	1.75	1.39	1.01
LEFT WRIST	1.16	3.54	2.88	1.36	-23.10	1.63

LEFT FOREARM: REGRESSION EQUATIONS

LEFT FOREARM VOLUME AND MOMENTS FROM STATURE AND WEIGHT

	STATURE	WEIGHT	CONSTANT	R	SE EST
VOLUME =	.19 +	6.05 +	39	.859	11.1%
X MOMENT =	422 +	305 -	69,806	.805	17.8%
Y MOMENT =	464 +	284 -	75,176	.789	18.8%
Z MOMENT =	-60 +	96 +	3,318	.871	20.1%

LEFT FOREARM VOLUME FROM:

ELBOW CIRC	RAD-STYLION LTH	MIDFOREARM CIRC	CONSTANT	R	SE EST
92.76		-	1,342.11	.921	8.4%
88.37 +	20.15	-	1,699.69	.929	8.0%
30.56 +	36.41 +	49.49 -	1,713.20	.948	7.0%

LEFT FOREARM X MOMENT FROM:

ELBOW CIRC	RAD-STYLION LTH	MIDFOREARM CIRC	CONSTANT	R	SE EST
5,077		-	82,776	.814	17.2%
4,256 +	3,766	-	149,621	.894	13.4%
1,278 +	4,604 +	2,549 -	150,317	.908	12.7%

LEFT FOREARM Y MOMENT FROM:

ELBOW CIRC	RAD-STYLION LTH	MIDFOREARM CIRC	CONSTANT	R	SE EST
4,793		-	77,374	.785	18.7%
3,910 +	4,054	-	149,318	.884	14.3%
879 +	4,906 +	2,594 -	150,027	.899	13.5%

LEFT FOREARM Z MOMENT FROM:

MIDFOREARM CIRC	ELBOW CIRC	MIDFOREARM BR	CONSTANT	R	SE EST
1,187		-	17,905	.931	14.8%
625 +	712	-	23,358	.947	13.2%
1,057 +	667 -	1,242 -	22,583	.951	12.8%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE		MEAN	S.D.
X-AXIS	17,917 -	73,321	41,197	12,096
Y-AXIS	17,192 -	76,313	39,673	11,844
Z-AXIS	3,021 -	15,305	7,283	2,916

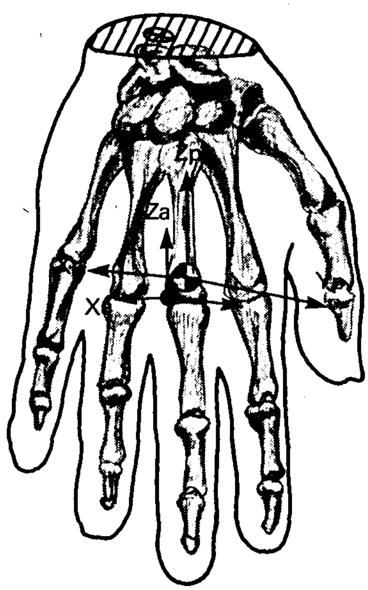
PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	24.11	66.41	94.69	STD. DEV. OF ROT. X = 3.21
Y	112.64	24.54	81.02	STD. DEV. OF ROT. Y = 2.38
Z	82.14	96.37	10.15	STD. DEV. OF ROT. Z = 12.03

TABLE 12

LEFT HAND

ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
WRIST CIRC	13.8- 19.0	15.72	1.16
HAND CIRC	16.5- 20.6	18.86	.92
HAND BR	6.7- 8.5	7.76	.40
META III-DACT LTH	7.6- 10.2	8.99	.51
HAND LTH	15.0- 19.2	17.08	.84



L HAND RANGE	VOLUME MEAN	S.D.
234 - 449	334	47

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	-.71 - 1.24	.39	.41
Y-AXIS	-1.34 - -.32	-.90	.22
Z-AXIS	.85 - 2.50	1.69	.33

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
L RADIAL STYLOID	1.13	1.17	.22	.50	7.57	.44
L ULNAR STYLOID	-.69	1.07	-4.80	.47	6.46	.69
L METACARPALE V	0.00	0.00	-4.84	.28	0.00	0.00
L METACARPALE II	0.00	0.00	2.90	.26	0.00	0.00
LEFT DACTYLION	0.00	0.00	.47	.62	-9.71	.58

LOCATION OF THE CUT CENTROID FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
LEFT WRIST	1.38	4.04	-2.44	.87	6.98	.99

LEFT HAND: REGRESSION EQUATIONS

LEFT HAND VOLUME AND MOMENTS FROM STATURE AND WEIGHT

	STATURE	WEIGHT	CONSTANT	R	SE EST
VOLUME =	.92 +	.83 +	70	.546	12.1%
X MOMENT =	58 +	23 -	5,140	.515	19.4%
Y MOMENT =	55 +	18 -	5,091	.499	19.5%
Z MOMENT =	5 +	9 -	55	.557	20.5%

LEFT HAND VOLUME FROM

HAND BR	WRIST CIRC	HAND LTH	CONSTANT	R	SE EST
87.86		-	347.40	.738	9.6%
60.54 +	15.39	-	377.22	.798	8.7%
50.64 +	12.84 +	12.67 -	476.78	.819	8.4%

LEFT HAND X MOMENT FROM:

HAND BR	HAND LTH	WRIST CIRC	CONSTANT	R	SE EST
2,904		-	15,089	.697	16.0%
1,958 +	831	-	21,944	.783	14.1%
1,577 +	735 +	276 -	21,687	.797	13.8%

LEFT HAND Y MOMENT FROM:

HAND LTH	HAND BR	STATURE	CONSTANT	R	SE EST
1,152		-	13,380	.697	15.9%
789 +	1,425	-	18,243	.777	14.1%
1,033 +	1,436 -	50 -	14,510	.792	13.9%

LEFT HAND Z MOMENT FROM:

HAND BR	WRIST CIRC	STATURE	CONSTANT	R	SE EST
944		-	5,332	.778	15.3%
643 +	169	-	5,661	.844	13.2%
673 +	178 -	8 -	4,794	.849	13.2%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE		MEAN	S.D.
X-AXIS	4,359 -	11,460	7,445	1,648
Y-AXIS	3,756 -	9,444	6,288	1,382
Z-AXIS	1,050 -	3,311	1,993	480

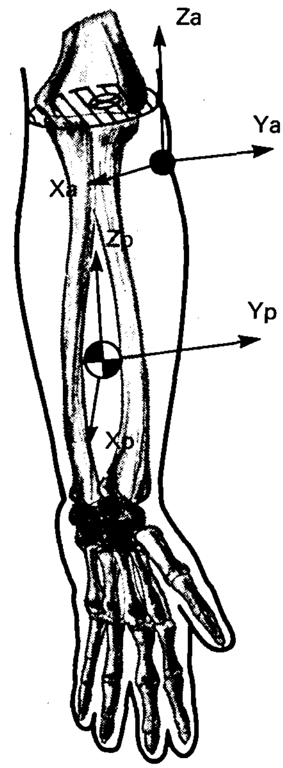
PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z		
X	14.66	102.33	97.81	STD. DEV. OF ROT. X =	3.19
Y	76.33	17.36	79.50	STD. DEV. OF ROT. Y =	5.48
Z	84.80	102.03	13.14	STD. DEV. OF ROT. Z =	4.76

TABLE 13

LEFT FOREARM PLUS HAND

ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
FOREARM + HAND LTH	35.4- 43.3	40.15	1.90
ELBOW CIRC	20.3- 29.2	24.42	1.94
MIDFOREARM CIRC	17.7- 27.0	21.22	2.29
WRIST CIRC	13.8- 19.0	15.72	1.16
MIDFOREARM BR	5.7- 9.2	7.13	.76
WRIST BR	3.8- 5.9	4.75	.34
HAND CIRC	16.5- 20.6	18.86	.92
ELBOW BR LT	5.1- 6.5	5.92	.37
HAND BR	6.7- 8.5	7.76	.40
META III-DACT LTH	7.6- 10.2	8.99	.51
HAND LTH	15.0- 19.2	17.08	.84



L FARM+H VOLUME

RANGE	MEAN	S.D.
786 - 1,748	1,258	227

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	.44 - 2.30	1.17	.35
Y-AXIS	.79 - 2.44	1.43	.38
Z-AXIS	-15.37 - -12.05	-13.84	.95

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
LEFT OLECRANON	.83	.83	-3.21	.61	1.93	.44
L RADIAL STYLOID	0.00	0.00	5.50	.42	-22.82	1.27
L ULNAR STYLOID	0.00	0.00	0.00	0.00	-22.95	1.13
LEFT RADIALE	0.00	0.00	0.00	0.00	0.00	0.00
LEFT DACTYLION	-2.06	2.39	2.22	1.81	-39.48	2.02

LOCATION OF THE CUT CENTROID FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
LEFT ELBOW	2.47	2.23	-1.82	1.75	1.39	1.01
LEFT WRIST	1.16	3.54	2.88	1.36	-23.10	1.63

LEFT FOREARM PLUS HAND: REGRESSION EQUATIONS

LEFT FOREARM PLUS HAND VOLUME AND MOMENTS FROM STATURE AND WEIGHT

		STATURE		WEIGHT		CONSTANT	R	SE EST
VOLUME	=	1.11	+	6.89	+	108	.852	9.7%
X MOMENT	=	1,572	+	784	-	215,823	.830	12.5%
Y MOMENT	=	1,587	+	755	-	216,740	.827	12.5%
Z MOMENT	=	-62	+	106	+	4,514	.864	17.5%

LEFT FOREARM PLUS HAND VOLUME FROM:

ELBOW CIRC		FOREARM + HAND LTH		MIDFOREARM CIRC		CONSTANT	R	SE EST
107.71					-	1,372.80	.921	7.1%
100.39	+	19.28			-	1,967.69	.933	6.7%
44.79	+	27.28	+	47.93	-	1,948.30	.947	6.0%

LEFT FOREARM PLUS HAND X MOMENT FROM:

ELBOW CIRC		FOREARM + HAND LTH		HAND BR		CONSTANT	R	SE EST
13,631					-	184,652	.815	12.8%
10,564	+	8,070			-	433,752	.923	8.6%
9,953	+	7,616	+	7,978	-	452,542	.927	8.5%

LEFT FOREARM PLUS HAND Y MOMENT FROM:

ELBOW CIRC		FOREARM + HAND LTH		HAND BR		CONSTANT	R	SE EST
13,205					-	176,949	.807	13.0%
10,133	+	8,083			-	426,471	.922	8.6%
9,564	+	7,662	+	7,426	-	453,270	.925	8.6%

LEFT FOREARM PLUS HAND Z MOMENT FROM:

ELBOW CIRC		MIDFOREARM CIRC		MIDFOREARM BR		CONSTANT	R	SE EST
1,551					-	28,588	.933	12.4%
814	+	681			-	24,800	.950	10.9%
770	+	1,104	-	1,215	-	24,041	.953	10.7%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE		MEAN	S.D.
X-AXIS	76,108 -	212,147	148,212	32,461
Y-AXIS	74,903 -	206,974	145,527	31,742
Z-AXIS	4,114 -	17,938	9,526	3,245

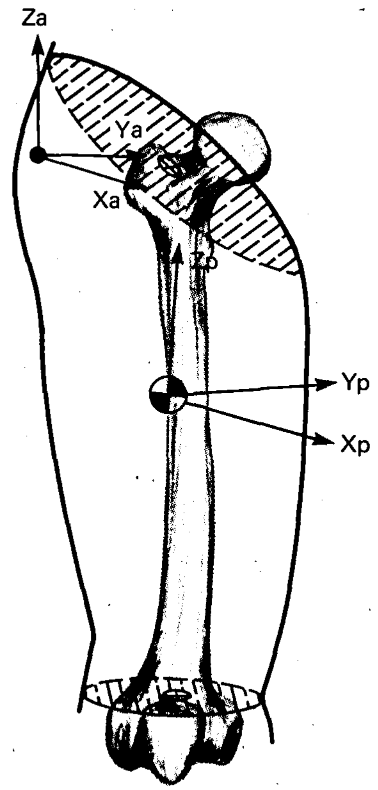
PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	16.56	74.41	95.46	STD. DEV. OF ROT. X = 2.17
Y	104.70	16.97	81.70	STD. DEV. OF ROT. Y = 2.80
Z	82.54	96.55	9.95	STD. DEV. OF ROT. Z = 10.56

TABLE 14

RIGHT THIGH

ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
BITROCH BR	27.1- 36.8	31.63	1.99
HIP BR	30.9- 45.4	37.25	3.34
BUTTOCK CIRC	83.5-130.2	100.08	9.69
UPPER THIGH CIRC	46.5- 73.5	59.44	5.63
GLUT FURROW DPTH	14.1- 24.6	18.92	2.00
BUTTOCK DEPTH	18.1- 35.7	24.12	3.49
KNEE BR RT	7.5- 10.0	8.81	.57
MIDTHIGH CIRC	39.9- 69.0	51.92	5.41
KNEE CIRC	30.7- 44.5	36.97	2.84
MIDTHIGH DEPTH	12.4- 23.5	16.50	2.05
THIGH LTH	35.6- 47.9	41.15	2.51



R THIGH VOLUME

RANGE	MEAN	S.D.
5,831 - 17,522	10,070	2,136

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	-4.88 - .51	-1.78	1.12
Y-AXIS	5.63 - 9.75	7.16	.79
Z-AXIS	-17.55 - -13.67	-15.57	1.00

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
R TROCHANTERION	0.00	0.00	0.00	0.00	0.00	0.00
R LAT FEM CONDYL	0.00	0.00	0.00	0.00	-38.41	2.30
R MED FEM CONDYL	0.00	0.00	11.39	1.28	-40.01	2.21
RIGHT TIBIALE	1.90	.70	9.00	1.15	-41.75	2.34
RIGHT FIBULARE	-1.34	.85	-.61	.29	-42.52	2.51

LOCATION OF THE CUT CENTROID FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
RIGHT HIP	6.30	2.13	6.47	1.31	.31	.38
RIGHT KNEE	-.73	1.12	6.62	1.59	-38.88	2.31

RIGHT THIGH: REGRESSION EQUATIONS

RIGHT THIGH VOLUME AND MOMENTS FROM STATURE AND WEIGHT

		STATURE		WEIGHT		CONSTANT	R	SE EST
VOLUME	=	60.01	+	65.04	-	8,770	.924	8.3%
X MOMENT	=	28,916	+	9,314	-	4,584,794	.895	13.4%
Y MOMENT	=	27,798	+	11,131	-	4,587,938	.899	13.8%
Z MOMENT	=	706	+	7,299	-	625,303	.919	17.3%

RIGHT THIGH VOLUME FROM:

UPPER THIGH CIRC	STATURE	MIDTHIGH CIRC	CONSTANT	R	SE EST
346.52			- 10,527.35	.914	8.7%
316.30 +	86.64		- 22,700.80	.942	7.3%
124.53 +	103.04 +	209.48	- 24,827.53	.962	6.0%

RIGHT THIGH X MOMENT FROM:

WEIGHT	THIGH LTH	BUTTOCK C	CONSTANT	R	SE EST
11,899			- 287,051	.808	17.4%
10,348 +	72,938		- 3,069,818	.919	11.8%
3,942 +	77,555 +	18,909	- 4,249,721	.929	11.3%

RIGHT THIGH Y MOMENT FROM:

WEIGHT	THIGH LTH	MIDTHIGH CIRC	CONSTANT	R	SE EST
13,616			- 456,352	.835	17.2%
12,142 +	69,319		- 3,101,034	.915	12.7%
7,259 +	73,555 +	27,352	- 4,007,559	.926	12.1%

RIGHT THIGH Z MOMENT FROM:

BUTTOCK CIRC	MIDTHIGH CIRC	STATURE	CONSTANT	R	SE EST
21,105			- 1,595,208	.923	16.6%
12,652 +	16,848		- 1,624,033	.941	14.9%
10,909 +	18,241 +	5,638	- 2,430,936	.952	13.6%

THE PRINCIPAL MOMENTS OF INERTIA

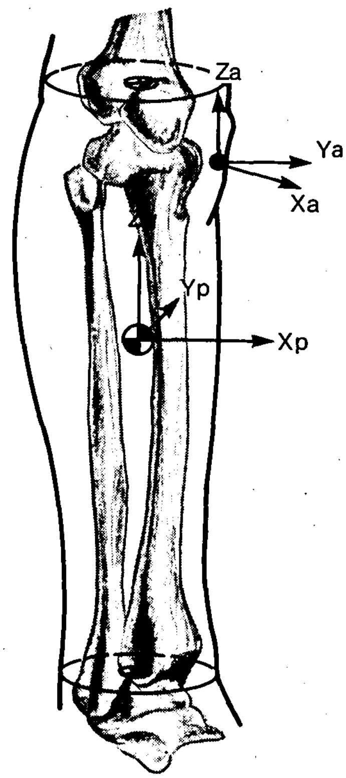
	RANGE	MEAN	S.D.
X-AXIS	659,904 - 2,661,938	1,389,544	407,093
Y-AXIS	678,930 - 3,056,288	1,462,212	451,084
Z-AXIS	189,238 - 1,461,319	516,974	221,562

PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	13.90	101.51	82.32	STD. DEV. OF ROT. X = 1.61
Y	78.30	11.71	90.60	STD. DEV. OF ROT. Y = 3.71
Z	97.40	87.87	7.70	STD. DEV. OF ROT. Z = 14.66

TABLE 15

RIGHT CALF



ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
CALF LTH	29.9- 40.3	35.95	2.06
CALF DEPTH	8.4- 14.3	10.80	.94
ANKLE BR	4.4- 6.3	5.37	.42
KNEE BR RT	7.5- 10.0	8.81	.57
KNEE CIRC	30.7- 44.5	36.97	2.84
CALF CIRC,RT	28.2- 47.4	35.43	3.20
ANKLE CIRC	18.2- 24.7	21.45	1.39
POST CALF SKINFOLD	1.2- 4.1	2.50	.76

R CALF VOLUME

RANGE	MEAN	S.D.
1,908 - 5,226	3,111	607

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	-4.23 - .20	-1.25	.82
Y-AXIS	-6.38 - -4.07	-5.44	.45
Z-AXIS	-16.17 - -10.55	-13.56	1.17

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
RIGHT SPHYRION	0.00	0.00	0.00	0.00	-36.45	2.03
RIGHT TIBIALE	0.00	0.00	0.00	0.00	0.00	0.00
RIGHT FIBULARE	2.11	1.39	-9.71	.97	-1.97	.90
R LAT MALLEOLUS	0.00	0.00	-6.57	.37	-36.89	1.89

LOCATION OF THE CUT CENTROID FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
RIGHT KNEE	-.67	1.65	-3.66	1.04	2.65	.91
RIGHT ANKLE	-1.24	2.01	-3.24	.91	-36.73	2.04

RIGHT CALF: REGRESSION EQUATIONS

RIGHT CALF VOLUME AND MOMENTS FROM STATURE AND WEIGHT

		STATURE		WEIGHT		CONSTANT	R	SE EST
VOLUME	=	10.40	+	17.54	-	1,037	.847	10.6%
X MOMENT	=	4,595	+	2,187	-	680,711	.785	16.7%
Y MOMENT	=	4,767	+	2,121	-	700,348	.782	16.6%
Z MOMENT	=	-83	+	592	-	20,903	.856	20.4%

RIGHT CALF VOLUME FROM:

CALF CIRC ,RT	KNEE CIRC	CALF LTH	CONSTANT	R	SE EST
180.03			- 3,267.26	.949	6.2%
140.16 +	51.83		- 3,770.84	.957	5.8%
137.20 +	47.91 +	33.92	- 4,740.57	.963	5.5%

RIGHT CALF X MOMENT FROM:

CALF DEPTH	CALF LTH	KNEE CIRC	CONSTANT	R	SE EST
82,855			- 526,656	.803	15.9%
70,805 +	15,775		- 963,634	.862	13.7%
33,442 +	16,094 +	14,694	- 1,114,812	.894	12.2%

RIGHT CALF Y MOMENT FROM:

CALF DEPTH	CALF LTH	KNEE CIRC	CONSTANT	R	SE EST
81,740			- 515,741	.800	15.9%
69,346 +	16,226		- 965,221	.863	13.5%
33,725 +	16,530 +	14,009	- 1,109,350	.893	12.2%

RIGHT CALF Z MOMENT FROM:

CALF CIRC ,RT	KNEE CIRC	KNEE BR RT	CONSTANT	R	SE EST
5,669			- 151,839	.960	10.9%
4,830 +	1,013		- 161,681	.963	10.6%
5,004 +	1,661 -	4,517	- 149,863	.966	10.3%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE		MEAN	S.D.
X-AXIS	192,415 -	661,410	368,177	96,843
Y-AXIS	191,586 -	650,494	367,056	95,899
Z-AXIS	19,237 -	128,745	49,026	18,882

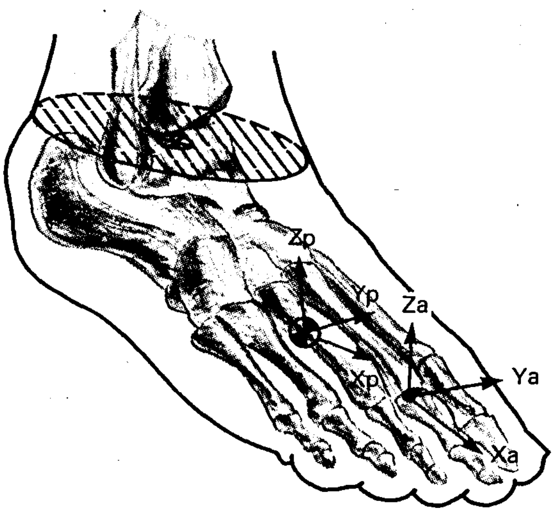
PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	1.27	88.90	90.64	STD. DEV. OF ROT. X = .96
Y	91.08	1.81	88.55	STD. DEV. OF ROT. Y = 1.54
Z	89.33	91.44	1.58	STD. DEV. OF ROT. Z = 30.26

TABLE 16

RIGHT FOOT

ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
SPHYRION HT	5.2- 7.0	6.26	.38
FOOT BR	7.5- 10.7	9.22	.57
FOOT LTH	20.3- 26.2	23.51	1.19
ANKLE BR	4.4- 6.3	5.37	.42
ANKLE CIRC	18.2- 24.7	21.45	1.39
BALL OF FOOT CIRC	19.4- 25.5	22.80	1.21
ARCH CIRC	19.9- 25.7	23.21	1.11



R FOOT RANGE	VOLUME MEAN	S.D.
445 - 968	673	103

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	-8.60 - -5.53	-7.22	.64
Y-AXIS	-.27 - .98	.44	.28
Z-AXIS	.45 - 1.57	1.02	.30

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
RIGHT SPHYRION	-10.55	.84	4.09	.48	4.31	.43
R METATARSAL V	-2.09	.58	-4.74	.50	0.00	0.00
R METATARSAL I	0.00	0.00	4.29	.45	0.00	0.00
RIGHT TOE II	5.74	.54	0.00	0.00	-.80	.41
R POS CALCANEUS	-17.57	.98	0.00	0.00	0.00	0.00

LOCATION OF THE CUT CENTROID FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
RIGHT ANKLE	-12.81	1.73	1.63	1.54	4.58	.44

RIGHT FOOT: REGRESSION EQUATIONS

RIGHT FOOT VOLUME AND MOMENTS FROM STATURE AND WEIGHT

		STATURE		WEIGHT		CONSTANT	R	SE EST
VOLUME	=	8.48	+	1.51	-	908	.758	10.2%
X MOMENT	=	94	+	19	-	12,709	.704	18.3%
Y MOMENT	=	505	+	82	-	70,275	.826	13.7%
Z MOMENT	=	512	+	87	-	71,115	.830	13.3%

RIGHT FOOT VOLUME FROM:

FOOT LTH	SPHYRION HT	ANKLE CIRC		CONSTANT	R	SE EST
62.77			-	803.06	.726	10.6%
51.11 +	118.17		-	1,268.55	.837	8.6%
38.27 +	121.67 +	22.70	-	1,475.74	.879	7.5%

RIGHT FOOT X MOMENT FROM:

BALL OF FOOT CIRC	SPHYRION HT	FOOT LTH		CONSTANT	R	SE EST
769			-	12,368	.716	17.7%
621 +	1,412		-	17,829	.815	14.9%
438 +	1,313 +	305	-	20,212	.842	14.0%

RIGHT FOOT Y MOMENT FROM:

FOOT LTH	SPHYRION HT	WEIGHT		CONSTANT	R	SE EST
3,836			-	67,518	.845	12.8%
3,434 +	4,070		-	83,549	.889	11.2%
2,881 +	3,658 +	49	-	74,865	.914	10.0%

RIGHT FOOT Z MOMENT FROM:

FOOT LTH	WEIGHT	SPHYRION HT		CONSTANT	R	SE EST
4,009			-	70,574	.860	12.1%
3,297 +	59		-	62,111	.896	10.6%
3,063 +	52 +	3,140	-	75,378	.919	9.6%

THE PRINCIPAL MOMENTS OF INERTIA

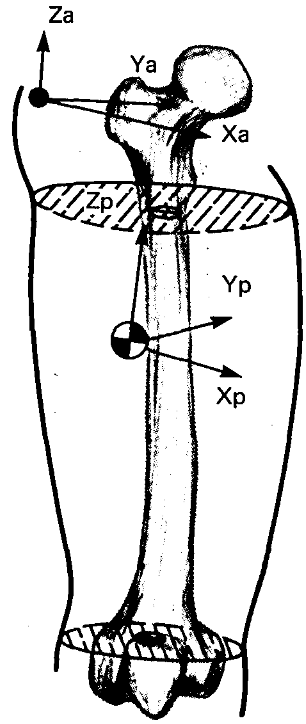
	RANGE			MEAN	S.D.
X-AXIS	2,546	-	9,191	5,173	1,301
Y-AXIS	11,807	-	38,708	22,558	5,388
Z-AXIS	12,219	-	40,668	23,676	5,536

PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	6.39	89.83	96.39	STD. DEV. OF ROT. X = 13.54
Y	88.31	16.91	73.18	STD. DEV. OF ROT. Y = 2.58
Z	83.84	106.91	18.06	STD. DEV. OF ROT. Z = 2.82

TABLE 17

RIGHT THIGH MINUS FLAP



ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
THIGH LTH	35.6- 47.9	41.15	2.51
BITROCH BR	27.1- 36.8	31.63	1.99
BUTTOCK CIRC	83.5-130.2	100.08	9.69
KNEE BR RT	7.5- 10.0	8.81	.57
UPPER THIGH CIRC	46.5- 73.5	59.44	5.63
MIDTHIGH CIRC	39.9- 69.0	51.92	5.41
KNEE CIRC	30.7- 44.5	36.97	2.84
MIDTHIGH DEPTH	12.4- 23.5	16.50	2.05
GLUT FURROW DPTH	14.1- 24.6	18.92	2.00
BUTTOCK DEPTH	18.1- 35.7	24.12	3.49

R THI-F RANGE	VOLUME MEAN	S.D.
3,736 - 11,570	6,278	1,389

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	-3.28 - 1.07	-.66	.83
Y-AXIS	5.19 - 9.38	6.77	.88
Z-AXIS	-24.84 - -18.34	-21.90	1.48

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
R TROCHANTERION	0.00	0.00	0.00	0.00	0.00	0.00
R LAT FEM CONDYL	0.00	0.00	0.00	0.00	-38.41	2.30
R MED FEM CONDYL	0.00	0.00	11.39	1.28	-40.01	2.21
RIGHT TIBIALE	1.90	.70	9.00	1.15	-41.75	2.34
RIGHT FIBULARE	-1.34	.85	-.61	.29	-42.52	2.51

RIGHT THIGH MINUS FLAP: REGRESSION EQUATIONS

RIGHT THIGH MINUS FLAP VOLUME AND MOMENTS FROM STATURE AND WEIGHT

	STATURE	WEIGHT	CONSTANT	R	SE EST
VOLUME =	25.21 +	43.23 -	3,879	.911	9.4%
X MOMENT =	9,931 +	4,063 -	1,621,956	.868	15.6%
Y MOMENT =	9,117 +	4,765 -	1,579,744	.867	17.0%
Z MOMENT =	-694 +	3,918 -	181,293	.901	20.3%

RIGHT THIGH MINUS FLAP VOLUME FROM:

MIDTHIGH CIRC	STATURE	BUTTOCK CIRC	CONSTANT	R	SE EST
236.27		-	5,989.26	.920	8.8%
220.48 +	62.83	-	15,299.33	.956	6.6%
173.68 +	57.90 +	29.81 -	15,058.42	.960	6.4%

RIGHT THIGH MINUS FLAP X MOMENT FROM:

WEIGHT	THIGH LTH	MIDTHIGH CIRC	CONSTANT	R	SE EST
4,951		-	145,968	.808	18.3%
4,434 +	24,331	-	1,074,247	.881	14.9%
2,297 +	26,185 +	11,973 -	1,471,053	.897	14.1%

RIGHT THIGH MINUS FLAP Y MOMENT FROM:

WEIGHT	THIGH LTH	MIDTHIGH DEPTH	CONSTANT	R	SE EST
5,581		-	224,639	.826	19.0%
5,132 +	21,099	-	1,029,638	.870	16.8%
2,163 +	25,649 +	43,261 -	1,512,313	.893	15.5%

RIGHT THIGH MINUS FLAP Z MOMENT FROM:

MIDTHIGH DEPTH	WEIGHT	BITROCH BR	CONSTANT	R	SE EST
53,568		-	625,025	.925	17.6%
34,854 +	1,542	-	533,507	.939	16.1%
30,875 +	2,250 -	8,351 -	303,508	.943	15.8%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE	MEAN	S.D.
X-AXIS	254,810 - 1,131,581	551,564	169,396
Y-AXIS	250,883 - 1,310,392	561,681	186,888
Z-AXIS	94,202 - 795,051	258,845	118,428

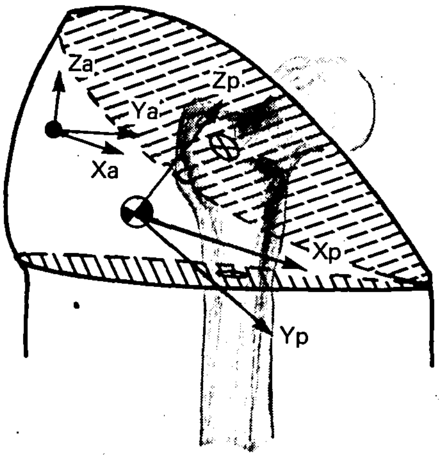
PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	8.12	81.69	89.58	STD. DEV. OF ROT. X = 1.95
Y	98.09	8.28	91.76	STD. DEV. OF ROT. Y = 4.14
Z	90.66	88.32	1.80	STD. DEV. OF ROT. Z = 22.27

TABLE 18

RIGHT FLAP

ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
THIGH FLAP LTH	14.2- 22.1	17.96	1.75
BUTTOCK DEPTH	18.1- 35.7	24.12	3.49
GLUT FURROW DPTH	14.1- 24.6	18.92	2.00
HIP BR	30.9- 45.4	37.25	3.34
BUTTOCK CIRC	83.5-130.2	100.08	9.69
UPPER THIGH CIRC	46.5- 73.5	59.44	5.63
ANT THIGH SKINFOLD	1.4- 5.2	3.11	.97
BISPINOUS BR	18.1- 33.2	23.25	2.96



R FLAP RANGE	VOLUME MEAN	S.D.
2,096 - 5,952	3,792	874

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	-7.78 - -.44	-3.61	1.62
Y-AXIS	5.67 - 10.47	7.81	.93
Z-AXIS	-6.74 - -3.56	-5.08	.80

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
R GLUTEAL FOLD	-10.05	1.96	9.41	2.03	-13.96	1.38
RIGHT ASIS	5.49	2.29	5.82	1.41	6.45	1.26
SYMPHYSION	8.85	2.88	17.05	1.87	-2.72	1.42
R TROCHANTERION	0.00	0.00	0.00	0.00	0.00	0.00

RIGHT FLAP: REGRESSION EQUATIONS

RIGHT FLAP VOLUME AND MOMENTS FROM STATURE AND WEIGHT

		STATURE		WEIGHT		CONSTANT	R	SE EST
VOLUME	=	34.80	+	21.81	-	4,891	.817	13.6%
X MOMENT	=	1,491	+	1,458	-	305,849	.835	21.6%
Y MOMENT	=	1,653	+	2,360	-	405,124	.870	21.0%
Z MOMENT	=	1,266	+	3,456	-	434,561	.891	20.2%

RIGHT FLAP VOLUME FROM:

UPPER THIGH CIRC	THIGH FLAP LTH	STATURE		CONSTANT	R	SE EST
125.33			-	3,657.69	.808	13.7%
91.98 +	212.14		-	5,485.53	.887	10.9%
90.90 +	177.39 +	18.77	-	7,823.86	.893	10.8%

RIGHT FLAP X MOMENT FROM:

BUTTOCK CIRC	THIGH FLAP LTH	STATURE		CONSTANT	R	SE EST
4,652			-	326,560	.843	20.8%
3,637 +	10,839		-	418,671	.895	17.4%
3,635 +	8,819 +	1,041	-	550,061	.900	17.2%

RIGHT FLAP Y MOMENT FROM:

BUTTOCK CIRC	THIGH FLAP LTH	GLUT FURROW DEPTH		CONSTANT	R	SE EST
7,200			-	526,632	.868	20.8%
5,745 +	15,396		-	657,469	.913	17.3%
3,033 +	16,245 +	14,144	-	668,969	.926	16.2%

RIGHT FLAP Z MOMENT FROM:

BUTTOCK CIRC	THIGH FLAP LTH	WEIGHT		CONSTANT	R	SE EST
10,329			-	777,275	.901	19.0%
8,730 +	16,916		-	921,032	.929	16.4%
4,632 +	17,428 +	1,492	-	730,323	.936	15.7%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE			MEAN	S.D.
X-AXIS	52,520	-	303,273	139,976	53,582
Y-AXIS	68,870	-	482,804	193,961	80,428
Z-AXIS	93,131	-	674,783	256,490	111,095

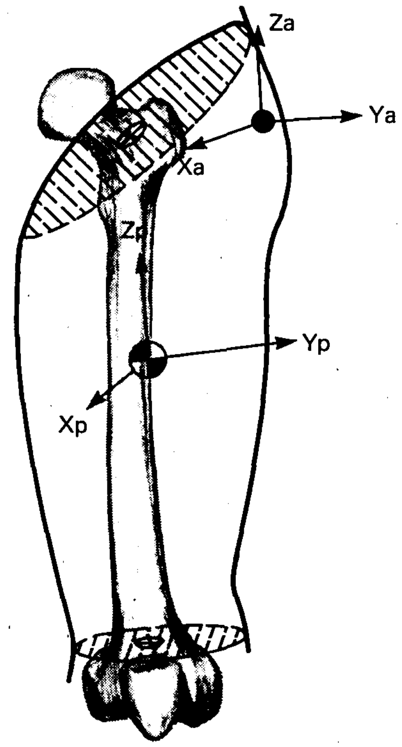
PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	17.24	104.44	80.78	STD. DEV. OF ROT. X = 5.24
Y	73.56	21.89	104.04	STD. DEV. OF ROT. Y = 4.50
Z	95.06	73.91	16.90	STD. DEV. OF ROT. Z = 12.28

TABLE 19

LEFT THIGH

ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
BITROCH BR	27.1- 36.8	31.63	1.99
HIP BR	30.9- 45.4	37.25	3.34
BUTTOCK CIRC	83.5-130.2	100.08	9.69
UPPER THIGH CIRC	46.5- 73.5	59.44	5.63
GLUT FURROW DPTH	14.1- 24.6	18.92	2.00
BUTTOCK DEPTH	18.1- 35.7	24.12	3.49
KNEE BR LT	7.4- 10.0	8.82	.57
MIDTHIGH CIRC	39.9- 69.0	51.92	5.41
KNEE CIRC	30.7- 44.5	36.97	2.84
MIDTHIGH DEPTH	12.4- 23.5	16.50	2.05
THIGH LTH	35.6- 47.9	41.15	2.51



L THIGH RANGE	VOLUME MEAN	S.D.
5,794 - 17,481	10,043	2,163

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	-4.76 - .02	-2.05	1.13
Y-AXIS	-9.64 - -5.87	-7.16	.78
Z-AXIS	-17.91 - -12.35	-15.35	1.10

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
L TROCHANTERION	0.00	0.00	0.00	0.00	0.00	0.00
L LAT FEM CONDYL	0.00	0.00	0.00	0.00	-38.35	2.34
L MED FEM CONDYL	0.00	0.00	-11.58	1.29	-39.72	2.23
LEFT TIBIALE	2.45	.92	-8.98	1.10	-41.42	2.35
LEFT FIBULARE	-1.41	.90	-.10	4.50	-42.23	2.48

LOCATION OF THE CUT CENTROID FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
LEFT HIP	5.84	1.80	-6.50	1.57	.40	.35
LEFT KNEE	-.02	1.20	-5.64	1.47	-38.65	2.35

LEFT THIGH: REGRESSION EQUATIONS

LEFT THIGH VOLUME AND MOMENTS FROM STATURE AND WEIGHT

	STATURE	WEIGHT	CONSTANT	R	SE EST
VOLUME =	56.00 +	65.65 -	8,236	.914	8.9%
X MOMENT =	26,130 +	9,759 -	4,201,311	.888	13.9%
Y MOMENT =	24,743 +	11,623 -	4,163,722	.891	14.5%
Z MOMENT =	1,394 +	7,215 -	722,096	.908	18.5%

LEFT THIGH VOLUME FROM:

UPPER THIGH CIRC	STATURE	MIDTHIGH CIRC	CONSTANT	R	SE EST
352.11		-	10,886.76	.917	8.7%
323.69 +	81.50	-	22,337.69	.941	7.5%
121.54 +	98.79 +	220.93 -	24,580.64	.963	6.0%

LEFT THIGH X MOMENT FROM:

WEIGHT	THIGH LTH	MIDTHIGH CIRC	CONSTANT	R	SE EST
12,096		-	317,566	.817	17.2%
10,660 +	67,466	-	2,891,564	.911	12.5%
5,338 +	72,084 +	29,816 -	3,879,806	.927	11.5%

LEFT THIGH Y MOMENT FROM:

WEIGHT	THIGH LTH	MIDTHIGH CIRC	CONSTANT	R	SE EST
13,835		-	486,096	.841	17.0%
12,451 +	65,050	-	2,967,913	.910	13.2%
6,207 +	70,467 +	34,979 -	4,127,212	.928	12.0%

LEFT THIGH Z MOMENT FROM:

BUTTOCK CIRC	MIDTHIGH CIRC	STATURE	CONSTANT	R	SE EST
21,082		-	1,590,720	.913	17.8%
11,529 +	19,043	-	1,623,301	.935	15.6%
9,572 +	20,607 +	6,330 -	2,529,158	.949	14.1%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE	MEAN	S.D.
X-AXIS	650,968 - 2,654,115	1,386,702	409,251
Y-AXIS	672,533 - 3,091,913	1,463,267	455,060
Z-AXIS	189,825 - 1,431,042	519,207	223,785

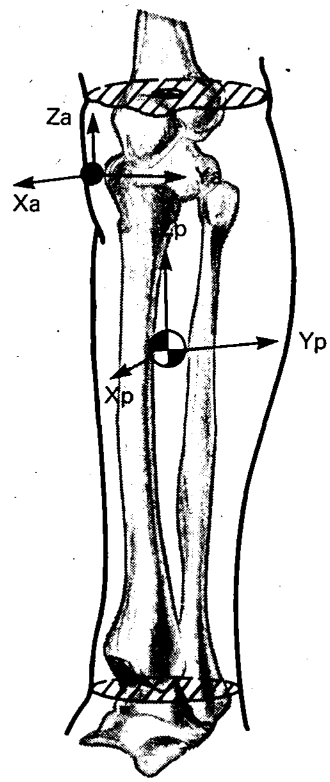
PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	16.57	76.31	80.84	STD. DEV. OF ROT. X = 1.90
Y	103.87	13.87	89.97	STD. DEV. OF ROT. Y = 3.59
Z	98.88	92.22	9.16	STD. DEV. OF ROT. Z = 13.63

TABLE 20

LEFT CALF

ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
CALF LTH	29.9- 40.3	35.95	2.06
CALF DEPTH	8.4- 14.3	10.80	.94
ANKLE BR	4.4- 6.3	5.37	.42
KNEE BR LT	7.4- 10.0	8.82	.57
KNEE CIRC	30.7- 44.5	36.97	2.84
CALF CIRC,LT	28.2- 50.6	35.79	3.48
POST CALF SKINFOLD	1.2- 4.1	2.50	.76
ANKLE CIRC	18.2- 24.7	21.45	1.39



L CALF RANGE	VOLUME MEAN	S.D.
1,734 - 5,755	3,151	656

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	-4.34 - -.04	-1.63	1.01
Y-AXIS	4.04 - 6.47	5.44	.51
Z-AXIS	-16.00 - -11.11	-13.55	1.17

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
LEFT SPHYRION	0.00	0.00	0.00	0.00	-36.60	2.07
LEFT TIBIALE	0.00	0.00	0.00	0.00	0.00	0.00
LEFT FIBULARE	.91	2.91	9.41	3.95	-1.71	1.03
L LAT MALLEOLUS	0.00	0.00	6.66	.42	-36.82	2.14

LOCATION OF THE CUT CENTROID FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
LEFT KNEE	-.10	2.22	4.19	.80	2.44	.83
LEFT ANKLE	-.47	1.97	3.69	.88	-36.99	2.12

LEFT CALF: REGRESSION EQUATIONS

LEFT CALF VOLUME AND MOMENTS FROM STATURE AND WEIGHT

	STATURE	WEIGHT	CONSTANT	R	SE EST
VOLUME =	9.49 +	19.41 -	1,115	.858	10.9%
X MOMENT =	4,402 +	2,381 -	672,548	.797	16.7%
Y MOMENT =	4,546 +	2,299 -	685,242	.794	16.6%
Z MOMENT =	-158 +	688 -	20,769	.851	23.2%

LEFT CALF VOLUME FROM

CALF CIRC ,LT	KNEE CIRC	CALF LTH	CONSTANT	R	SE EST
177.94		-	3,217.36	.943	7.0%
129.57 +	70.37	-	4,087.39	.957	6.2%
128.09 +	64.32 +	37.69 -	5,166.17	.964	5.7%

LEFT CALF X MOMENT FROM:

CALF DEPTH	CALF LTH	KNEE CIRC	CONSTANT	R	SE EST
89,404		-	592,862	.832	15.2%
79,271 +	13,266	-	960,343	.870	13.7%
42,758 +	13,578 +	14,360 -	1,108,081	.898	12.3%

LEFT CALF Y MOMENT FROM:

CALF DEPTH	CALF LTH	KNEE CIRC	CONSTANT	R	SE EST
87,545		-	573,846	.828	15.1%
77,170 +	13,583	-	950,097	.869	13.5%
41,464 +	13,887 +	14,042 -	1,094,570	.897	12.2%

LEFT CALF Z MOMENT FROM:

CALF CIRC ,LT	KNEE CIRC	KNEE BR LT	CONSTANT	R	SE EST
6,034		-	165,256	.957	12.7%
5,316 +	1,044	-	178,161	.960	12.5%
5,483 +	1,764 -	5,401 -	163,141	.963	12.1%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE		MEAN	S.D.
X-AXIS	156,852 -	725,810	372,701	100,813
Y-AXIS	156,093 -	708,434	371,643	99,167
Z-AXIS	16,650 -	157,380	50,687	21,919

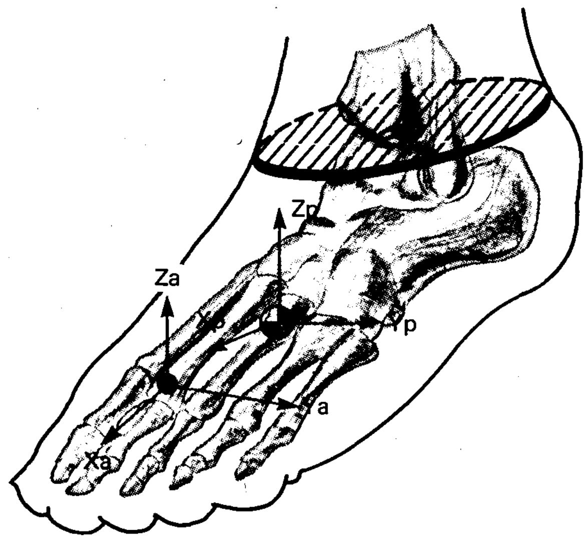
PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	47.57	42.44	90.34	STD. DEV. OF ROT. X = 1.43
Y	137.56	47.57	90.76	STD. DEV. OF ROT. Y = 1.78
Z	90.33	89.24	.83	STD. DEV. OF ROT. Z = 19.25

TABLE 21

LEFT FOOT

ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
SPHYRION HT	5.2- 7.0	6.26	.38
FOOT BR	7.5- 10.7	9.22	.57
FOOT LTH	20.3- 26.2	23.51	1.19
ANKLE BR	4.4- 6.3	5.37	.42
ANKLE CIRC	18.2- 24.7	21.45	1.39
BALL OF FOOT CIRC	19.4- 25.5	22.80	1.21
ARCH CIRC	19.9- 25.7	23.21	1.11



L FOOT VOLUME

RANGE	MEAN	S.D.
459 - 959	682	101

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	-8.70 - -5.44	-7.15	.52
Y-AXIS	-.86 - .46	-.26	.30
Z-AXIS	.32 - 1.45	.96	.28

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
LEFT SPHYRION	-10.27	.66	-3.88	.56	4.20	.46
L METATARSAL V	-2.21	.56	4.74	.50	0.00	0.00
L METATARSAL I	0.00	0.00	-4.19	.50	0.00	0.00
LEFT TOE II	5.67	.57	0.00	0.00	-1.03	.34
L POS CALCANEUS	-17.57	.87	0.00	0.00	0.00	0.00

LOCATION OF THE CUT CENTROID FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
LEFT ANKLE	-12.12	1.67	-.61	1.59	4.53	.57

LEFT FOOT: REGRESSION EQUATIONS

LEFT FOOT VOLUME AND MOMENTS FROM STATURE AND WEIGHT

		STATURE		WEIGHT		CONSTANT	R	SE EST
VOLUME	=	9.22	+	1.50	-	1,016	.804	9.0%
X MOMENT	=	106	+	19	-	14,585	.758	16.4%
Y MOMENT	=	536	+	77	-	74,036	.849	12.4%
Z MOMENT	=	522	+	80	-	71,333	.839	12.4%

LEFT FOOT VOLUME FROM

BALL OF FOOT CIRC	SPHYRION HT	FOOT LTH	CONSTANT	R	SE EST
63.02		-	754.44	.754	9.9%
52.11 +	103.95	-	1,156.42	.839	8.3%
32.65 +	93.42 +	32.44 -	1,409.56	.887	7.1%

LEFT FOOT X MOMENT FROM:

BALL OF FOOT CIRC	SPHYRION HT	FOOT LTH	CONSTANT	R	SE EST
806		-	13,109	.755	16.3%
674 +	1,259	-	17,976	.832	13.9%
492 +	1,160 +	303 -	20,341	.858	13.1%

LEFT FOOT Y MOMENT FROM:

FOOT LTH	SPHYRION HT	ANKLE CIRC	CONSTANT	R	SE EST
3,785		-	65,793	.846	12.4%
3,331 +	4,088	-	81,897	.890	10.7%
2,785 +	4,251 +	1,055 -	91,523	.923	9.1%

LEFT FOOT Z MOMENT FROM:

FOOT LTH	BALL OF FOOT CIRC	SPHYRION HT	CONSTANT	R	SE EST
3,860		-	66,604	.853	11.8%
2,726 +	1,722	-	79,190	.902	9.8%
2,586 +	1,522 +	2,754 -	88,574	.921	9.0%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE			MEAN	S.D.
X-AXIS	2,672	-	8,980	5,266	1,293
Y-AXIS	12,112	-	37,991	23,183	5,314
Z-AXIS	12,605	-	39,542	24,154	5,378

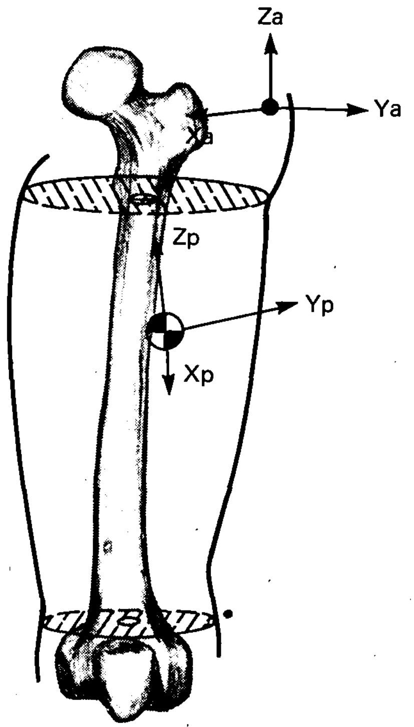
PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	6.47	90.33	96.46	STD. DEV. OF ROT. X = 13.36
Y	91.47	16.11	106.04	STD. DEV. OF ROT. Y = 2.31
Z	83.71	73.89	17.36	STD. DEV. OF ROT. Z = 2.63

TABLE 22

LEFT THIGH MINUS FLAP

ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
THIGH LTH	35.6- 47.9	41.15	2.51
BITROCH BR	27.1- 36.8	31.63	1.99
BUTTOCK CIRC	83.5-130.2	100.08	9.69
KNEE BR LT	7.4- 10.0	8.82	.57
UPPER THIGH CIRC	46.5- 73.5	59.44	5.63
MIDTHIGH CIRC	39.9- 69.0	51.92	5.41
KNEE CIRC	30.7- 44.5	36.97	2.64
MIDTHIGH DEPTH	12.4- 23.5	16.50	2.05
GLUT FURROW DPTH	14.1- 24.6	18.92	2.00
BUTTOCK DEPTH	18.1- 35.7	24.12	3.49



L THI-F RANGE	VOLUME MEAN	S.D.
3,701 - 12,156	6,211	1,432

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	-3.10 - 1.01	-.74	.87
Y-AXIS	-9.59 - -5.22	-6.76	.84
Z-AXIS	-24.86 - -18.07	-21.76	1.51

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
L TROCHANTERION	0.00	0.00	0.00	0.00	0.00	0.00
L LAT FEM CONDYL	0.00	0.00	0.00	0.00	-38.35	2.34
L MED FEM CONDYL	0.00	0.00	-11.58	1.29	-39.72	2.23
LEFT TIBIALE	2.45	.92	-8.98	1.10	-41.42	2.35
LEFT FIBULARE	-1.41	.90	-.10	4.50	-42.23	2.48

LEFT THIGH MINUS FLAP: REGRESSION EQUATIONS

LEFT THIGH MINUS FLAP VOLUME AND MOMENTS FROM STATURE AND WEIGHT

	STATURE	WEIGHT	CONSTANT	R	SE EST
VOLUME =	17.30 +	44.41 -	2,836	.890	10.8%
X MOMENT =	8,097 +	4,312 -	1,369,396	.848	17.2%
Y MOMENT =	6,689 +	5,033 -	1,236,081	.839	19.2%
Z MOMENT =	-1,121 +	4,060 -	135,628	.878	23.9%

LEFT THIGH MINUS FLAP VOLUME FROM:

MIDTHIGH CIRC	STATURE	BITROCH BR	CONSTANT	R	SE EST
242.33		-	6,371.00	.915	9.4%
228.37 +	55.55	-	14,602.74	.942	7.9%
253.27 +	80.63 -	141.89 -	15,450.17	.950	7.5%

LEFT THIGH MINUS FLAP X MOMENT FROM:

WEIGHT	STATURE	MIDTHIGH CIRC	CONSTANT	R	SE EST
5,036		-	165,963	.808	18.9%
4,312 +	8,097	-	1,369,396	.848	17.2%
261 +	11,468 +	21,400 -	2,453,232	.892	14.8%

LEFT THIGH MINUS FLAP Y MOMENT FROM:

WEIGHT	STATURE	MIDTHIGH CIRC	CONSTANT	R	SE EST
5,631		-	241,915	.817	20.1%
5,033 +	6,689	-	1,236,081	.839	19.2%
839 +	10,138 +	21,894 -	2,344,942	.878	17.1%

LEFT THIGH MINUS FLAP Z MOMENT FROM:

MIDTHIGH DEPTH	WEIGHT	BITROCH BR	CONSTANT	R	SE EST
55,374		-	657,970	.907	20.9%
37,669 +	1,459	-	571,384	.918	19.9%
31,525 +	2,552 -	12,892 -	216,327	.927	19.0%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE	MEAN	S.D.
X-AXIS	281,897 - 1,204,795	543,517	172,258
Y-AXIS	276,772 - 1,420,279	551,554	190,568
Z-AXIS	93,286 - 870,803	255,597	124,925

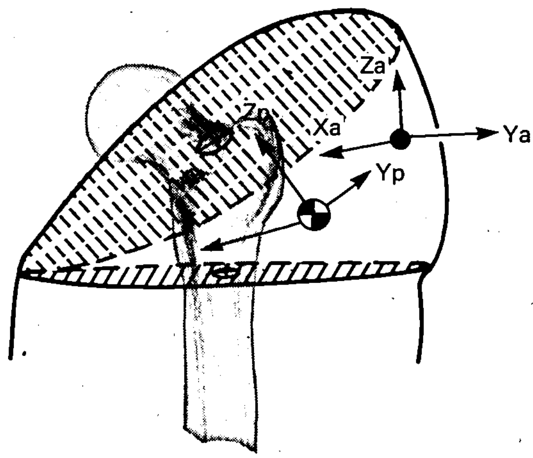
PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	15.26	74.80	88.69	STD. DEV. OF ROT. X = 2.10
Y	105.23	15.31	88.44	STD. DEV. OF ROT. Y = 2.88
Z	90.85	91.85	2.03	STD. DEV. OF ROT. Z = 22.77

TABLE 23

LEFT FLAP

ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
THIGH FLAP LTH	14.2- 22.1	17.96	1.75
BUTTOCK DEPTH	18.1- 35.7	24.12	3.49
GLUT FURROW DPTH	14.1- 24.6	18.92	2.00
HIP BR	30.9- 45.4	37.25	3.34
BUTTOCK CIRC	83.5-130.2	100.08	9.69
UPPER THIGH CIRC	46.5- 73.5	59.44	5.63
ANT THIGH SKINFOLD	1.4- 5.2	3.11	.97
BISPINOUS BR	18.1- 33.2	23.25	2.96



L FLAP RANGE	VOLUME MEAN	S.D.
2,093 - 6,334	3,832	896

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE			MEAN	S.D.
X-AXIS	-8.20	-	-1.34	-4.18	1.62
Y-AXIS	-10.67	-	-5.35	-7.79	.99
Z-AXIS	-6.96	-	-1.95	-4.97	.98

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
L GLUTEAL FOLD	-9.95	1.99	-9.52	2.18	-13.94	1.39
LEFT ASIS	4.91	1.85	-5.82	1.36	6.82	1.69
SYMPHYSION	8.11	2.96	-17.01	1.91	-2.35	1.52
L TROCHANTERION	0.00	0.00	0.00	0.00	0.00	0.00

LEFT FLAP: REGRESSION EQUATIONS

LEFT FLAP VOLUME AND MOMENTS FROM STATURE AND WEIGHT

		STATURE		WEIGHT		CONSTANT	R	SE EST
VOLUME	=	38.70	+	21.24	-	5,400	.797	14.4%
X MOMENT	=	1,926	+	1,399	-	367,148	.802	24.2%
Y MOMENT	=	2,211	+	2,244	-	474,098	.848	22.1%
Z MOMENT	=	2,238	+	3,259	-	558,922	.864	22.0%

LEFT FLAP VOLUME FROM

UPPER THIGH CIRC		THIGH FLAP LTH		STATURE		CONSTANT	R	SE EST
130.41					-	3,919.85	.820	13.5%
99.55	+	196.32			-	5,611.38	.884	11.2%
98.20	+	153.06	+	23.37	-	8,522.40	.893	10.9%

LEFT FLAP X MOMENT FROM:

HIP BR		THIGH FLAP LTH		ANT THIGH SKINFOLD		CONSTANT	R	SE EST
13,874					-	376,203	.831	22.3%
11,259	+	9,115			-	442,532	.865	20.3%
9,270	+	10,624	+	9,507	-	425,078	.875	19.9%

LEFT FLAP Y MOMENT FROM:

UPPER THIGH CIRC		THIGH FLAP LTH		GLUT FURROW DEPTH		CONSTANT	R	SE EST
12,394					-	538,160	.863	20.8%
9,830	+	16,316			-	678,743	.915	16.8%
14,705	+	15,187	-	13,739	-	688,344	.919	16.6%

LEFT FLAP Z MOMENT FROM:

UPPER THIGH CIRC		THIGH FLAP LTH		HIP BR		CONSTANT	R	SE EST
17,465					-	776,979	.882	20.3%
14,576	+	18,379			-	935,338	.916	17.5%
9,545	+	16,391	+	9,750	-	963,787	.923	17.1%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE			MEAN	S.D.
X-AXIS	52,640	-	320,199	140,585	55,714
Y-AXIS	70,003	-	430,634	198,568	80,837
Z-AXIS	95,141	-	572,623	261,161	111,545

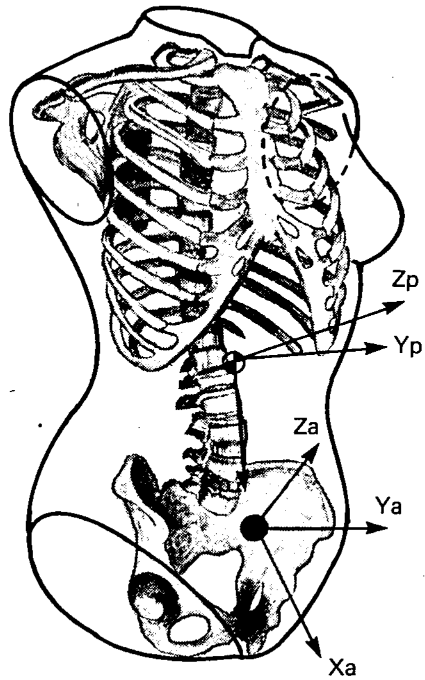
PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	18.32	74.97	79.77	STD. DEV. OF ROT. X = 5.01
Y	107.35	22.84	75.62	STD. DEV. OF ROT. Y = 4.23
Z	95.69	106.78	17.78	STD. DEV. OF ROT. Z = 12.20

TABLE 24

TORSO

ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
BIACROMIAL BR	33.5- 40.2	36.79	1.63
CHEST BR	25.2- 36.8	28.64	2.29
TENTH RIB BR	21.0- 33.3	25.67	2.99
WAIST BR	24.5- 40.6	31.05	4.12
BISPINOUS BR	18.1- 33.2	23.25	2.96
HIP BR	30.9- 45.4	37.25	3.34
BUST CIRC	62.0-122.6	95.41	8.15
TENTH RIB CIRC	62.0-106.2	75.94	10.43
WAIST C	68.7-118.8	86.70	13.22
BUTTOCK C	83.5-130.2	100.08	9.69
CHEST D	13.5- 23.0	17.81	1.71
BUTTOCK DEPTH	18.1- 35.7	24.12	3.49
SITTING HT	77.5- 92.5	86.21	3.47



TORSO VOLUME RANGE	MEAN	S.D.
20,480 - 56,462	31,120	7,402

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	-10.42 - 1.22	-5.29	3.09
Y-AXIS	-1.53 - 1.75	.14	.64
Z-AXIS	16.32 - 22.34	19.89	1.52

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
CERVICALE	-4.46	6.73	.14	1.61	50.94	2.44
LEFT ASIS	0.00	0.00	11.84	1.55	0.00	0.00
RIGHT ASIS	0.00	0.00	-11.93	1.59	0.00	0.00
SUPRASTERNALE	4.15	5.69	.37	1.38	41.84	2.17
SYMPHYSION	0.00	0.00	-.02	.72	-9.12	1.58

LOCATION OF THE CUT CENTROID FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
NECK	-2.48	6.70	.10	1.61	50.49	2.43
RIGHT HIP	-1.29	.87	-10.92	1.48	-5.95	1.27
RIGHT SHOULDER	-4.69	5.63	-15.85	2.08	37.27	2.07
LEFT HIP	-1.35	.93	10.76	1.64	-6.23	1.59
LEFT SHOULDER	-4.02	4.98	16.97	1.89	37.44	2.48

TORSO: REGRESSION EQUATIONS

TORSO VOLUME AND MOMENTS FROM STATURE AND WEIGHT

		STATURE		WEIGHT		CONSTANT	R	SE EST
VOLUME	=	-212.59	+	272.13	+	27,051	.958	7.0%
X MOMENT	=	-14,095	+	99,580	-	2,264,883	.928	11.8%
Y MOMENT	=	-24,678	+	95,743	-	837,924	.930	12.1%
Z MOMENT	=	-65,506	+	59,565	+	5,604,420	.949	15.1%

TORSO VOLUME FROM:

TENTH RIB CIRC		WEIGHT		BUST CIRC		CONSTANT	R	SE EST
683.71					-	20,800.94	.964	5.4%
425.35	+	107.15			-	16,278.60	.978	5.1%
271.37	+	83.15	+	287.58	-	28,680.52	.983	4.5%

TORSO X MOMENT FROM:

WEIGHT		BISPINOUS BR		BUST CIRC		CONSTANT	R	SE EST
98,320					-	4,359,863	.928	11.7%
78,951	+	255,427			-	7,569,498	.945	10.3%
57,813	+	183,864	+	99,643	-	12,434,211	.951	9.8%

TORSO Y MOMENT FROM:

WEIGHT		BUST CIRC		SITTING HT		CONSTANT	R	SE EST
93,537					-	4,505,763	.929	12.0%
57,241	+	136,142			-	12,381,046	.944	10.8%
34,080	+	198,297	+	139,975	-	27,115,045	.955	9.9%

TORSO Z MOMENT FROM:

TENTH RIB CIRC		BUST CIRC		SITTING HT		CONSTANT	R	SE EST
148,430					-	7,836,221	.962	12.9%
88,111	+	82,079			-	11,086,754	.973	11.2%
93,802	+	72,334	+	37,739	-	13,890,348	.976	10.6%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE	MEAN	S.D.
X-AXIS	5,231,694 -20,700,673	9,493,427	2,931,045
Y-AXIS	4,626,184 -19,270,170	8,673,554	2,784,751
Z-AXIS	1,631,449 - 9,618,198	3,435,530	1,609,203

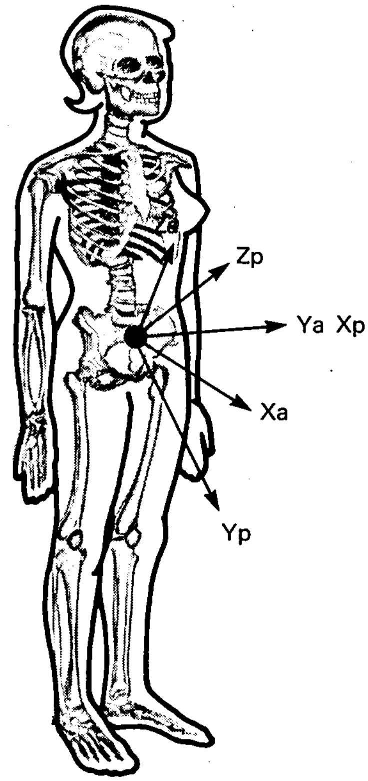
PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	7.97	90.38	97.96	STD. DEV. OF ROT. X = 2.19
Y	89.73	.83	90.78	STD. DEV. OF ROT. Y = 7.03
Z	82.04	89.26	8.00	STD. DEV. OF ROT. Z = 2.27

TABLE 25

TOTAL BODY

ANTHROPOMETRY OF SEGMENT	RANGE	MEAN	S.D.
BIACROMIAL BR	33.5- 40.2	36.79	1.63
CHEST BR	25.2- 36.8	28.64	2.29
10 RIB BR	21.0- 33.3	25.67	2.99
WAIST BR	24.5- 40.6	31.05	4.12
BITROCH B	27.1- 36.8	31.63	1.99
HIP BR	30.9- 45.4	37.25	3.34
BUSTPT-BUSTPT	13.9- 22.2	18.02	1.72
BUST CIRC	82.0-122.8	95.41	8.15
10 RIB C	62.0-106.2	75.94	10.43
WAIST C	68.7-118.8	86.70	13.22
BUTTOCK C	83.5-130.2	100.08	9.69
CHEST D	13.5- 23.0	17.81	1.71
BUTTOCK D	18.1- 35.7	24.12	3.49
SITTING HT	77.5- 92.5	86.21	3.47
STATURE	145.1-172.3	161.23	5.96
WEIGHT	91.1-231.5	140.90	27.65



TOT BODY VOLUME

RANGE	MEAN	S.D.
45,757 -111,473	69,130	13,403

LOCATION OF THE CENTER OF VOLUME FROM THE ANATOMICAL AXIS ORIGIN

	RANGE	MEAN	S.D.
X-AXIS	-15.27 - -5.45	-9.56	1.80
Y-AXIS	-1.21 - 1.47	-.03	.53
Z-AXIS	-3.81 - 8.35	2.46	2.40

LOCATION OF THE ANATOMICAL LANDMARKS FROM THE ANATOMICAL AXIS ORIGIN

	X-MEAN	X-S.D.	Y-MEAN	Y-S.D.	Z-MEAN	Z-S.D.
CERVICALE	-4.46	6.73	.14	1.61	50.94	2.44
LEFT ASIS	0.00	0.00	11.84	1.55	0.00	0.00
RIGHT ASIS	0.00	0.00	-11.93	1.59	0.00	0.00
SUPRASTERNALE	4.15	5.69	.37	1.38	41.84	2.17
SYMPHYSION	0.00	0.00	-.02	.72	-9.12	1.58

TOTAL BODY: REGRESSION EQUATIONS

TOTAL BODY VOLUME AND MOMENTS FROM STATURE AND WEIGHT

		STATURE		WEIGHT		CONSTANT	R	SE EST
VOLUME	=	-42.98	+	487.29	+	7,401	.998	1.4%
X MOMENT	=	1,270,395	+	473,772	-	179,716,949	.986	3.3%
Y MOMENT	=	1,212,510	+	419,917	-	169,700,927	.983	3.6%
Z MOMENT	=	-23,650	+	137,098	-	3,917,115	.985	5.8%

TOTAL BODY VOLUME FROM:

WEIGHT		WAIST CIRC		BUSTPOINT-BUSTPOINT		CONSTANT	R	SE EST
483.45					+	1,012.47	.997	1.4%
459.89	+	54.74			-	414.89	.998	1.4%
469.05	+	62.23	-	272.86	+	2,561.39	.998	1.3%

TOTAL BODY X MOMENT FROM:

WEIGHT		STATURE		WAIST CIRC		CONSTANT	R	SE EST
587,371					+	9,102,800	.908	8.3%
473,772	+	1,270,395			-	179,716,949	.986	3.3%
646,175	+	1,086,602	-	362,489	-	142,947,665	.991	2.7%

TOTAL BODY Y MOMENT FROM:

WEIGHT		STATURE		WAIST CIRC		CONSTANT	R	SE EST
528,340					+	10,515,238	.897	8.6%
419,917	+	1,212,510			-	169,700,927	.983	3.6%
599,571	+	1,020,986	-	377,734	-	131,385,160	.990	2.8%

TOTAL BODY Z MOMENT FROM:

WEIGHT		TENTH RIB BR		BUSTPOINT-BUSTPOINT		CONSTANT	R	SE EST
134,984					-	7,432,283	.985	5.8%
113,655	+	219,115			-	10,051,738	.987	5.3%
117,453	+	232,308	-	111,957	-	8,908,090	.988	5.2%

THE PRINCIPAL MOMENTS OF INERTIA

	RANGE	MEAN	S.D.
X-AXIS	53,022,463 - 146,524,531	91,863,338	17,895,959
Y-AXIS	49,115,918 - 134,986,707	84,958,384	16,295,528
Z-AXIS	5,829,991 - 23,963,725	11,586,898	3,791,128

PRINCIPAL AXES OF INERTIA WITH RESPECT TO ANATOMICAL AXES
COSINE MATRIX EXPRESSED IN DEGREES

	X	Y	Z	
X	13.14	89.74	103.14	STD. DEV. OF ROT. X = 2.01
Y	90.33	.44	90.29	STD. DEV. OF ROT. Y = 7.16
Z	76.86	89.65	13.14	STD. DEV. OF ROT. Z = 1.91

IV CONCLUSIONS

Results of this study of 46 females confirm findings obtained in the companion male study that both total body and segmental mass distribution data on living populations can be predicted from anthropometric measurements using regression analysis. In comparing the results of this study with those obtained in the earlier male study, the following observations were made. The women's segmental volumes and, as a consequence, their principal moments of inertia were, on the average, smaller than those obtained on the male subjects. Exceptions to this general pattern were for the abdominal segment, the thigh flaps and the thighs, where the female sample had greater mean values for volume and, in general, larger principal moments of inertia than the male sample. The principal axes were similarly aligned for the male and female data with few exceptions. The few exceptions noted, again like the volume and moments data, appear to reflect sex-specific differential mass distribution characteristics.

The multiple regression correlation coefficients of the anthropometry for predicting the segmental volume and moments were, in general, somewhat lower for the female sample than those for the male data. Such differences were, however, not large and may well be a function of the 'W' sample strategy used in the male study.* In the selection of anthropometric variables as predictors in the regression equations, a measure related to mass (weight, circumference or skinfold) was generally selected as the first predictor and a measure of linearity (stature, segment length) as the second predictor. This pattern was very similar to that seen in the male results with the major difference being that in the women's regression analysis circumferences, rather than body weight, were selected far more often than in the male analysis.

Reconfirmed in this study was the phenomenon of approximately 10 percent overestimation of volumes obtained by stereophotometric techniques as compared to measurements obtained by immersion techniques. Comparative measurements undertaken in this study further revealed that measured and estimated moments of inertia about the whole body X axis differs by as much as 5.74%, but not always in the same direction. The results from a comparison of 25 subjects gives a mean delta percent of 0.153.

These results indicate a level of good agreement and do not suggest the overestimation of inertial value that might be anticipated from the observed overestimation of volume by the photometric technique. The observed level of agreement may, however, be spurious as the measured moments of total body inertia may have an error, due to oscillatory rotation which is not through the body center of mass. The error is proportional to the distance (body

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* The 'W' sample strategy calls for subsets drawn from three discontinuous segments of the height-weight distribution to provide samples of equal size from the center and both ends of the distribution.

rotational axis to center of mass) squared, and is always positive. This error could thus offset the error from the volume overestimation to give the favorable moment comparison observed.

Duplicate measurements on selected subjects were made to test the accuracy of both measuring techniques--anthropometry and stereophoto. With few exceptions, measuring errors were found to be within acceptable levels of tolerance within techniques.

The results of this study and the earlier companion volume on a male sample provide researchers in modeling and biomechanics with better methods than previously available for estimating the physical mass distribution properties of individuals and groups based on body size and proportions.

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APPENDIX A

ANTHROPOMETRIC MEASUREMENTS AND LANDMARKS

Anthropometry played several roles in this study in addition to providing the measurements necessary for comparison with the mass distribution properties. Anthropometric landmarks were used to define anatomical axis systems for the body and its segments from which to specify principal (inertial) axis systems. These landmarks were also used for defining planes of segmentation so that the body could be consistently photographically segmented.

The purpose of this section is to describe and explain the anthropometric procedures, measurements and landmarks which were employed in this study.

Selection of Measurements and Landmarks

A major objective in the design of this survey was to parallel a recent study which used male subjects and was conducted by investigators from the Air Force Aerospace Medical Research Laboratory (AFAMRL), Anthropology Research Project, Biostereometrics Laboratory at Baylor School of Medicine, and the FAA Civil Aeromedical Institute. This objective determined for the most part the selection of the measurements and landmarks to be used although five alterations were made during the process of the survey.

First, the landmarks for the axis systems and planes of segmentation were revised in the male study after the data had already been collected. The revision rendered two of the original landmarks, infrapatella and medial malleolus, useless for purposes of the female study, and they were therefore not used.

Second, in the male survey the subjects wore caps to compress the hair. It was apparent that the hint of a problem which arose in accounting for the amount of hair under the caps would be intensified in the female study. In an attempt to resolve the problem, 10 head measurements were added:

sagittal arc	bitragion-coronal arc w/cap
bitragion-coronal arc	horizontal head circ w/cap
horizontal head circ	head length with cap
bitragion breadth	head breadth with cap
sagittal arc with cap	maximum head circ w/cap

Six of these new measurements were taken with the subject wearing an elastic cap, and the remaining four measurements obtained without the cap.

Third, it was thought to be desirable to determine body type. This resulted in the addition of two skinfold measurements, anterior thigh skinfold, and posterior calf skinfold, which when combined with existing calf and thigh circumferences could, according to Heath and Carter (1967), be used to establish body type.

Fourth, alterations were necessary to accommodate primary sex differences. In the female survey the subjects were to wear bras; thus thelion, a landmark in the male study, could not be located. Instead, a bustpoint landmark was substituted. Also, two measurements were added (bustpoint-to-bustpoint and midsagittal chest depth) to account for differences between male and female contours.

Finally, in the process of the female survey, two differences from the male study were noted. Because it appears to protrude more on women, the cricoid cartilage was consistently located in place of the thyroid cartilage. Since this point was included for location of the X-Z plane only, the difference should cause no problems. Also, wrist breadth, which was measured as the maximum breadth of the wrist across the styloid processes in the male study, was inadvertently measured as the minimum breadth of the wrist superior to the styloid processes in the female study.

The primary landmarks, 75 in number, were used for both measurements and stereophotographs, with an additional eight landmarks located for measurement purposes only. For photographic purposes they were first marked in pencil, then covered with a sticker. Those landmarks which were on the sides of the body or segment, and thus not visible to the camera, were also marked with an offset.

Landmark Descriptions

Acromion (right and left): the most lateral point on the lateral margin of the acromial process of each scapula.

Axillary Arm: the anterior horizontal mark on the right arm which was made when locating the scye point.

Biceps (right and left): the level of maximum protrusion of the strongly contracted biceps brachii. Subject's upper arm is horizontal, forearm flexed approximately 90 degrees; locate by palpation and inspection from lateral side of arm.

Bustpoint Level: a series of three points; one each on the point of maximum anterior protrusion of each bra cup, and one in the anterior midsagittal line at this level.

Posterior Calcaneous Point (right and left): the posterior point of each heel.

Calf Circumference (right): subject stands erect, legs slightly apart and weight equally distributed on both feet. With a tape perpendicular to the long axis of the lower leg, mark and measure the maximum circumference of the calf.

Cervicale: the superior tip of the spine of the 7th cervical vertebra. (The protrusion of the spinal column at the base of the neck.)

Clavicale (right and left): the point on the most imminent prominence of the superior aspect of the medial end of each clavicle.

Cricoid Cartilage: the anterior point in the midsagittal plane of the cricoid cartilage.

Dactylion (right and left): the tip of digit III of each hand.

Femoral Epicondyle, Lateral (right and left): the lateral point on the lateral epicondyle of each femur.

Femoral Epicondyle, Medial (right and left): the medial point on the medial epicondyle of each femur.

Fibulare (right and left): the proximal tip of each fibula.

Gluteal Furrow (right and left): the lowest point on each gluteal fold.

Gonion (right and left): the lateral and inferior point on the back of the mandible at the intersection of the vertical and horizontal portions of each side of the jaw.

Head Circumference: a point in the midsagittal line of the forehead just above the brow ridges.

Humeral Epicondyle, Lateral (right and left): the lateral point on the lateral epicondyle of each humerus with the arm in the anatomical position.

Humeral Epicondyle, Medial (right and left): the medial point on the medial epicondyle of each humerus with the arm in the anatomical position.

Iliac Spine, Anterior-Superior (right and left): the inferior point of each anterior-superior iliac spine.

Iliac-Midspine, Posterior-Superior: the point on the midspine made at the level of the posterior-superior iliac spines. (A dimple often indicates the site of this iliac spine.)

Iliocristale Points (right and left): the highest point on the crest of each ilia in the midaxillary line.

Infraorbitale (right and left): the lowest point on the inferior margin of each orbit.

Malleoli, Lateral (right and left): the most lateral point on each lateral malleolus.

Mastoid (right): the inferior tip of the mastoid process.

Metacarpale II (right and left): the most laterally prominent point on the lateral surface of the head of the second metacarpal, with the hand in the anatomical position.

Metacarpale III (right and left): the distal point in the midline on the head of the third metacarpal with the hand rotated 180 degrees from the anatomical position.

Metacarpale V (right and left): in the anatomical position, the most medially prominent point on the medial surface of the head of the fifth metacarpal.

Metatarsus I (right and left): the medial point on the head of each metatarsus I.

Metatarsus V (right and left): the lateral point on the head of each metatarsus V.

Midforearm (right): the level midway between the radiale landmark and the stylion landmark, determined by measurement when the arm is in the anatomical position.

Midthigh (right): the level midway between the trochanterion and fibulare landmarks determined by measurement.

Nuchale: the lowest point in the midsagittal plane of the occiput that can be palpated among the muscles in the posterior-superior part of the neck. This point will usually be obscured by hair.

Olecranon (right and left): the most posterior point on the olecranon process of the ulna with each arm in the anatomical position.

Radiale (right and left): the highest palpable point on the head of each radius with the arm in the anatomical position.

Sellion: the point in the midsagittal plane of the deepest depression of the nasal root.

Scye Points (right and left): these are a series of marks drawn at the axillary folds formed by the juncture of the arms and trunk. Subject stands and initially abducts slightly her right arm; a straight edge is placed horizontally under the armpit so that the top of the straight edge touches, without compressing the tissue, the inferior point of the axillary fold. The subject then relaxes the arm and short horizontal lines are drawn at the level of the top of the straight edge on the anterior and posterior surfaces of the arms and torso. The process is repeated on the left side of the body. The intersections of the horizontal marks and the vertical lines following the axillary folds in the direction of the acromion are the scye point landmarks.

Sphyrion (right and left): the distal end of each tibia.

Stylion or **Radial Styloid (right and left):** the distal end of each radius.

Suprasternale: the lowest point of the jugular notch on the superior margin of the sternum.

Symphysion: the anterior point in the midsagittal plane on the notch of the superior border of the pubic symphysis.

Tenth Rib: a series of three marks indicating the level of the inferior point on the inferior margin of the lowest of the two tenth ribs. Right and left marks are made in the midaxillary line and a midspine mark is made at this level.

Tibiale (right and left): the superior point on the medial margin of the head of each tibia.

Toe II (right and left): the tip of digit II of each foot.

Tragion (right and left): the deepest point of the notch just above the tragus of each ear.

Triceps: with the right elbow flexed 90 degrees, the level on the back of the upper arm halfway between acromion and the inferior point of the elbow.

Trochanterion: the proximal point of the greater trochanter of each femur.

Ulnar Styloid (right and left): the distal point of each ulna.

Measurement Descriptions

Unless otherwise specified, all measurements were made on the right side of the body.

Acromion Height: subject stands erect, heels together, weight equally distributed on both feet, looking straight ahead. With an anthropometer, measure the vertical distance from the floor to the acromion landmark.

Acromion-Radiale Length: subject stands erect, looking straight ahead, arms in the anatomical position. With a beam caliper, measure the distance parallel to the long axis of the upper arm between the acromion and radiale landmarks.

Ankle Breadth: subject stands, feet slightly apart, weight evenly distributed on both feet. With a beam caliper parallel to the floor, measure the minimum breadth of the ankle just above the medial and lateral malleoli.

Ankle Circumference: subject stands, legs slightly apart, weight evenly distributed on both feet. With a tape perpendicular to the long axis of the lower leg, measure the minimum circumference of the ankle.

Anterior-Superior Iliac Spine Height: subject stands, heels together, weight equally distributed on both feet, looking straight ahead. With an anthropometer, measure the vertical distance from the standing surface to the anterior-superior iliac spine landmark.

Anterior Thigh Skinfold: subject stands with right leg slightly flexed. Pick up a skinfold on the anterior thigh superior to the mid-thigh landmark and parallel to the long axis of the thigh. Using a Lange skinfold caliper, measure the thickness of the fold at the mid-thigh landmark.

Arch Circumference: subject stands, weight evenly distributed on both feet. With a tape perpendicular to the long axis of the foot and passing over the highest point in the arch, measure the circumference of the arch of the foot.

Axillary Arm Circumference: subject stands, arms slightly abducted, in a relaxed position approximately 90 degrees from anatomical position with thumbs forward. With a tape perpendicular to the long axis of the upper arm and at the level of the axillary arm landmark, measure the circumference of the arm.

Axillary Arm Depth: subject stands erect, arms held relaxed at sides and in the anatomical position. With the beam caliper perpendicular to the long axis of the upper arm, measure the depth of the upper arm at the axillary arm landmark.

Ball of Foot Circumference: subject stands, feet slightly apart, weight evenly distributed on both feet. With a tape passing over the metatarsal I and metatarsal V landmarks, measure the circumference of the foot.

Biacromial Breadth: subject stands erect, arms at sides, looking straight ahead. With a beam caliper, measure the distance between the right and left acromion landmarks.

Biceps Circumference, Flexed: subject stands, upper arm and forearm both flexed 90 degrees, with fist clenched and biceps brachii strongly contracted. With a tape, measure the circumference of the upper arm at the level of the biceps landmark. Measure both the right and left biceps.

Biceps Circumference, Relaxed: subject stands, arms held loosely at sides, not in the anatomical position. With a tape perpendicular to the long axis of the upper arm, measure the circumference of the upper arm at the biceps landmark. Measure both right and left sides.

Biceps Depth: subject stands, arms held in the anatomical position. With the beam caliper perpendicular to the long axis of the upper arm, measure the depth of the arm at the biceps landmark.

Biceps Skinfold: subject stands relaxed, arms held loosely at sides. Pick up a skinfold on the arm superior to the biceps landmark parallel to the long axis of the arm. Using a Lange skinfold caliper, measure the thickness of the fold at the biceps landmark.

Bicristal Breadth (Bone): subject stands erect, heels together, weight equally distributed on both feet, looking straight ahead. With a beam caliper, measure the horizontal distance in the mid-axillary line between the right and left ilia, exerting sufficient pressure to compress the tissue overlying the bone.

Bispinous Breadth: subject stands erect, heels together, weight equally distributed on both feet, looking straight ahead. With a beam caliper, measure the distance between the right and left anterior-superior iliac spine landmarks.

Bitragion Breadth: subject sits, looking straight ahead. With a spreading caliper, measure the breadth of the head at the right and left tragion landmarks.

Bitragion-Coronal Arc: subject sits, looking straight ahead. With a tape held as close to the scalp as possible, measure the surface distance in a coronal plane from the left to the right tragion landmark. Repeat with cap on and use the lightest pressure possible.

Bitrochanteric Breadth (Bone): subject stands erect, heels together, weight equally distributed on both feet. With a beam caliper, measure the horizontal distance between the maximum lateral protrusions of the right and left greater trochanters, exerting sufficient pressure to compress the tissue overlying the bones.

Bust circumference: subject stands erect, breathing normally, looking straight ahead, heels together, weight distributed equally on both feet. The arms are abducted sufficiently to allow clearance of a tape between the arms and trunk. With a tape held in a horizontal plane, measure the circumference of the trunk at the level of the bustpoint landmarks. The reading is made at the point of mid-tidal respiration.

Bustpoint Height: subject stands erect, heels together, weight equally distributed on both feet, looking straight ahead. With an anthropometer, measure the vertical distance from the floor to the right bustpoint landmark.

Bustpoint-to-Bustpoint Breadth: subject stands erect, heels together, weight equally distributed on both feet, looking straight ahead. With a beam caliper, measure the distance between the right and left bustpoint landmarks.

Buttock Circumference: subject stands erect, looking straight ahead, heels together, weight distributed equally on both feet. With a tape held in a horizontal plane, measure the circumference of the trunk at the level of the greatest posterior protrusion of the right buttock.

Buttock Depth: subject stands erect, heels together, weight equally distributed on both feet. With a beam caliper, measure the horizontal depth of the torso at the level of maximum posterior protrusion of the right buttock.

Calf Circumference: subject stands erect, legs slightly apart, weight evenly distributed on both feet. With a tape perpendicular to the long axis of the lower leg, measure the maximum circumference of the calf. Measure both the right and left calves.

Calf Depth: subject stands erect, heels together, weight evenly distributed on both feet. With a beam caliper, measure the horizontal depth of the calf at the level of the calf circumference landmark.

Cervicale Height: subject stands erect, heels together, weight equally distributed on both feet, head in the Frankfort plane. With an anthropometer, measure the vertical distance from the floor to the cervicale landmark.

Chest Breadth: subject stands erect, looking straight ahead, heels together, weight equally distributed on both feet, arms raised to allow positioning of the beam caliper and then lowered. Measure the horizontal breadth of the chest, from the back, making sure not to include the breasts, at the level of the bustpoint landmarks.

Elbow Breadth (Bone): subject sits, forearm and upper arm both flexed 90 degrees. With a spreading caliper, measure the maximum breadth across the humeral epicondyles exerting sufficient pressure to compress the tissue. Measure both the right and left elbows.

Elbow Circumference: subject stands, arm in the anatomical position. With a tape passing over the olecranon process of the ulna and into the crease of the elbow, measure the circumference of the elbow.

Fibulare Height: subject stands, heels together, weight equally distributed on both feet. With an anthropometer, measure the vertical distance from the standing surface to the fibulare landmark.

Foot Breadth: subject stands, feet slightly apart, weight evenly distributed on both feet. With a sliding caliper, measure the breadth of the foot between the right metatarsus I and metatarsus V landmarks.

Foot Length: subject stands, feet slightly apart, weight evenly distributed on both feet. With a beam caliper parallel to the long axis of the foot, measure the length of the foot between the right posterior calcaneous landmark to the tip of the longest toe.

Gluteal Furrow Depth: subject stands erect, heels together, weight equally distributed on both feet. With the beam caliper, measure the horizontal depth of the thigh at the level of the gluteal furrow.

Gluteal Furrow Height: subject stands, heels together, weight equally distributed on both feet. With an anthropometer, measure the vertical distance from the standing surface to the gluteal furrow landmark.

Hand Breadth: subject stands, fingers together, thumb slightly abducted, fingers extended but not hyper-extended, dorsal surface up. With a beam caliper, measure the breadth of the hand between the metacarpale II and V landmarks.

Hand Circumference: subject stands, fingers together and extended but not hyper-extended, thumb slightly abducted, dorsal surface up. With a tape passing around the metacarpal II and metacarpal V landmarks, measure the circumference of the hand.

Hand Length: subject stands, fingers together, extended but not hyper-extended, volar surface up. With a beam caliper held parallel to the long axis of the hand, measure the length of the hand from the distal wrist crease to dactylion.

Head Breadth: subject sits, looking straight ahead. With a spreading caliper, measure the maximum horizontal breadth of the head above the level of the ears. Repeat with cap on using as little pressure as possible.

Head Circumference #1: subject sits, head in the Frankfort plane. With the tape passing over the head circumference landmark, measure the maximum circumference of the head. Repeat with cap on using as little pressure as possible.

Head Circumference #2: subject sits, head in the Frankfort plane. With the tape, measure the horizontal circumference of the head at the level of the head circumference landmark. Repeat with cap on using as little pressure as possible.

Head Length: subject sits, looking straight ahead. With the spreading caliper, measure the maximum head length between the glabella and the occiput. Repeat with cap on using as little pressure as possible.

Hip Breadth: subject stands erect, heels together. With a beam caliper, measure the horizontal distance across the greatest lateral protrusions of the hips.

Iliac Crest Height: subject stands erect, heels together, weight equally distributed on both feet, looking straight ahead. With an anthropometer, measure the vertical distance from the floor to the right iliocristale landmark.

Knee Breadth (Bone): subject sits with legs dangling. With a spreading caliper, measure the maximum breadth of the knee across the femoral epicondyles exerting sufficient pressure to compress the tissue. Measure both the right and left knees.

Knee Circumference: subject stands erect, legs slightly apart, weight evenly distributed on both feet. With a tape perpendicular to the long axis of the leg and passing over the middle of the patella, measure the circumference of the knee.

Mastoid Height: subject stands erect, heels together, weight equally distributed on both feet, head in the Frankfort plane. With an anthropometer, measure the vertical distance from the floor to the mastoid landmark.

Metacarpale III-Dactylion Length: subject extends hand but does not hyper-extend fingers. Dorsal hand surface is up. With a beam caliper parallel to the long axis of digit III, measure the distance from the metacarpale III landmark to dactylion.

Midforearm Breadth: subject stands, arms in the anatomical position. With a beam caliper perpendicular to the long axis of the forearm, measure the breadth of the arm at the midforearm landmark.

Midforearm Circumference: subject stands, arms held in the anatomical position. With a tape perpendicular to the long axis of the forearm and at the level of the midforearm landmark, measure the circumference of the forearm.

Midsagittal Chest Depth: subject stands erect, looking straight ahead, right arm raised to allow placement of instrument. With a body caliper, measure the horizontal depth of the torso in the midsagittal plane at the level of the bustpoint landmark.

Midthigh Circumference: subject stands erect, legs slightly apart, weight evenly distributed on both feet. With a tape perpendicular to the long axis of the leg and at the level of the midthigh landmark, measure the circumference of the thigh.

Midthigh Depth: subject stands erect, heels together, weight equally distributed on both feet. With a beam caliper, measure the horizontal depth of the thigh at the midthigh landmark.

Neck Breadth: subject stands erect, head in the Frankfort plane. With a beam caliper, measure the maximum horizontal breadth of the neck superior to the trapezius muscles.

Neck Circumference: subject sits, head in the Frankfort plane. With a tape in a plane perpendicular to the long axis of the neck and passing across the cricoid cartilage landmark, measure the circumference of the neck.

Omphalion Height: subject stands erect, heels together, weight equally distributed on both feet, looking straight ahead. With an anthropometer, measure the vertical distance from the floor to the omphalion.

Posterior Calf Skinfold: subject stands with right leg on chair, calf muscles relaxed. Pick up a skinfold on the posterior calf superior to the calf landmark and parallel to the long axis of the calf. Using a Lange skinfold caliper, measure the thickness of the fold at the calf landmark.

Radiale-Stylion Length: subject stands erect, looking straight ahead, arms in the anatomical position. With a beam caliper parallel to the long axis of the forearm, measure the distance between the radiale and stylion landmarks.

Sagittal Arc: subject sits, looking straight ahead. With a tape held as close to the scalp as possible, measure the surface distance in the midsagittal plane from the glabella landmark to nuchale. Repeat with cap on and use the lightest pressure possible.

Sitting Height: subject sits erect, head in the Frankfort plane, hands resting on thighs. With the anthropometer arm firmly touching the scalp, measure the vertical distance from the sitting surface to vertex.

Sphyrion Height: subject stands, feet slightly apart, weight distributed equally on both feet. With the special measuring block, measure the vertical distance from the standing surface to the sphyrion landmark.

Stature: subject stands erect, heels together, weight equally distributed on both feet, head in the Frankfort plane. With an anthropometer firmly touching the scalp, measure the vertical distance from the floor to the top of the head.

Subscapular Skinfold: subject stands relaxed. Pick up a skinfold just below the inferior margin of the right scapula and parallel to the tension lines of the skin. Using a Lange skinfold caliper, measure the thickness of the fold.

Supine Stature: subject lies supine on a table with heels together, feet firmly contacting adjacent wall. The head is oriented in a Frankfort plane relative to the wall surface. With a table graph and block, measure the horizontal distance from the wall to the top of the subject's head.

Suprailiac Skinfold: subject stands relaxed. Pick up a skinfold posterior to the iliocristale landmarks and parallel to the tension lines of the skin. Using a Lange skinfold caliper, measure the thickness of the fold at iliocristale.

Suprasternale Height: subject stands erect, heels together, weight equally distributed on both feet, head in the Frankfort plane. With an anthropometer, measure the vertical distance from the floor to the suprasternale landmark.

Symphysion Height: subject stands, heels together, weight equally distributed on both feet. With an anthropometer, measure the vertical distance from the standing surface to the symphysion landmark.

Tenth Rib Breadth: subject stands erect, heels together, looking straight ahead, weight equally distributed on both feet. With a beam caliper, measure the horizontal breadth of the torso at the level of the 10th rib landmark.

Tenth Rib Circumference: subject stands erect, breathing normally, looking straight ahead, heels together, weight distributed equally on both feet. The arms are abducted sufficiently to allow clearance of a tape between the arms and trunk. With a tape held in a horizontal plane, measure the circumference of the trunk at the level of the tenth rib landmark. The reading is made at the point of mid-tidal respiration.

Tenth Rib Height: subject stands erect, heels together, weight equally distributed on both feet, looking straight ahead. With an anthropometer, measure the vertical distance from the floor to the tenth rib midspine landmark.

Tibiale Height: subject stands, feet slightly apart, weight equally distributed on both feet. With an anthropometer, measure the vertical distance from the standing surface to the tibiale landmark.

Tragion Height: subject stands erect, heels together, weight equally distributed on both feet, head in the Frankfort plane. With an anthropometer, measure the vertical distance from the floor to the tragion landmark.

Triceps Skinfold: subject stands relaxed, arm held loosely at side. Pick up a skinfold on the arm superior to the triceps landmark and parallel to the long axis of the upper arm. Using a Lange Skinfold caliper, measure the thickness of the fold at the triceps landmark.

Trochanterion Height: subject stands, heels together, weight equally distributed on both feet. With an anthropometer, measure the vertical distance from the standing surface to the trochanterion landmark.

Upper Thigh Circumference: subject stands erect, legs slightly apart, weight evenly distributed on both feet. With a tape perpendicular to the long axis of the leg and passing just below the lowest point of the gluteal furrow, measure the circumference of the thigh. Where the furrow is deeply indented, the measurement is taken just distal to the furrow.

Waist Breadth: subject stands erect, heels together, looking straight ahead, weight equally distributed on both feet. With a beam caliper, measure the horizontal breadth of the body at the level of the omphalion.

Waist Circumference: subject stands erect, breathing normally, looking straight ahead, heels together, weight distributed equally on both feet. With a tape held in a horizontal plane, measure the circumference of the trunk at the level of the omphalion. The reading is made at the point of mid-tidal respiration. The subject must not pull in the stomach.

Weight: body weighed with scales read to the nearest one tenth kilogram.

Wrist Breadth (Bone): subject stands, with the right hand rotated 180 degrees from the anatomical position. With a beam caliper, measure the minimum breadth of the wrist superior to the most lateral and medial protrusions of the radial and ulnar styloid processes with sufficient pressure to compress the tissue over the bone.

Wrist Circumference: subject stands, arms held in the anatomical position. With a tape perpendicular to the long axis of the forearm, measure the minimum circumference of the wrist proximal to the radial and ulnar styloid processes.

Derived Measurements

In addition to the measured variables, a series of derived anthropometric variables were created for use in the regression analysis. These variables and the method of derivation are as follows:

Head Height	= Stature minus Mastoid Height
Neck Length	= Mastoid Height minus Cervicale Height
Torso Length	= Cervicale Height minus Gluteal Furrow Height

Thorax Length	= Cervicale Height minus Tenth Rib Height
Abdomen Length	= Tenth Rib Height minus Iliac Crest Height
Pelvis Length	= Iliac Crest Height minus Gluteal Furrow Height
Thigh Flap Length	= Anterior Superior Iliac Spine Height minus Gluteal Furrow Height
Thigh Length	= Trochanteric Height minus Tibiale Height
Calf Length	= Tibiale Height minus Sphyrion Height
Forearm and Hand Length	= Radiale-Stylion Length plus Hand Length

Summary Statistics

The summary statistics in the following table (A-1) lists, for each variable, the mean, standard deviation (STD DEV), a measure of symmetry in distribution (V-I), a measure of kurtosis in distribution (V-II), coefficient of variation (V), minimum dimensional value (MINIMUM), maximum dimensional value (MAX), and number of test subjects (N).* The weight values are expressed in kilograms and all dimensional values are expressed in centimeters.

* For a discussion of the methods used in computing these summary statistics, see Clauser et al. (1972), in particular Section IV, The Statistical Measures.

SUMMARY STATISTICS

NO.	VARIABLE NAME	MEAN	STD DEV	V-I	V-II	V	MINIMUM	MAX	N
1	AGE	31.2	7.3	.33	1.74	23.4%	21.0	45.0	46
2	HIGHEST KNOWN WT	69.7	17.6	2.66	12.99	25.2%	42.2	154.2	46
3	USUAL WEIGHT	62.1	12.8	1.53	6.05	20.6%	40.8	108.9	46
4	WEIGHT AT 18 YRS	55.6	11.3	2.95	16.91	20.4%	37.2	114.3	44
5	WEIGHT AT 23 YRS	57.8	9.4	1.09	5.64	16.2%	40.8	90.7	40
6	RECENT WT CHANGE	-.9	3.7	0.00	0.00	0.0%	-4.5	9.1	19
7	WEIGHT	63.9	12.5	.95	4.48	19.6%	41.3	105.0	46
8	SUPINE STATURE	163.4	6.1	-.38	2.71	3.7%	148.2	174.0	46
9	STATURE	161.2	6.0	-.47	2.97	3.7%	145.1	172.3	46
10	CERVICALE HEIGHT	138.7	5.6	-.35	2.80	4.0%	124.6	148.7	46
11	TRAGION HEIGHT	149.0	5.7	-.43	2.77	3.8%	134.8	159.8	46
12	MASTOID HEIGHT	145.6	5.7	-.44	2.71	3.9%	131.5	156.5	46
13	ACROMION HEIGHT	131.0	5.3	-.28	2.50	4.0%	118.7	140.4	46
14	SUPRASTERNALE HT	131.5	5.3	-.41	3.02	4.0%	118.3	142.5	46
15	BUSTPOINT HEIGHT	116.4	5.0	-.03	2.34	4.3%	105.6	127.5	46
16	TENTH RIB HEIGHT	102.5	4.4	-.36	2.42	4.3%	92.0	110.1	46
17	ILIAC CREST HT	97.6	4.9	-.23	3.14	5.0%	84.0	107.1	46
18	OMPHALION HEIGHT	95.9	4.4	-.49	3.07	4.5%	83.1	103.3	46
19	ASIS HEIGHT	89.7	4.5	-.28	2.74	5.0%	78.1	99.0	46
20	SYMPHYSION HT	81.2	4.3	-.26	3.32	5.3%	68.3	90.4	46
21	TROCHANTERION HT	83.4	4.3	-.08	3.35	5.1%	71.4	94.4	46
22	GLUTEAL FURROW HT	71.7	3.5	-.40	2.98	4.8%	62.2	77.9	46
23	TIBIALE HEIGHT	42.2	2.2	-.35	3.14	5.2%	35.8	46.5	46
24	FIBULARE HEIGHT	40.9	2.1	-.17	3.73	5.0%	34.8	45.5	46
25	SPHYRION HEIGHT	6.3	.4	-.09	2.76	6.1%	5.2	7.0	46
26	FOOT BREADTH	9.2	.6	-.13	3.92	6.2%	7.5	10.7	46
27	FOOT LENGTH	23.5	1.2	-.21	3.03	5.1%	20.3	26.2	46
28	ANKLE BREADTH	5.4	.4	-.41	2.92	7.9%	4.4	6.3	46
29	CALF DEPTH	10.8	.9	.60	6.27	8.7%	8.4	14.3	46
30	MIDTHIGH DEPTH	16.5	2.0	.97	4.51	12.4%	12.4	23.5	46
31	GLUT FURROW DPTH	18.9	2.0	.23	3.39	10.6%	14.1	24.6	46
32	BUTTOCK DEPTH	24.1	3.5	1.06	4.35	14.5%	18.1	35.7	46
33	ACROM-RAD LTH	29.7	1.7	-.32	3.14	5.6%	25.6	32.8	46
34	RAD-STYLION LTH	23.1	1.3	.05	2.64	5.5%	20.4	25.7	46
35	NECK BREADTH	10.5	.7	.74	3.39	6.7%	9.2	12.5	46
36	BIACROMIAL BRDTH	36.8	1.6	.16	2.54	4.4%	33.5	40.2	46
37	CHEST BREADTH	28.6	2.3	1.25	5.10	8.0%	25.2	36.8	46
38	BUSTPT-BUSTPT	18.0	1.7	-.17	3.83	9.5%	13.9	22.2	46
39	TENTH RIB BREADTH	25.7	3.0	.95	3.27	11.6%	21.0	33.3	46
40	WAIST BREADTH	31.1	4.1	.53	2.32	13.3%	24.5	40.6	46

SUMMARY STATISTICS

NO.	VARIABLE NAME	MEAN	STD DEV	V-I	V-II	V	MINIMUM	MAX	N
41	BICRISTAL BREADTH	27.9	1.9	.11	2.02	6.7%	24.6	31.9	46
42	BISPINOUS BREADTH	23.3	3.0	.77	4.14	12.7%	18.1	33.2	46
43	BITROCH BRDTH	31.6	2.0	.16	3.01	6.3%	27.1	36.8	46
44	HIP BREADTH	37.3	3.3	.42	2.46	9.0%	30.9	45.4	46
45	MIDSAG CHEST DPTH	17.8	1.7	.08	4.18	9.6%	13.5	23.0	46
46	AXILLARY ARM CIRC	30.2	3.7	.77	3.18	12.4%	24.8	40.1	46
47	BICEPS CR RLXD RT	27.8	3.7	.89	3.42	13.2%	22.5	38.6	46
48	BICEPS CR FLXD RT	28.8	3.6	1.05	3.97	12.6%	22.8	40.3	46
49	ELBOW CIRC	24.4	1.9	.38	3.11	7.9%	20.3	29.2	46
50	MIDFOREARM CIRC	21.2	2.3	.83	3.19	10.8%	17.7	27.0	46
51	WRIST CIRC	15.7	1.2	.75	3.61	7.4%	13.8	19.0	46
52	HAND CIRC	18.9	.9	-.67	2.88	4.9%	16.5	20.6	46
53	BICEPS CR RLXD LT	27.7	3.8	1.14	4.43	13.9%	22.0	40.9	46
54	BICEPS CR FLXD LT	28.6	3.8	1.32	5.10	13.4%	22.4	42.3	46
55	NECK CIRC	32.9	2.2	.97	3.56	6.7%	29.6	39.1	46
56	BUST CIRC	95.4	8.2	.97	4.22	8.5%	82.0	122.8	46
57	TENTH RIB CIRC	75.9	10.4	.95	3.40	13.7%	62.0	106.2	46
58	WAIST CIRC	86.7	13.2	.72	2.57	15.2%	68.7	118.8	46
59	BUTTOCK CIRC	100.1	9.7	.78	3.53	9.7%	83.5	130.2	46
60	AXILLARY ARM DEPTH	11.4	1.6	.43	3.07	13.9%	8.2	15.4	46
61	BICEPS DPTH RLXD	9.3	1.3	.76	3.31	13.7%	7.1	12.9	46
62	MIDFOREARM BRDTH	7.1	.8	.66	3.21	10.7%	5.7	9.2	46
63	WRIST BREADTH	4.7	.3	.22	5.14	7.1%	3.8	5.9	46
64	HAND BREADTH	7.8	.4	-.73	3.14	5.1%	6.7	8.5	46
65	META III-DACT LTH	9.0	.5	-.36	3.85	5.7%	7.6	10.2	46
66	HAND LENGTH	17.1	.8	-.28	3.33	4.9%	15.0	19.2	46
67	SITTING HEIGHT	86.2	3.5	-.13	2.46	4.0%	77.5	92.5	46
68	HEAD LENGTH	18.7	.6	-.17	2.24	3.4%	17.3	19.9	46
69	HEAD BREADTH	14.6	.4	.27	2.72	3.0%	13.7	15.7	46
70	BITRAGION BRDTH	13.2	.5	-.29	3.13	3.6%	11.8	14.3	46
71	ELBOW BRDTH RT	5.9	.4	.11	2.23	7.1%	5.1	6.9	46
72	KNEE BREADTH RT	8.8	.6	-.05	2.66	6.5%	7.5	10.0	46
73	KNEE BREADTH LT	8.8	.6	-.20	2.88	6.4%	7.4	10.0	46
74	ELBOW BREADTH LT	5.9	.4	-.10	1.89	6.3%	5.1	6.5	46
75	HEAD CIRC NO 1	54.8	1.2	-.33	2.33	2.2%	52.1	56.6	46
76	HEAD CIRC NO 2	54.6	1.5	.09	2.36	2.7%	51.3	57.2	46
77	SAGITTAL ARC	37.3	1.3	-.11	3.80	3.5%	33.5	40.7	46
78	BITRAG-CORON ARC	33.9	1.3	.13	2.87	3.9%	31.0	37.0	46
79	UPPER THIGH CIRC	59.4	5.6	.13	2.66	9.5%	46.5	73.5	46
80	MIDTHIGH CIRC	51.9	5.4	.65	3.72	10.4%	39.9	69.0	46

SUMMARY STATISTICS

NO.	VARIABLE NAME	MEAN	STD DEV	V-I	V-II	V	MINIMUM	MAX	N
81	KNEE CIRC	37.0	2.8	.12	2.88	7.7%	30.7	44.5	46
82	CALF CIRC,RT	35.4	3.2	.85	5.92	9.0%	28.2	47.4	46
83	ANKLE CIRC	21.4	1.4	-.14	2.84	6.5%	18.2	24.7	46
84	ARCH CIRC	23.2	1.1	-.59	3.65	4.8%	19.9	25.7	46
85	BALL OF FOOT CIRC	22.8	1.2	-.25	3.28	5.3%	19.4	25.5	46
86	CALF CIRC,LT	35.8	3.5	1.43	8.48	9.7%	28.2	50.6	46
87	SUBSCAPULAR SKFLD	1.5	.8	1.10	4.15	51.6%	.6	4.2	46
88	TRICEPS SKINFOLD	2.0	.7	.97	4.84	33.9%	.9	4.4	46
89	BICEPS SKINFOLD	1.2	.5	.81	3.45	46.0%	.3	2.8	46
90	SUPRAILIAC SKFLD	1.9	.8	.71	3.23	43.4%	.6	4.2	46
91	ANT THIGH SKFLD	3.1	1.0	.38	2.23	31.2%	1.4	5.2	45
92	POST CALF SKFLD	2.5	.8	.24	2.35	30.4%	1.2	4.1	45
93	HEAD LTH CAP	19.8	.8	.56	3.12	4.0%	16.4	22.0	46
94	HEAD BRDTH CAP	15.6	.5	.18	2.61	3.1%	14.6	16.6	46
95	HEAD CIRC 1 CAP	56.7	1.3	.15	2.58	2.3%	54.4	59.9	46
96	HEAD CIRC 2 CAP	56.5	1.5	.01	2.45	2.6%	53.2	59.8	46
97	SAGITTAL ARC CAP	39.2	1.4	.50	2.58	3.6%	37.0	42.5	46
98	BITRAG-COR ARC CAP	36.0	1.5	.22	3.51	4.2%	32.5	40.3	46

APPENDIX B

COMPARATIVE MEASUREMENT TECHNIQUES AND EXPERIMENTAL ACCURACY

Inherent in the nature of derived data and predictive methods are questions of confidence in the accuracy and comparability of the methods used. The experimental techniques used by Chandler et al. (1975) and McConville et al. (1980) in earlier stages of this research revealed distinct and sometimes predictable differences in values derived from biostereometric data and those obtained by direct measurement, especially with regard to volumes. In the interest of comparing measured values with derived values for body volume, inertial characteristics and linear dimensions, a number of validation tests were conducted in connection with this study. The direct measurements conducted for comparative purposes included (1) a water displacement technique for partial and total body (less head) volumes, (2) submerged water suspension weighing (hydrostatic weighing) to determine total body density, and (3) total body inertia by the torsional pendulum technique. In addition to these test measurements, duplicate anthropometric measurements and stereophotos were made to test the accuracy of each technique, and comparisons were made between values obtained from anthropometry and stereophotogrammetry.

To eliminate or reduce the effects of typical daily changes which occur in the body, a continuous, sequential test schedule for each subject involved in these additional tests was established. Certain measurements were completed within the same work day; others requiring more than one day were preceded by weighing before and after all tests. All subjects cooperated by restricting food intake or fasting and drinking known amounts of liquid throughout each test day. Total body weight was measured immediately before each procedure to determine any shift in weight from water input or output. Twelve subjects participated in these tests.

Equal-Volume Displacement Technique for Determining Segment Volumes

The CAMI laboratory equipment used in this procedure consisted of (1) a free-standing water tank with elevating platform and channeled overflow spillway. The tank had sufficient capacity to completely submerge an erect standing subject, (2) a run-off tank suspended by an integrated load cell to measure the displaced water weight, and (3) peripheral instrumentation with an X-Y plotter to record displaced water weight as a continuous function of the distance between the submerged platform (loaded with standing subject) and the tank water surface. The subject tank was first over-filled with warm water of approximate body temperature, then allowed to stabilize at the spillway level. Next, the subject platform was adjusted so as to be level with the water surface. The subject was positioned on the platform standing erect with feet slightly abducted, and slightly abducted arms extending downward. The subject was instructed to breathe normally throughout the procedure. Although variations in volume plots could be detected as coincident with the breathing cycles, significant changes in volumes were not demonstrated when the abdomen and thorax segments were submerged. The limits of instrumentation sensitivity could not detect small changes associated with typical, shallow breathing. A problem of subject buoyancy did occur with some subjects. When this occurred, the subject was instructed to abduct her arms fully to contact the tank walls and stabilize herself. The endpoint for maximum submersion was the cervicale landmark. After a brief pause at this level to stabilize the water level, the subject was asked to inhale for maximum chest expansion and hold her breath. This maneuver produced maximum volume displacement for the submerged portions of the body. Because of the slow rate of submersion and the necessity of brief stabilizing periods, total body submersion measurements were not attempted.

Total Body Density Technique

Total body density experiments for each of the subjects were conducted at the University of Oklahoma Human Performance Laboratory. Each subject was transported to the laboratory for testing within one hour following the stereophotographic procedures. She was weighed, tested for vital lung capacity and residual lung volume, and then positioned onto the submerged tank seat. A vertical seat adjustment was made to allow the entire head to be above the water surface in an erect sitting position. Prior to the test runs, the subject practiced lowering her head for complete submersion and forcibly exhaling to her maximum capacity. Multiple test runs of this procedure were conducted on each subject for averaging the underwater weight values. These tests provided information to determine total body density for calculating total body volume.

Comparative Volumetric Data

The stereophotometric analysis included calculations of the accumulative percentage of body volume as a function of distance from the floor as a percentage of total stature. Volume comparisons could be made between specific reference levels for the partially submerged subject and the derived stereometric values.

Body volume data presented in Tables B-1 and B-2 compare total body volume and partial body volumes, respectively. Results show that greater total body volumes are estimated by the stereophotometrics in all cases. Differences range from 7.76 to 12.35 percent with a mean value of 10.01 percent. Comparisons of partial body volumes, shown in Table B-2, are made at 10 percent intervals from the tenth to eightieth percent levels of composite (accumulative volume) stature. These comparisons also confirm the phenomenon of volume overestimation by the stereophotometric technique, as compared to results obtained by water immersion, and by about the same percentage. Not unexpectedly, the differential values of smaller composite segment volumes are erratic and inconsistent with those of larger accumulative volumes. The differences occurring with the smaller volume measurements, typically the feet

TABLE B-1

COMPARISON OF TOTAL BODY VOLUMES CALCULATED FROM MEASURED DENSITIES AND WEIGHTS AND ESTIMATED STEREOPHOTOMETRICALLY

Subject Number	Total Body Weight (kg)	(lbs)	Total Body Density	Calculated Volume (V=W/D)	Stereo-photo-metric	Δ%
27	42.5	93.5	1.030	41,262	45,791	9.89
15	45.6	100.3	1.051	43,387	49,502	12.35
42	50.6	111.3	1.051	48,145	54,572	11.78
7*	53.3	117.3	1.048	50,859	57,160	11.02
22*	54.8	120.6	1.030	53,204	59,068	9.93
30	60.9	134.0	1.030	59,126	65,980	10.39
21	61.4	135.1	1.016	60.433	66,652	9.33
8	62.1	136.6	1.044	59,482	65,089	8.61
12	65.1	143.2	1.029	63,265	71,674	11.73
31*	67.8	149.2	1,023	66,276	72,105	8.08
11*	70.6	155.3	1.034	68,279	75,188	9.19
14	86.5	190.3	1.008	85,813	93,032	7.76

* Experimental control subjects

TABLE B-2

COMPARISONS OF PARTIAL SEGMENT VOLUMES DERIVED FROM PHOTOMETRIC ANALYSES AND MEASURED BY A DIRECT WATER VOLUME DISPLACEMENT TECHNIQUE

Percent difference (±) of derived photometric volumes from measured volumes at comparative percent intervals of total stature from the floor. Positive values indicate greater photometric values.

Subject Number	Total Body Weight (kg)	(lbs)	10%	20%	30%	40%	50%	60%	70%	80%	|X̄|	SD
33	42.5	93.5	+24	+22	+17	+15	+ 8	+10			16.00	6.36
17	45.6	100.3	−15	+ 4	+ 1	+ 7	+ 7	+ 7	+ 9	+10	7.50	4.14
50	50.6	111.3	+ 6	+ 9	+ 9	+12	+10	+12	+11	+13	10.25	2.25
14	53.3	117.3	+27	+16	+15	+11	+11	+11	+11	+12	14.25	5.52
29	54.8	120.6	+ 8	+10	+12	+10	+11	+ 9	+ 9	+10	9.88	1.25
55	60.9	134.0	+18	+ 6	+ 8	+ 7	+ 7	+ 9	+ 8	+10	9.13	3.80
25	61.4	135.1	+ 9	+ 8	+12	+ 6	+ 8	+10	+10	+ 9	9.00	1.77
8	62.1	136.6	+14	+11	+14	+12	+10	+ 9	+11	+12	11.63	1.77
12	65.1	143.2	− 6	0	+ 5	+ 7	+ 4	+ 7	+ 5	+ 6	5.00	2.27
37	67.8	149.2	+ 5	+11	+11	+10	+ 9	+ 7	+ 8	+ 8	8.63	2.07
18	70.6	155.3	+14	+ 8	+ 7	+ 4	+ 5				7.60	3.91
16	86.5	190.3	+ 9	+ 4	+ 7	+ 4	+ 6	+ 8	+ 8	+ 7	6.63	1.85
		|X̄|	12.92	9.08	9.83	8.75	8.00	9.00	9.00	9.70		
		SD	7.18	5.79	4.55	3.44	2.30	1.67	1.89	2.26		

and adjacent leg areas, may be attributed to the limited capability of the experimental techniques for discriminating small volumes. Relative consistency of accumulative volume values, for most subjects, usually occurs above the knee level of total stature. At this level (approximately 20% level) and above, the mean differences at each accumulative volume level for all subjects ranged from 8.00 to 9.83 percent. The absolute mean differential values for each subject at all volume levels ranges from 5.00 to 16.00 percent with a composite mean value of 9.55 percent.

It is apparent within the limitations of the small sample presented here, that a consistent trend of a nine to 10 percent overestimation of volume by stereophotometrics seems to occur with consistency. Ascertaining why this should occur is beyond the scope of this study.

Comparative Total Body Inertia

Tests were conducted to determine total body moment of inertia about an X axis of a fully extended body position. Inertial measurements were limited to the X axis because of the difficulty of accommodating other positions for reasonable experimental controls. The position tested is defined as the supine anatomical position with bilateral abduction of extended arms and legs. This position approximates that assumed by the subject for stereophotography. All tests were conducted in the CAMI laboratories utilizing a torsion pendulum (Space Electronics, Inc., Model XR-250) with a removable subject platform and peripheral electronic counter to measure oscillation periods. The rigid, lightweight platform was fitted with a centered mounting post for a balanced horizontal attachment to the pendulum. An electric hoist, vertically aligned above the platform and pendulum centers, was used to lift the platform and subject for individual and composite balancing. The platform, disconnected from the pendulum, was first raised by the hoist to clear the pendulum mounting post then lowered a small distance onto support blocks at both ends for subject mounting and alignment. The subject was guided to a supine position on the platform so that her approximate center of gravity was near to that of the platform. The loaded platform was then raised a small distance from the support blocks and stabilized to visually check the vertical alignment of the platform pivot post and the pendulum post receptacle. This procedure was repeated, if necessary, to shift the subject's position for proper alignment of the post and receptacle. The balanced platform was then lowered onto the pendulum and locked. The hoist cables were removed and the platform set in motion to check the range of motion. At least six complete test runs were made for each subject to obtain values for averaging. A test was considered complete after any three sequential counts of oscillation periods did not vary more than 0.1 percent. If the timer did not indicate three valid sequential counts within 10 or more oscillation periods, the platform was stopped and restarted for another test run. Altogether, a total of 25 subjects were tested.

In 15 of the 25 comparisons, the stereophotometrically estimated principal moment exceeded the measured X moment by percentages $\left(\frac{\Delta I_{xx}}{MI_{xx}}\right)$ ranging from a low of 0.07 percent to a high of 5.74 percent (subject #36) (Table B-3). In the 10 cases where the estimated principal moments underestimated the measured X moments, the underestimates ranged from a low of 0.23 percent to a high of 5.74 percent (subject #14). The mean percent, while positive, approached zero (0.153 percent) with a standard deviation of 3.10 percent. It must be noted that in the experimental determination of the total body moment of inertia, any error in the location of the center of gravity will result in an overestimation of the measured moment as:

$$I_{XX} \text{ (observed)} = I_{xx} \text{ (absolute)} + d^2M$$

where d is the distance of the measured from the true center of gravity and M is the total body mass.

A reinterpretation of the observed correspondence in the (measured vs. estimated) moments given the positive error in measured moments would mean that the error associated with the term (d^2M) is, on the average, equal to the overestimation of moments due to the observed $\sim$10 percent overestimation of volume. An alternative interpretation would be that the error term in the measured moments is negligible and the estimating of the moments from volume, using a segment density of 1 gm cm^3 (an underestimation of segment density), in essence, reduces the effects on the computed moments of the overestimation of volume.

Comparative Anthropometry

The complete set of anthropometric measurements was taken twice on each of four subjects in order to determine the accuracy of these measurements. The second set of measurements was taken within one or two days of the first. For each of the dimensions on a given subject, the second measurement was subtracted from the first. The results indicate that for each subject the differences were reasonably small, with a mean Δ value of 1.07 percent. This translates to an average difference of 4.32 mm and a standard deviation of 4.91 mm. The differences ranged from zero to 30 percent, with the largest percentage differences appearing in the skinfolds (e.g. 30 percent value for anterior thigh skinfold = 9 mm).

TABLE B-3

COMPARISON OF MEASURED X MOMENTS AND STEREOMETRICALLY ESTIMATED PRINCIPAL X MOMENTS OF INERTIA FOR THE TOTAL BODY

Subject Number	Weight (kg)	Stature (cm)	Measured I_{xx} (gm cm^2 x 10^2)	Estimated I_{xx} (gm cm^2 x 10^2)	Δ	Δ%
27	42.5	147.7	507,920	530,262	22,342	4.40
15	45.6	152.6	604,490	592,233	-12,257	-2.03
33	50.2	163.6	808,650	802,856	- 5,794	-0.72
36	50.5	156.3	717,530	758,710	41,180	5.74
42	50.6	161.9	779,850	792,078	12,228	1.57
7*	53.3	159.6	802,278	806,486	4,208	0.52
22*	54.8	160.2	770,980	789,816	18,836	2.44
38	58.0	160.3	846,450	850,074	3,624	0.43
37	59.0	162.5	893,430	907,637	14,207	1.59
13	59.1	158.3	804,850	824,715	19,865	2.47
28	59.2	157.3	819,800	835,072	15,272	1.86
23	60.2	160.7	867,790	860,723	- 7,067	-0.81
30	60.9	152.3	835,820	800,620	-35,200	-4.21
21	61.4	161.5	875,090	912,771	37,681	4.31
8	62.1	166.5	990,130	941,083	-49,047	-4.95
32	62.5	165.8	969,870	966,309	- 3,561	-0.37
39	63.4	166.4	947,960	945,792	- 2,168	-0.23
12	65.1	165.6	1,021,400	1,027,251	5,851	0.57
40	65.8	169.1	1,002,680	1,043,791	41,111	4.10
31*	67.8	157.2	896,670	904,959	8,289	0.92
11*	70.6	172.3	1,152,680	1,153,494	814	0.07
44	76.9	164.3	1,060,240	1,068,075	- 7,835	-0.74
46	78.6	156.8	1,029,900	994,433	-35,467	-3.44
14	86.5	169.5	1,387,000	1,307,312	-79,688	-5.74
45	94.9	162.0	1,286,790	1,217,320	-69,470	-5.40

* Experimental control subjects

Comparative Stereophotogrammetry

To determine the accuracy of the stereophoto techniques, three sequential sets of data photographs were produced for comparison with each other. In addition, a duplicate analysis of a fourth photographic set was made. Table B-4 compares the differences in stature, total body volume, and total body inertia for four subjects, each photographed three times. Percentage difference values* vary from 0.02 to 0.13 percent for stature, 0.24 to 1.69 percent for total body volume, and 1.24 to 3.04 percent for total body inertia. To further test the validity of the photometric technique, Table B-5 compares the results of the duplicate analysis from the film sets of the four control subjects. This table first compares the dimensional differences, expressed as percentages, in the three separate, original stereophotometric analyses, then compares the difference between a duplicate dimensional analysis of a single photographic set. Differences remain inconsequential.

Comparison of Anthropometric Values with Stereophoto Values

A comparison of stereometrically obtained linear body dimensions with those measured by manual anthropometric techniques was made on the 31 variables that were determined to be comparable for the entire study sample. This comparison was an effort to identify a possible cause in the phenomenon of volume overestimation by stereometric techniques. The approach was to treat results of the two experimental techniques as matched samples and compare the differences. The summary data for the sample are listed in Table B-6 as the (1) mean differences, (2) standard deviation of the differences, (3) a percentage comparison of the two mean values (stereophotometrics as a percent of anthropometrics), and (4) a significance statistic (P value). The P value statistic is included to indicate the significance of the mean value shift. Since the anthropometric landmarks were used to position the targets and offsets for stereophotography, there should be no differences between the two measures because of individual interpretation of landmarks. The differences between the means, using standard scores

$$Z = \frac{\overline{X}\ \Delta}{\text{Anthropometric SD}}$$

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* Percentage difference was calculated as the range (maximum minus minimum) of observed values divided by the mean value x 100.

TABLE B-4

VARIATIONS IN STATURE, TOTAL BODY VOLUME, AND TOTAL BODY INERTIA (I_{xx}) VALUES OF CONTROL SUBJECTS DERIVED FROM SEQUENTIALLY DUPLICATED SETS OF STEREOPHOTOGRAPHS

Control Subject Number	Photo Series Number	Stature (cm)	Total Body Volume (cc)	Total Body Inertia (I_{xx}) (gm cm^2)
7	1	161.00	57,160	80,648,643
	2	160.88	57,745	81,598,993
	3	160.97	58,144	82,856,809
	$\overline{X}$	160.95	57,683	81,701,482
	SD	0.06	495	1,107,646
	%	0.07	1.69	2.67
22	1	161.02	59,068	78,981,585
	2	161.01	58,749	78,529,441
	3	160.99	58,422	77,426,348
	$\overline{X}$	161.01	58,746	78,312,458
	SD	0.01	323	800,003
	%	0.02	1.09	1.97
31	1	158.88	72,105	90,495,880
	2	158.94	73,164	93,328,675
	3	159.08	73,213	92,911,047
	$\overline{X}$	158.97	72,827	92,245,201
	SD	0.10	626	1,529,279
	%	0.13	1.51	3.04
11	1	172.95	75,009	115,349,366
	2	172.92	75,188	113,923,889
	3	172.94	75,147	114,433,677
	$\overline{X}$	172.94	75,115	114,568,977
	SD	0.01	94	722,312
	%	0.02	0.24	1.24

TABLE B-5

COMPARISONS OF VARIABILITY IN DERIVED DATA TECHNIQUES FROM DUPLICATE ANALYSES OF SINGLE STEREOPHOTOGRAPHIC SETS AND SINGLE ANALYSES OF SEQUENTIAL SERIES OF STEREOPHOTOGRAPHIC SETS WITH CONTROL SUBJECTS

Stereophotometric Data Type and Analysis Procedure	Percent variation of total range in derived values of single and duplicate analyses			
	Subject 7	Subject 22	Subject 31	Subject 11
STATURE				
1. Single analyses of sequential photo sets	0.07	0.02	0.13	0.02
2. Duplicate analysis of single photo set	0.08	0.01	0.09	0.04
TOTAL BODY VOLUME				
1. Single analyses of sequential photo sets	1.69	0.24	1.09	1.51
2. Duplicate analysis of single photo set	2.12	1.84	0.65	1.73
TOTAL BODY INERTIA				
1. Single analyses of sequential photo sets	2.67	1.24	1.97	3.04
2. Duplicate analysis of single photo set	2.58	2.64	0.16	2.23

TABLE B-6

A COMPARISON OF ANTHROPOMETRIC AND STEREOPHOTO VALUES

Variable	Anthro	Photo	$\overline{X}\Delta$	SD Δ	Max Pos. Δ	Max Neg. Δ	Δ Range	Percentage Comparison of Means	Two-Sided P Value $\leq$
Bitragion	131.6	136.6	5.0	3.0	12.4	-4.9	17.3	104.00	.001
Stature-Cerv	225.6	230.8	5.2	8.9	22.8	-20.2	45.0	102.00	.002
Rad-Styloid	230.7	236.1	5.4	4.0	12.4	-4.2	16.6	102.00	.001
Axillary-Arm D	113.8	120.1	6.3	5.9	25.8	-2.7	28.5	106.00	.001
Abdomen Lgth	49.4	54.1	4.7	4.5	15.2	-3.9	19.1	109.00	.001
Symph Ht-Iliac Ht	164.1	167.7	3.7	7.1	26.0	-9.3	35.3	102.00	.002
Fibulare Ht	408.9	413.1	4.2	2.4	8.7	-1.4	10.1	101.00	.001
Acromion Ht	1310.1	1320.3	10.2	10.3	40.1	-8.3	48.4	100.70	.001
Bispinous Br	232.5	237.7	5.2	3.5	12.6	-3.0	15.6	102.00	.001
Bustpoint Br	180.2	183.0	2.9	2.4	10.2	-1.8	12.0	102.00	.001
Tibiale-Sphyrion	359.5	361.8	2.4	3.9	11.1	-5.3	16.4	100.60	.001
Stature	1612.4	1618.2	5.9	9.8	38.9	-11.2	50.1	100.30	.001
Iliac Ht-ASIS Ht	78.6	79.8	1.2	5.3	14.1	-9.7	23.8	102.00	.126*
10th Rib Ht	1025.1	1028.0	2.9	4.2	13.6	-4.6	18.2	100.20	.001
Acromion-Rad	297.4	298.4	1.0	5.37	15.9	-12.1	28.6	100.30	.208*
Tibiale Ht	422.1	422.6	0.5	3.8	12.0	-7.7	19.7	100.10	.352*
Troch-Sphyrion	771.0	771.8	0.9	6.0	9.0	-23.9	32.9	100.10	.308*
Suprasternale Ht	1315.2	1316.0	0.8	7.2	16.67	-12.6	29.2	100.06	.453*
Cervicale Ht	1386.7	1387.4	0.7	5.5	22.5	-11.3	33.8	100.05	.327*
Bustpoint Ht	1164.2	1164.6	0.4	12.9	30.4	-27.5	57.9	100.03	.834*
Foot Breadth	92.2	92.2	0.04	2.4	3.9	-5.5	9.4	100.00	.912*
Trochanterion	833.5	832.6	-0.94	5.8	7.4	-26.8	34.2	99.80	.276*
Iliac Crest Ht	975.7	973.9	-1.9	5.0	6.0	-19.4	25.4	99.80	.010
Tragion Ht	1489.6	1486.0	-3.6	8.4	21.1	-23.5	44.6	99.75	.004
ASIS Ht	897.1	894.1	-3.0	5.4	6.8	-14.7	21.5	99.66	.002
Cerv-10th Rib	361.6	359.5	-2.2	4.0	8.9	-8.9	17.8	99.40	.002
Symphysion Ht	811.6	806.2	-5.4	8.2	6.6	-34.5	41.1	99.30	.001
Gluteal Fold Ht	717.5	712.7	-4.9	4.8	7.5	-20.5	28.0	99.30	.001
Hand Breadth	77.6	77.0	-0.6	1.9	4.4	-3.5	7.9	99.20	.036
Troch-Fibulare	424.6	419.5	-5.1	5.2	2.5	-30.6	33.1	98.80	.001
Sphyrion Ht	62.6	60.8	-1.84	2.5	4.3	-7.9	12.2	97.10	.001

* Insignificant at $P \leq .05$

Values are expressed in millimeters

to place the stereophotometric measures within the anthropometry distribution, are illustrated in Table B-7. For example, the variable of bitragion breadth shows a five millimeter mean difference between techniques. This value, divided by the standard deviation for the anthropometry (4.79), results in another value (1.04) that represents the number of standard deviations that the stereophotometric mean has shifted away from the anthropometric mean value. Translating this value into percentile points, the stereophotometric mean would rank at the 84th percentile level of the anthropometry distribution (Table B-7). • Two thirds of the stereophoto measurements are larger than the traditional anthropometric values. Since only a relatively small number of dimensions were comparable, it is unclear if this represents a consistent trend. Several explanations can be made for the differences observed between the two techniques. Changes in body posture, stages of the respiratory cycle, and the amount of pressure applied to the soft tissue with the measuring instrument are all possible causes of measurement discrepancies. It should be stressed that differences in these values reflect a difference in techniques and are not thought to reflect errors in either method.

TABLE B-7

RELATIVE NUMBER OF STANDARD DEVIATIONS THAT PHOTOMETRIC MEAN VALUES HAVE SHIFTED AWAY FROM ANTHROPOMETRIC MEAN VALUES (Listed anthropometric percentiles indicate the level at which each photometric mean occurs after shift)

Body Measurement	Relative Photo $\bar{X}$ SD Shift	Anthropometric Percentiles of Photometric $\bar{X}$
Bitragion Breadth	1.04	84.0
Vertex-Cervicale Distance	0.45	67.0
Radiale-Stylion Length	0.43	67.0
Axillary Arm Depth	0.39	65.0
Iliac Crest-10th Rib Distance	0.26	60.0
Iliac Crest-Symphysion Distance	0.22	59.0
Fibulare Height	0.20	58.0
Acromion Height	0.19	57.0
Bispinous Breadth	0.17	57.0
Bustpoint-to-Bustpoint	0.16	56.0
Tibiale-Sphyrion Distance	0.12	55.0
Stature	0.10	54.0
Iliac Crest-Anterior Superior Iliac Spine Distance	0.08	53.0
10th Rib Height	0.06	52.0
Acromion-Radiale Length	0.06	52.0
Tibiale Height	0.02	50.8
Trochanterion-Sphyrion Distance	0.02	50.8
Suprasternale Height	0.02	50.8
Cervicale Height	0.01	50.4
Bustpoint Height	0.01	50.4
Foot Breadth	0.01	50.4
Trochanterion Height	-0.02	49.8
Iliac Crest Height	-0.03	49.0
Tragion Height	-0.06	48.0
Anterior Superior Iliac Spine Height	-0.07	47.0
Cervicale-10th Rib Distance	-0.10	46.0
Symphysion Height	-0.12	45.0
Gluteal Fold Height	-0.13	45.0
Hand Breadth	-0.16	44.0
Trochanterion-Fibulare Distance	-0.19	42.0
Sphyrion Height	-0.47	32.0

Positive values indicate photometric overestimations.
Negative values indicate photometric underestimations.

*U.S. GOVERNMENT PRINTING OFFICE : 1984 O-421-428/323