SOMATOTYPING BY PHYSICAL ANTHROPOMETRY

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TWO FIGURES

In 1940 Sheldon, Stevens and Tucker introduced their method of somatotyping by inspection of standard photographs. Their work has provided an immense stimulus to anthropologists. While fully recognizing the great value of this contribution there are certain practical difficulties which have hindered the more general adoption of their method. Among these difficulties are the following:

1. Standards of somatotype dominance are subjectively determined. This means that where the metric method is used and the labor of taking 17 photographic measurements, calculating the corresponding ratio indices and looking up the most fitting somatotype in tables has been correctly completed, the result may still be wrong if the original choice of dominance was incorrect. It is believed that the long metric method of typing recommended in "Varieties of Human Physique" by Sheldon and his colleagues has largely fallen into disuse and this is no doubt partly due to the great deal

[1] I am most grateful to my personal assistants, to Mrs. C. C. Standley who measured most of the photographs and carried out the photometric typing according to my photoscopic estimates, and to Mrs. S. C. McIntosh for statistical help especially in compiling the deviation tables. Dr. J. M. Tanner introduced me to somatotyping and himself measured and photographed many of the Oxford undergraduates. Dr. R. H. Bolton, Senior University Medical Officer, kindly granted me permission to carry out the anthropometric survey of first year students at Birmingham in the course of their routine overhaul. The first part of the work was undertaken while I was Student Health Physician at the Institute of Social Medicine, Oxford, the latter part while in receipt of a further grant from the Nuffield Foundation to undertake research in the constitutional aspects of psychiatric medicine at the Warneford Hospital, Oxford.

of labor involved, amounting in my experience to not less than one hour's work for each subject. If this is so then an important prop of objectivity has been removed and there remains insufficient guarantee against shifting standards of rating. In due course a more complete reference book of somatotype photographs may become available for general use. This will help, but agreement as to a given somatotype will still depend on personal interpretation of visual impressions, not upon measurement. If somatotypers agree it will mean that they have learnt to sing in harmony, but their song does not thereby become a science, it remains an art. Sheldon, Hartl and McDermott ('51) emphasize the skill required in anthroposcopic somatotyping and say "somatotyping cannot begin and end with millimeters." It is agreed that the photographic record provides information in more assimilable form than any large number of bare measurements, therefore somatotyping cannot end with millimeters, but it may reasonably begin with measurement and it is hoped to show here that physical anthropometry can provide a useful degree of scientific objectivity as a preliminary guide to somatotypists, though inspection of the photograph may lead to some slight subsequent revision of this preliminary estimate.

2. The second difficulty is that objection to being photographed in the nude may render the somatotyped sample unrepresentative of a population chosen for study. This applies more particularly in somatotyping women.

3. A third difficulty not infrequently encountered is to find accommodation for the 10 meter camera-subject distance recommended by Tanner and Weiner together with the cost of photographic equipment, development and standard enlargement of photographs.

The purpose of this paper is to describe a short physical anthropometric method, which can be used during clinical interview for the following purposes:

(a) To provide objective guidance as to dominance of somatotype in healthy persons.

(b) To estimate the Sheldonian somatotype objectively and as accurately at least as the agreement achieved between experts at photoscopic somatotyping.

(c) To make an estimate of women's somatotype possible although in the absence of a published reference file of photographs this estimate cannot yet be checked by photoscopic standards.

(d) To reduce the cost, labor, delay and other handicaps inherent in photometric methods.

DEVIATION CHART PROFILE OF PHYSIQUE

The method of estimating dominance depends primarily on what will be described as the Standard Deviation Chart. On this chart (see table 1) standard scales are shown for height, weight, height/$\sqrt[3]{\text{weight}}$ (hereinafter referred to as the ponderal index), for two bone sizes, the bicondylar measurements of humerus and femur, for two muscle girths, namely that over the tensed biceps with fully flexed elbow and the calf girth standing, and lastly for three skinfold measurements of subcutaneous fat and the total of these three fat measurements. A discriminant function scale of androgyny as described by Tanner ('51) is also included but this is of secondary importance for estimating somatotype. Subsidiary scales are used also for biacromial measurement, bi-iliac, chest width and chest depth, but these too are of secondary importance for the main purpose, though they serve at times to provide useful supplementary evidence.

The scales were each plotted around the mean value, with one column unit equivalent to one-half standard deviation, giving a 13-point scale over all.[2] The necessary measurements occupy about 5 minutes in the taking and by ringing the appropriate measurement for a given person on the deviation

[2] These are "extensive" scales which differ in certain respects from the "equal appearing interval" scales used in somatotyping. See "Varieties of Human Physique," p. 115. Note that the scales are extended in the minus direction beyond the "— 3" line; this is to cover the range of female values, and the female means are shown in boxes.

TABLE 1

Deviation chart of physique

Name ______________________ Age ______ Ref. no. ______________

Somatotype ______________

STANDARD SCALE	−5	−4½	−4	−3½	−3	−2½	−2	−1½	−1	−½	MEAN	+½	+1	+1½	+2	+2½	+3
Height (ins.)	57.5	58.8	60.1	61.4	62.6	63.8	65.0	66.3	67.5	68.8	70	71.2	72.4	73.6	74.9	76.1	77.3
Weight (lbs.)	60	69	78	87	96	105	114	123	132	141	150	158	167	176	185	193	202
H.W. Ratio	10.5	10.75	11.0	11.3	11.6	11.8	12.1	12.4	12.6	12.9	13.2	13.5	13.7	14.0	14.3	14.5	14.8
Bone: Humerus	5.0	5.2	5.4	5.56	5.74	5.9	6.1	6.3	6.4	6.6	6.8	7.0	7.1	7.3	7.5	7.7	7.8
(cm) Femur	7.7	7.9	8.1	8.3	8.5	8.7	8.9	9.1	9.3	9.5	9.7	9.9	10.1	10.3	10.5	10.7	10.9
Muscle: Biceps	19.8	20.9	22.0	23.2	24.3	25.4	26.5	27.6	28.7	29.9	31.0	32.1	33.2	34.3	35.4	36.5	37.6
(cm) Calf	26.2	27.2	28.2	29.2	30.2	31.2	32.3	33.3	34.3	35.3	36.3	37.3	38.3	39.4	40.4	41.4	42.4
Fat: Subcut. subscapular					5.0	6.0	7.0	8.5	10.5	12.5	15.0	18.0	21.5	26.0	31.0	38.0	+
(mm) Subcut. suprailiac					3.0	4.0	5.0	6.5	8.0	10.0	12.0	15.0	19.0	23.0	28.0	35.0	+
Subcut. over triceps					3.5	4.5	5.0	6.0	7.5	9.0	10.5	12.5	15.0	18.0	21.0	25.0	30.0
Total of 3 subcut. (T.F.)					12	14	17	20	24	29	35	42	50	60	72	87	104
Androgyny: 3 Biac — Bi-iliac	66.4	68.8	71.2	73.5	75.9	78.3	80.6	83.0	85.4	87.8	90.1	92.5	94.8	97.2	99.6	102.0	104.3
Biacromial (cm)	30.7	31.6	32.4	33.3	34.2	35.1	36.0	36.9	37.7	38.6	39.5	40.4	41.3	42.2	43.0	43.9	44.8
Bi-iliac (cm)				23.0	23.8	24.6	25.4	26.2	27.0	27.8	28.6	29.4	30.2	31.0	31.8	32.6	33.4
Chest width (cm)		20.3	21.2	22.0	22.9	23.8	24.7	25.6	26.4	27.3	28.5	29.0	29.8	30.7	31.5	32.4	33.3
Chest depth (cm)			13.9	14.7	15.6	16.3	17.1	18.0	18.9	19.7	20.6	21.5	22.3	23.2	24.0	24.8	25.6
H.W. Ratio					12.2	12.3	12.5	12.7	12.9	13.1	13.2	13.4	13.6	13.8	14.0	14.2	14.4
					or less	12.4	12.6	12.8	13.0		13.3	13.5	13.7	13.9	14.1	14.3	+
Provisional estimate Ectomorphy at ages 16–20 yrs.					1	1½	2	2½	3	3½	3½ or 4	4½	5	5½	6	6½	7
• Provisional estimate Endomorphy from T.F. column above					1.0	1.5	2.3	3.0	3.2	3.5	3.8	4.1	4.75	5.4	6.1	6.5	7.0
Column code	8	8½	9	9½	1	1½	2	2½	3	3½	4	4½	5	5½	6	6½	7

chart, a profile is outlined which reveals the main physical characteristics at a glance. The profile may be read on sight and an opinion formed as to somatotype dominance. Armed with this and Sheldon's somatotype table for each ponderal index, a fairly accurate estimate of somatotype may be obtained, and there is the distinct advantage that the chart may be employed to provide an estimate of somatotype during the clinical interview.

For subsequent more exact quantification or to guide beginners in interpretation of the profile, a set of tables is supplied in the appendix which give estimates of the direction of endomorphic-mesomorphic dominance corresponding to each bone and girth measurement, for each height and ponderal index. These tables were derived from the measurements of 405 undergraduates at Oxford, 1948 to 1951, and 508 first year students at Birmingham, 1952. When constructing the tables, age limits were set from 17 to 24 years inclusive. The Oxford series had been somatotyped using Sheldon's long photometric method; in addition 283 had also been independently typed photoscopically (78 of them by Dr. C. W. Dupertuis) as reported elsewhere by Tanner ('52).

VALIDITY OF RESULTS

Deviation table typing compared with the photometric method

Estimates of somatotype obtained by physical anthropometry have been compared with results obtained using Sheldon's long photometric method. For this comparison only men aged 16–20 have been included according to the limits within which Sheldon's tables were standardized. There were 154 men of that age and table 2 summarizes the differences. A plus sign implies that deviation table ratings were higher.

It will be seen that in 90.0% of cases ratings were correct to half a unit. This compares well with the agreement between experts using the photoscopic method (Tanner, '52).

That the agreement is not actually closer could be due in part to incorrect photometric typing, since the essential preliminary photoscopic estimates of dominance might have been wrong.

TABLE 2

Amounts by which deviation table estimates of 154 Oxford men differed from ratings based on Sheldon's photometric tables

DIFFERENCES	− 1½	− 1	− ½	0	+ ½	+ 1	MEAN DIFFERENCE
Endomorphy	1	11	58	57	23	4	— 0.169
Mesomorphy	1	17	40	59	32	5	— 0.075
Ectomorphy	0	2	27	81	39	5	+ 0.058
Total no. ratings	2	30	125	197	94	14	462
Total per cent	0.4	6.5	27.1	42.6	20.3	3.0	99.9

TABLE 3

Differences between deviation table estimates and photoscopic ratings in 282 Oxford men

DIFFERENCES	− 1½	− 1	− ½	0	+ ½	+ 1	+ 1½	MEAN DIFFERENCE
Endomorphy	1	25	82	97	64	12	1	— 0.08
Mesomorphy	0	7	44	95	98	32	6	+ 0.22
Ectomorphy	0	10	55	146	57	13	1	+ 0.02
Total no. ratings	1	42	181	338	219	57	8	846
Total per cent	0.1	4.9	21.4	40.0	25.9	6.7	1.0	100.0

Deviation table typing compared with anthroposcopy

Deviation table estimates have also been compared with photoscopic ratings (see table 3). The subjects for this comparison numbered 282 from the series of Oxford undergraduates reported by Tanner ('52).

It will be seen that in 87.3% of cases the ratings were correct to half a unit. There was a tendency, however, in the photoscopic method to rate mesomorphy lower by roughly one-fifth of a unit.

DETAILS OF THE METHOD

Construction of the standard scales on the deviation chart was straightforward where the frequency distribution was sufficiently natural or Gaussian in shape. This was generally so, but there were two exceptions. The ponderal index distribution showed some skewness. Though this ratio correlates very closely with ectomorphy the standard scale does not correspond precisely with Sheldon's scale of ectomorphy and in order to make a provisional estimate of ectomorphy from the ponderal index corresponding values are included in the lowest section of the deviation chart. The values are derived from table 23 in "Varieties of Human Physique" and a provisional estimate may be expected in young men aged 16 to 20 to be within plus or minus half a point of the true value, with only rare exceptions where the provisional estimate may be as much as one unit out. The skinfold measurements of subcutaneous fat also showed a skewed distribution. To relieve the skewness fat measurements were converted to logarithmic scales and the same thing was done with the total of the three fat measurements. Once the scale had been constructed, however, the appropriate number could be ringed as for the other individual measurements and no reference to logarithmic tables is necessary when using the deviation chart.

Method of taking the measurements

Height was recorded in inches. The subject stands back to a wall scale, takes a deep breath and stretches up to maximal height, his heels remaining in contact with the ground.

Weight is recorded to the nearest pound, for the Oxford series this was without clothes, for the Birmingham series a pair of pants and socks were permitted, weight approximately 8 oz.

Bone measurements (in centimeters). The distance between median and lateral epicondyles of the humerus was taken and secondly the distance between median and lateral epicondyles of the femur. Engineers' steel calipers fitted with

Vernier scale were used for the femur but ordinary steel outside curved calipers fitted with screw adjustment do equally well and are preferable for the elbow. The points of the calipers with the measurer's index finger alongside are placed firmly against the tips of each epicondyle and the subject himself tightens the screw. A steel centimeter rule allows the distance between caliper points to be measured to 0.5 mm. The caliper points are slightly blunted with a file and the skin is eased away with the forefinger to prevent scratching when the calipers are removed. Alternatively the split screw may be released half a turn while the calipers are withdrawn and subsequently tightened by the same amount.

Muscle girth measurements (in centimeters). Biceps girth was taken with a highly flexible steel tape in light contact with the skin over a tensely contracted biceps with the elbow fully flexed. Calf girth taken with the subject standing erect, the legs almost touching and the tape in light contact with the skin. The maximal girth was recorded.

Skinfold measurements of subcutaneous fat (in millimeters) were recorded with modified Franzen subcutaneous tissue calipers at three sites:

1. *Subscapular.* The skinfold was raised with the thumb and forefinger of the left hand over the angle of the scapula, the skinfold running downwards in the direction of the ribs. The subject's arm hangs by his side. The skinfold should not be held too tightly because it is tender when pinched.

2. *Suprailiac.* The skinfold is raised as before with the left hand in a position one to two inches above the anterior superior iliac spine, and the fold is raised so that it runs in the direction of the intercostal nerves.

3. *Over triceps muscle.* Halfway between the acromion and the olecranon on the posterior aspect of the arm. Care was taken to make sure no muscle fibers were included; in case of doubt if the subject locks his elbow momentarily the muscle fibers will withdraw from the fold. The elbow should not be held locked for this partly tethers the skin.

Biacromial width (centimeters). For this it is important to make certain that the shoulder muscles are relaxed and that the shoulder girdle is not braced back or upwards, neither should the shoulders be rounded too far forward. Comparison of the results obtained using a pelvimeter and an anthropomenter showed that the pelvimeter with its diminished scale was not a fully satisfactory instrument. A suitable instrument has been made at very moderate cost by fitting arms to a standard 50 cm steel rule. The arms are pressed firmly against the outer aspect of each acromial process.

Bi-iliac width (centimeters) is taken between the outer aspects of the iliac crest using firm pressure against the bone.

TABLE 4

Correlation coefficients between individual skinfold measurements and the sum of all three

	410 OXFORD MEN AGED 17–24	164 OXFORD WOMEN AGED 17–23
Total fat and subscapular fat	r = 0.97	r = 0.82
Total fat and suprailiac fat	r = 0.93	r = 0.81
Total fat and triceps region fat	r = 0.84	r = 0.82

Chest width and chest depth (centimeters) were taken with the thorax midway between full inspiration and expiration. The arms of the pelvimeter were held horizontally level with the greatest width or depth. This level varied quite widely. Anatomical precision was foregone with the object of indicating the relationship between maximal antero-posterior and maximal lateral development of the thorax.

The three fat measurements as an indication of the total subcutaneous fat

It is necessary to consider how far these three skinfold measurements may be taken to indicate the total amount of subcutaneous fat in the body. The first step taken was to correlate each of the three subcutaneous measurements with the sum of all three. The results are given in table 4. These results are encouraging and perhaps a little surprising, for it seemed clear after only short clinical experience that sites of adiposity vary to some extent from one individual to another. In order to evaluate the sum of the three fat measurements used in the survey as an indication of general subcutaneous fat in the body it was desirable to correlate this total with totals obtained using a much larger number of measurements.

Edwards ('50) published interesting observations on the distribution of subcutaneous fat. He had measured 53 sites including the three used in this survey and he has been kind enough to allow me to use his measurements. Edwards' subjects were 24 obese women but 48 sets of measurements were used since each person was measured before and after 28 lbs. or more reduction in weight. The coefficient of correlation between the sum of measurements at 53 sites and the sum at the three sites used in this survey showed very close agreement, 0.99. This high degree of correlation in women, among whom variation of individual measurements is greater than in men, made it possible to proceed with a fair degree of confidence that the sum of the particular three measurements chosen was a fairly good indication of the total subcutaneous fat in the body.

These remarks do not imply that individual variation does not occur in the pattern of fat storage. It was clear in table 4 that in men fat in the region of triceps departed more often from the average pattern. A large amount of fat over the triceps muscle is in fact a feminine feature and in men high fat measurement in this region relative to others suggests gynandromorphy.[3] In mesomorphs the fat measurement with the highest standard score is commonly the subscapular one; in endomorphs the suprailiac.

The total of the three fat measurements will be used in the deviation chart profile to obtain a provisional estimate

[3] In the Oxford series, excluding central somatotypes, 61% of endomorphic-ectomorphs had their highest fat standard score in the triceps region, but among mesomorphs this feature was only present in 22%.

of endomorphy. It is recognized that this ignores other important anatomical characteristics of endomorphs, for example their relatively small bone structure, but this feature is directly visible on the deviation chart.

On the last line of the deviation chart there will be found a provisional estimate of endomorphy corresponding to the total fat score in the same column above it. These provisional estimates represent average endomorphy figures in the Oxford series (photometric ratings) corresponding to the total fat score. The ultimate justification for using total fat measurements as an indication of endomorphy may be judged from the closeness of the final estimates obtained by this method and by expert anthroposcopic typing.

The profiles

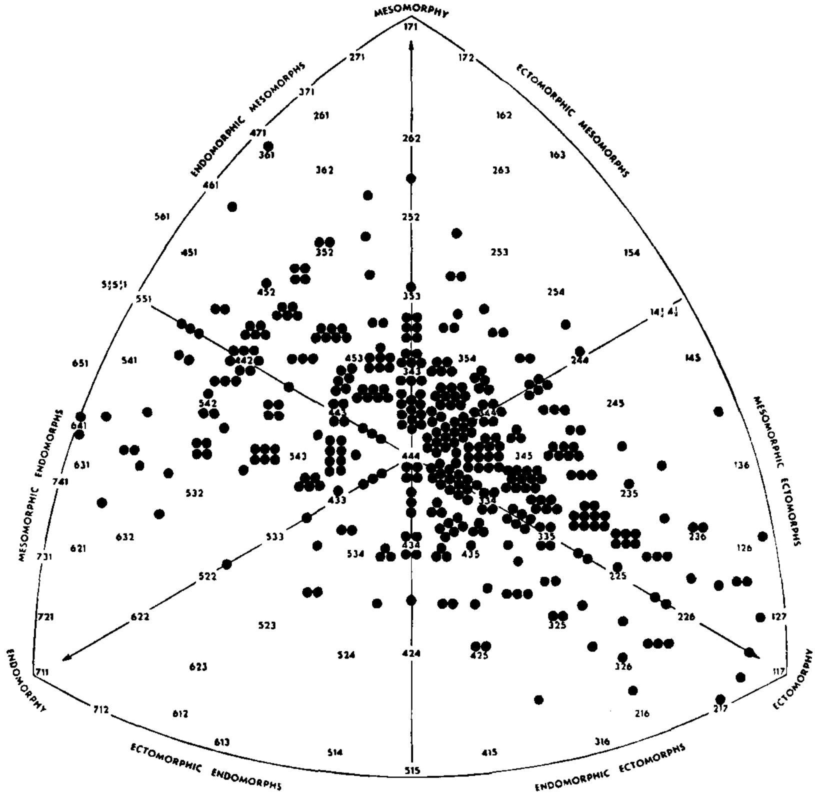
The varieties of somatotype dominance are found on Sheldon's chart (fig. 1) on which incidentally the distribution of 405 Oxford men has been plotted, as derived by deviation table typing.

The next step is to describe the main characteristics of profiles corresponding to each somatotype dominance. For a person of about average height, that is for someone whose height lies within approximately three inches of the mean, figure 2 illustrates the relationship between height, bone, muscle girth and subcutaneous fat standard scores.

In the diagram, "B" is taken as the average of the two bone standard scores, "M" is the average of the two muscle girth scores and a cross is used to indicate an average value for bone and muscle development. A straight line has been drawn connecting the height and total fat standard scores.

In endomorphs and endomorphic-mesomorphs this line "HF" lies in the direction of the French "accent grave" (top left to bottom right). This was found to be true of even the tallest endomorphs in the series.

In ectomorphs and ectomorphic-mesomorphs the line "HF" runs in the direction of the French "accent aigu" (top right to bottom left). The only exception to this is in short ectomorphs but here the ponderal index will save confusion since at this age all ectomorphs, including those with shared primary dominance, have a ratio exceeding 13.25.



A SCHEMATIC TWO-DIMENSIONAL PROJECTION OF THE THEORETICAL SPATIAL RELATIONSHIPS AMONG THE KNOWN SOMATOTYPES

Fig. 1 The somatotype distribution of 405 Oxford men undergraduates.

The line "HF" is vertical in the somatotypes 444 of average height. It is vertical also in endomorph-ectomorphs (434, 424) and primary mesomorphs (343, 353, 262) when secondary dominance is shared.

Primary mesomorphic dominance is present where the "BM" average point marked with a cross lies to the right of both the height standard score "H" and the "HF" line.

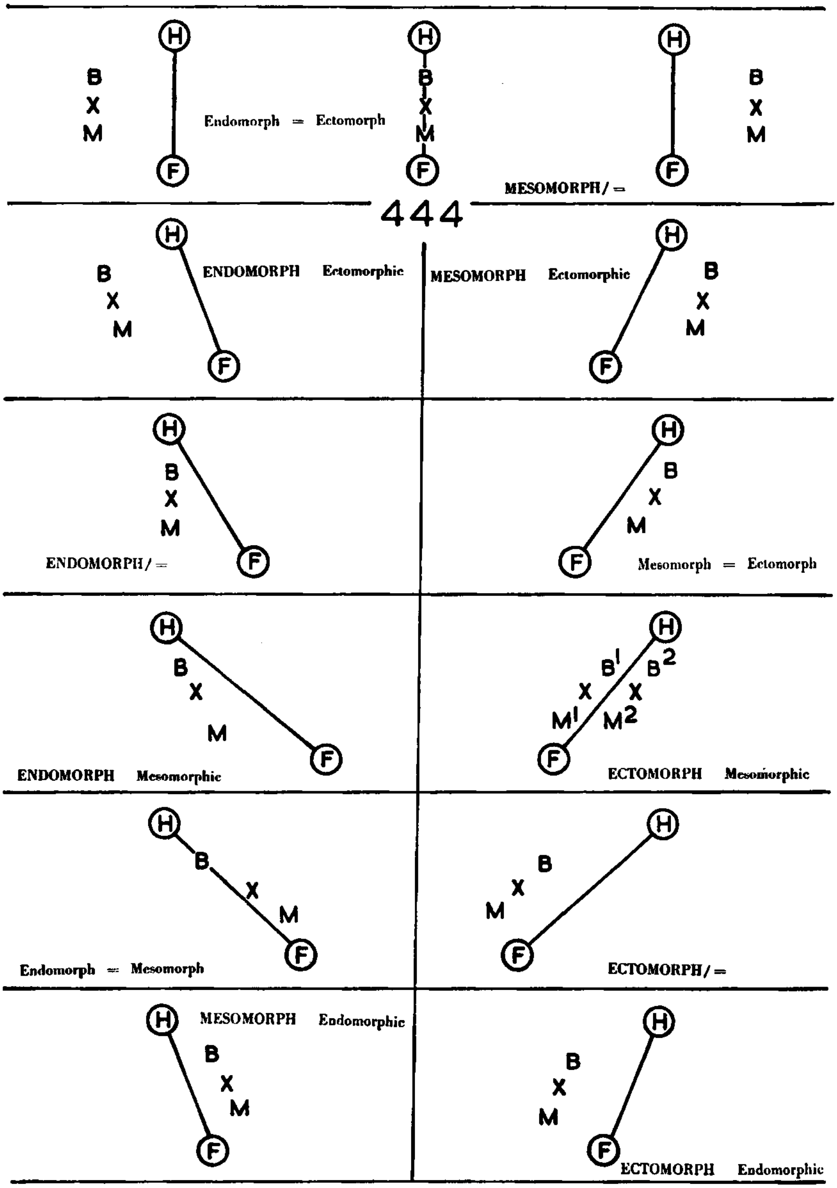


Fig. 2 Diagram illustrating the relationship of height (H), bone (B), muscle girth (M) and subcutaneous fat (F) standard scores on the deviation chart according to dominance of somatotype in a person of about average height.

Mesopenia (that is mesomorphy 3 or less) is present where the "BM" average point lies to the left of the "HF" line.

The layout of the standard deviation chart is such that the horizontal line on which the "BM" average is marked lies halfway between the height and total fat lines. When the "BM" cross falls on the "HF" line a rating of mesomorphy 4 is found. As a further rough guide, if the "BM" cross is discovered to the right of the "HF" line half a point in mesomorphy is gained for each column passed. Conversely, mesopenia may be roughly estimated by half point reductions of mesomorphy for each column lying between the midpoint of the "HF" line and the "BM" average point to its left. There is an exception. In endomorph-mesomorphs the primary dominance is shared but the girth measurements which here contain a fair proportion of fat give a slightly exaggerated impression of mesomorphy. Allowance has to be made for this, the actual amount depending on the total fat estimate. A reduction in mesomorphy by half a point is usual but reductions of one unit may be necessary in the presence of obesity.

One further explanatory note to the diagram concerns mesomorphic-ectomorphs. "B^1M^1" profiles relate to the mesomorphic-ectomorphs with low mesomorphy, somatotypes 235, 236, 136, 126 and 127. "B^2M^2" points lying to the right of the "HF" line relate to somatotypes 145, 245 and 345 where mesomorphy is rated higher.

So far these empirical instructions appear perhaps a little complicated. A momentary pause in which to consider the underlying reasons for this procedure may therefore be an advantage. The first point is that, in the process of Sheldonian somatotyping, size as expressed in terms of height is excluded; the main concentration of interest is on body shape, which is expressed in body proportions. Height is therefore taken as the starting point for the guide line "HF." It must further be remembered that endomorphy and mesomorphy are defined as mutually exclusive components. If "F" is accepted as the other reference point for the guide line, the mesomorphy estimate based on the relationship of bone and muscle measurements to this guide line will be relatively great where "F" has a low value; conversely it will be relatively low where there is a large amount of fat and the guide line "HF" thereby moves to the right.

The last stage in estimating somatotype is to select the most suitable type with appropriate ponderal index and component dominance from Sheldon's set of tables. This stage may or may not be completed during clinical interview according to choice.

Further notes on profile interpretation

While it is understood that suitable ponderal index-somatotype tables for each 5-year age group from 18 to 63 will shortly be published, it must be remembered that the standard deviation chart is standardized for 18- to 24-year-old men. Although the bone measurements do not change, the deviation chart remains unsuitable for older persons unless appropriate allowance for age changes in muscle girth and subcutaneous fat can be made. Further reference is made to this in a later section.

Comparatively low bone standard scores have been noticed in endomorphs, but skinfold measurements have been used as the main guide to endomorphy. Fat measurements may clearly be affected to a considerable degree by environmental influence, and the same is true, though to a smaller extent, of the girth measurements used in estimating mesomorphy. It is likely therefore that the results only approximate the somatotype, where it is known that the subject is neither greatly overweight nor wasted. Endomorphy and mesomorphy have not themselves been measured, if indeed they ever can be precisely in terms of their original definition.

Mesomorphy was defined[4] as "relative predominance of muscle, bone and connective tissue," that is of tissues derived from the mesoderm or embryonic layer. Evidence from the

[4] "Varieties of Human Physique," p. 5.

deviation chart profiles shows that although bone and muscle follow fairly consistent patterns by dominance of somatotype, they nevertheless vary somewhat independently of one another.

It has already been mentioned that the last stage of the procedure just described for estimating somatotype involves a change from body proportions based on the "extensive" scales of the deviation chart to the 7-point "equal appearing interval" scales of somatotype components. Practically, the adjustment required in the middle part of the scales is small, seldom if ever exceeding a half point, and this is fortunate because central somatotypes often present difficulty photoscopically. Towards the ends of the scales it is sometimes less easy to interpret a profile correctly, and experience is necessary to read the right answer at sight, but extreme physiques are less difficult to recognize photoscopically.

A further difficulty arises from the point already mentioned that fat contributes to girth measurements. In ectomorphs there is less than average fat to contribute to muscle girth and consequently the smaller girth measurements may lead to underestimates of mesomorphy. But among endomorphs and many endomorphic-mesomorphs there is more than average fat, and mesomorphy is apt to be overestimated in consequence, a 443 for example being incorrectly interpreted as a 44½3. The effect of this was not fully appreciated when first attempts were made to sight-read the profiles and the result was to rotate the whole distribution slightly clockwise.

Objective estimate of dominance by tables

Partly to correct this rotation and further to make due allowance for the effect of height on other measurements, tables (see appendix) were prepared to indicate the balance of endomorphic-mesomorphic dominance for each height and ponderal index group separately. These tables were constructed in the following manner: first the average bone, girth and total fat measurements were calculated for each height and ponderal index separately; scales were then built around the average measurements using the same half standard deviation units as on the deviation chart. Next the average endomorphy and mesomorphy ratings were calculated for each ponderal index group among Oxford men (see table 5). Finally the scales were placed against the appropriate top line estimates of endomorphy and mesomorphy, so that the mean measurements and the mean somatotype ratings came into the same column. Thus a guide to the balance of endomorphic-mesomorphic dominance was obtained by comparing total fat equivalent in endomorphy with the average

TABLE 5

Mean ratings in endomorphy and mesomorphy for each ponderal index in Oxford undergraduates aged 17–24

PONDERAL INDEX	AVERAGE RATING	
	Endomorphy	Mesomorphy
Less than 12.45	4.9	4.0
12.50–12.95	4.1	3.9
13.00–13.45	3.5	3.8
13.50–13.65	3.0	3.3
13.70–13.95	2.7	2.7
14.00 +	1.9	2.0

estimate of mesomorphy obtained from the 4 measurements, two of bone and two of muscle girth, which mainly contribute to this component.

Six examples are given below, one from each ponderal index group, to illustrate the use of the tables and a variety of somatotype dominance.

1. Height 73.6 ins. Weight 134 lbs. Ht./$\sqrt[3]{Wt.}$ 14.4. Age 21

			Endo-meso estimate		
"B"	Humerus	6.7 cm	1.00		Most fitting somatotype from Sheldon's tables with dominance suggested by 2.4/2.0 is:
	Femur	9.6 cm	1.75	2.0	
"M"	Biceps	27.7 cm	2.50		
	Calf	35.0 cm	2.90		
			4/ 8.15		
Total fat		32.0 mm		2.4	2 1 ½ 7

2. Height 73.25 ins. Weight 158 lbs. Ht./$\sqrt[3]{\text{Wt.}}$ 13.55. Age 18.

			Endo-meso estimate		
"B"	Humerus	6.8 cm	2.25	2.7	
	Femur	9.8 cm	2.75		
"M"	Biceps	29.2 cm	3.00		
	Calf	34.8 cm	2.75		
			4/10.75		
Total fat		44.0 mm		4.0	42½5

Most fitting somatotype from Sheldon's tables with dominance suggested by 4.0/2.7 is: 42½5

3. Height 69.6 ins. Weight 146 lbs. Ht./$\sqrt[3]{\text{Wt.}}$ 13.2. Age 24.

			Endo-meso estimate		
"B"	Humerus	6.5 cm	2.50	3.75	
	Femur	9.8 cm	4.25		
"M"	Biceps	30.5 cm	4.50		
	Calf	34.8 cm	3.75		
			4/15.00		
Total fat		20.0 mm		2.1	24½4

Most fitting somatotype from Sheldon's tables with dominance suggested by 2.1/3.75 is: 24½4

4. Height 71.4 ins. Weight 164 lbs. Ht./$\sqrt[3]{\text{Wt.}}$ 13.1. Age 20.

			Endo-meso estimate		
"B"	Humerus	7.1 cm	4.00	4.5	
	Femur	9.5 cm	3.00		
"M"	Biceps	34.3 cm	5.50		
	Calf	39.4 cm	5.50		
			4/18.00		
Total fat		42.0 mm		4.0	443

Most fitting somatotype from Sheldon's tables with dominance suggested by 4.0/4.5 is: 443

Note: On account of the fat in the girth measurements, a reduction of the mesomorphic estimate is required if a close fit is to be found in Sheldon's tables.

5. Height 72.9 in. Weight 184 lbs. Ht./$\sqrt[3]{\text{Wt.}}$ 12.8. Age 23.

			Endo-meso estimate		
"B"	Humerus	7.2 cm	4.25	4.5	
	Femur	10.5 cm	4.50		
"M"	Biceps	35.6 cm	5.10		
	Calf	39.4 cm	4.00		
			4/17.85		
Total fat		26.0 mm		2.6	2½52

Most fitting somatotype from Sheldon's tables with dominance suggested by 2.6/4.5 is: 2½52

6. Height 65.25 ins. Weight 147 lbs. Ht./$\sqrt[3]{\text{Wt.}}$ 12.35. Age 18.

			Endo-meso estimate		
"B"	Humerus	6.6 cm	4.25	4.1	
	Femur	9.1 cm	3.25		
"M"	Biceps	32.5 cm	5.35		
	Calf	35.1 cm	3.60		
			4/16.45		
Total fat		60.0 mm		5.4	5½31½

Most fitting somatotype from Sheldon's tables with dominance suggested by 5.4/4.1 is: 5½31½

Note: A reduction of one unit in the estimate of mesomorphy was required in order to find a close fit in Sheldon's tables, where the total fat (60 mm) was much above average.

Certain practical hints

The tables give an estimate of the direction of endomorphic-mesomorphic dominance, but in adjusting this estimate to somatotype ratings experience shows that:

(a) There is a tendency to underestimate mesomorphy among mesomorphs with low endomorphy (see examples 3 and 5) because there is less than average fat in the girth measurements, and furthermore where endomorphy exceeds ectomorphy in secondary dominance, endomorphic influence tends to lower bone standard scores also.

(b) Conversely in mesopenes, especially central or ectomorphic mesopenes, bone size standard scores are commonly larger than girth scores although the girth scores are to some degree swollen by fat content. In short there is a tendency to overestimate mesomorphy and to underestimate mesopenia. Additional evidence in mesopenes that the table estimate of mesomorphy needs lowering will be found in feminine features such as maximal fat appearing over the triceps, or a low androgyny score, or again if chest width and depth are both small in relation to height.

It is correct to stick closely to Sheldon's ponderal index tables in the final estimate, but it increases confidence to know in what direction the slight adjustments of provisional endomorphy-mesomorphy estimates are likely to be necessary according to areas on the somatotype chart. Lastly it is well to remember that in persons more than two inches shorter or taller than the inner limit of the end categories in the tables provided still further allowance may be necessary for the effects of height.

Dysplasia. With the above points in mind it should be possible to estimate the somatotype of a healthy young man who is neither over nor under average weight for his build. The most common difficulty encountered is that connected with the presence of dysplasia, whether this is between the primary components or in the form of gynandromorphy.

Hints of both may be present on the deviation chart, for example:

1. Humerus and biceps scores may be small and femur and calf scores high or vice versa indicating uneven development of arms and legs.

2. A low androgyny score and/or high skinfold score over triceps compared with elsewhere are common feminoid features in men.

In other forms of dysplasia between the limbs and trunk there may be no indication on the deviation chart and it happens every now and again (2 or 3% in the Oxford series) that the dominance of the head and neck, thorax and abdomen is the reverse of that in the limbs. It is in such cases that the photographic record is particularly valuable in preventing incorrect estimates, quite apart from the other information it may provide. If therefore, say on grounds of economy, no photograph is obtained, a special point should be made of looking for reversal of dominance during clinical inspection. Much valuable information will certainly be lost if use of the deviation chart and tables is allowed to replace clinical or photographic inspection. The question is in fact often asked as to whether somatotyping may be carried out using the measurements and tables alone, without even the deviation chart. Certainly an answer may be obtained in this way but the risk of error is greater; for the procedure although objective is blind, and if suitable allowance is to be made for dysplastic anomalies it is better to keep the profile in view just as it is better not to relinquish the photographic record.

Possible sources of criticism. The standard scales derived from measurement of university students are representative neither of the general population nor of other special populations, say in the armed forces or in industry, whom it may be desirable to somatotype. The peculiar advantage of this highly selected university group is that on the average the

Oxford students are taller and heavier than any other section of the community and this may be taken as the physical expression of a high tide mark in total endowment, both bodily and mental. According to Sheldon's scheme the total rating of his three components should add up to no more than 12 in the most highly endowed somatotypes; thus it is reasonable for somatotype 444 of average height to have in addition the average measurements of the group in whom physical expression of total endowment reaches its highest level. For somatotyping it is not supremely important that the deviation chart scales should represent any particular population in an absolute sense. Such scales would in any case be liable to revision to allow for secular trends in growth and nutrition. The main concern in somatotyping is with body shape, that is the sum of body proportions of which the profile is the outline. What scales are used is of less account, the more important point being that all investigators should use the same standards.

Apprehension is sometimes felt that mingling two methods so essentially different in their approach as photographic inspection and physical measurement may lead to confusion, but the deviation chart should be regarded as an aid in objectification, as a means of grading small differences the sum of which in widely contrasting physiques is obvious enough to the veriest beginner examining photographs.

The purist may claim that the deviation chart procedure is not somatotyping on the grounds for example that endomorphy cannot be defined solely in terms of subcutaneous fat. But skinfold measurements are a more accurate guide to subcutaneous fat than photographic estimates of this feature. Thus it may come about in practice that gains in exactness of measurement at any given time may outweigh loss of a partly speculative hope that the "morphogenotype" can be assessed more precisely by photographic inspection. But whatever view is taken it seems that the same or at least a closely allied objective is being pursued by both methods, otherwise it is hard to understand why such close agreement should obtain between the results.[5]

What has been said relates to healthy persons. When somatotyping ill people it should help to inquire into the subject's weight history, weight at 18 years and subsequently if obtainable, the highest known weight and the subject's belief as to his optimum weight. The standard photograph is of special value to a skillful interpreter but looseness of the skin, from wasting or dehydration, is unlikely to be missed by the physician who carries and uses subcutaneous tissue calipers.

Use of the deviation chart for estimating the somatotype of older men. Without testing the method against a sufficiently large sample of older subjects who have been somatotyped when young no absolutely reliable conclusion can be reached, but there are several points about the deviation chart which suggest that its use might be developed for older age groups. First, height and bone width measurements were more or less constant from 21 to 29 years of age and it is probable that they change little up to the age of 50 and possibly afterwards. Analysis of calf girth measurements showed an insignificant increase with age from 17 to 30 years; in the same period there was an increase in biceps girth, significant in the statistical sense, but amounting to little more than half a standard deviation, that is one column on the deviation chart. In this increase fat is probably the chief factor and the chief age variables to be considered on the deviation chart are therefore the weight and skinfold measurements. Their variation may be gauged to some extent,

[5] Hunt ('52) reviews a rather different system of classification being developed by Professor E. A. Hooton and his associates. In this the first component is simply called "fat," and the second "muscularity," the third component being derived from the ponderal index or "index of attenuation" as he calls it. The method is easier to operate than Sheldon's technique, but ratings obviously change to a great extent with variations in weight caused by age, diet, exercise or illness, whereas Sheldon contends, how rightly is uncertain but perhaps more rightly than many of his opponents admit, that his somatotype ratings are nearly independent of environmental influence.

especially if an older subject happens to know what his weight was at the age of 18. If not, the average weight variation with age is indicated by standard age, height and weight tables, though these make no allowance either for individual somatotype or for secular trends. If in such tables in place of weight for each height and age the appropriate ponderal index is given instead, it appears that whatever the individual's height a reduction of approximately 0.7 occurs in the ponderal index between the ages of 18 and 50; of this about 0.2 occurs in the first 4 years, 0.3 by 27, 0.4 by 32, 0.5 by 37 and the remainder in the last 15 years. The majority of persons are likely to require midrange or near average adjustments but it must be stressed that no exact allowance can be made in this way for weight changes characteristic of individual somatotype; for these Sheldon gives numerous descriptive notes in "Varieties of Human Physique."

The increasing trend in mean values of subcutaneous fat measurements associated with age in the present series was significant, but under the age of 30 amounted to less than half a unit on the standard scale for the total of three fat measurements. The mean value of course conceals what really matters here, namely what happens to individuals, but the standard deviation was also found to increase. Such a widening of the scatter might occur if say endomorph-mesomorphs mature early on one side of the mean while persons with low ratings in endomorphy reach their mature weight later, some after 30 years of age, others never gaining weight at all.

Use of the deviation charts for estimating the somatotype of women. No metric standards have been published for women so far, no index file or reference atlas of known somatotypes. There being no source of reference it is impossible to tell how far a provisional estimate of somatotype reached by applying certain guiding rules of interpretation to the deviation chart would in fact approximate to the Sheldonian somatotype. Doctor Sheldon has, however, been kind enough to show me a distribution chart of 1,000 college women in the United States. The greatest concentration on this chart is immediately below somatotype 543 in the triangle 543, 533, 433. Now if the average measurements of Oxford women students are plotted on the male deviation chart and the guiding rules are used to arrive at a provisional estimate of the average woman's somatotype, it will be found to work out as $4\frac{3}{4}3\frac{1}{2}3$. This is virtually identical with the central concentration of American women students. Furthermore, Sheldon uses the same ponderal index scales for women as he does for men. It therefore seems very likely that the primary component scales of endomorphy, mesomorphy and ectomorphy approximate more closely to male standards, which would not be surprising since the earliest work was based on the study of 4,000 college men.

Standard scales for women. The question therefore arises as to how appropriate such scales are for women and anyone who takes the trouble to plot women's measurements on a man's deviation chart will soon find a number of women with measurements beyond the standard scales. It is for this reason that in the deviation chart illustrated the scales have been extended downward to cover the range of Oxford women's measurements, their mean values being indicated by boxes.

On the other hand investigators may feel that a deviation chart based on women's measurements is more appropriate for women; they may prefer dimensions whose nature is more exactly understood than that of the so-called primary components. If these components are primary in the biological sense that they originate in a common germ cell for men and women, it might be more logical to choose measurements halfway between the average man and the average woman as the definition of the central somatotype 444. But it is not so easy to change ships in mid-ocean. The ship of somatotyping was launched over 13 years ago. A great deal of work has already been done on the correlation of somatotype with traits of temperament, psychosis and psychoneurosis. In addition if a change is to be recommended to women's standards the only ones at present available are based on the measurements of college women. Although this highly selected group has the one distinct advantage already mentioned, it must not be forgotten that it differs physically from the general population. For example the average ponderal index at Oxford was 12.86 and although this is very close to the figure for American college women, a ponderal index derived from the average height and average weight of 18-year-old insured women would be about 13.1.

From the quandary thus reached it is necessary to return to the primary question and purpose of this discussion — can a deviation chart be used to estimate the Sheldonian somatotype of women? The only reasonable answer at present is that by using a man's deviation chart it may be possible but it has not yet been shown how closely this may be done except in the case of the "average Oxford woman." If an investigator, on the other hand, prefers to type women against women's standard measurements, he may use their deviation chart and follow rules of interpretation of his own. In this case it would have to be clearly understood that if no reference is made to Sheldon's tables the results obtained would be quite distinct from and probably not even a close approximation to Sheldonian somatotype. The final choice of standards is likely to be settled by comparing the usefulness of each method for the particular purpose in view.

SUMMARY AND CONCLUSIONS

1. A method is described of estimating Sheldonian somatotype in young men, aged 17 to 24, by physical anthropometry. Since the measurements occupy only 5 minutes in the taking the method is suitable for general clinical use, the result being available in the form of a profile during the clinical interview. Greater objectivity in somatotyping is obtained by tables of bone, muscle girth and subcutaneous fat measurements for each height and ponderal index group. These tables provide a simple and reliable guide to dominance in

all but a small percentage of individuals who show reversal of dominance in trunk and limbs.

2. Agreement to half a unit was obtained in 90% of all somatotype ratings between estimates by deviation chart and tables and estimates made by the long photometric method. Between estimates by deviation chart and tables and photoscopic estimates by expert somatotypists agreement to half a unit was found in 87.3%.

3. The prospect for somatotyping by deviation chart and tables in older men and women subjects is discussed.

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APPENDIX

Men aged 17–24

Height/$\sqrt[3]{\text{weight}}$ < 12.50

HEIGHT INCHES	ENDO-MESO ESTIMATE	2	2½	3	3½	4	4½	5	5½	6	6½
< 64	Humerus, cm	5.6	5.8	5.9	6.1	6.3	6.5	6.6	6.8	7.0	
	Femur, cm	8.1	8.3	8.5	8.7	8.9	9.1	9.3	9.5	9.7	
	Biceps, cm	23.7	24.8	26.0	27.1	28.2	29.3	30.4	31.5	32.7	
	Calf, cm	30.5	31.5	32.5	33.5	34.5	35.6	36.6	37.6	38.6	
	Total fat, mm	17	20	25	30	36	43	51	62	75	90
64–65.9	Humerus, cm	5.8	6.0	6.2	6.4	6.5	6.7	6.9	7.0	7.2	
	Femur, cm	8.6	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.2	
	Biceps, cm	25.0	26.1	27.2	28.3	29.5	30.6	31.7	32.8	33.9	
	Calf, cm	31.7	32.7	33.8	34.8	35.8	36.8	37.9	38.9	39.9	
	Total fat, mm	18	21	25	31	37	44	53	63	76	92
66–67.9	Humerus, cm	5.9	6.1	6.3	6.5	6.7	6.8	7.0	7.2	7.3	
	Femur, cm	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.2	10.4	
	Biceps, cm	28.0	29.1	30.3	31.4	32.5	33.6	34.7	35.9	37.0	
	Calf, cm	32.3	33.3	34.3	35.3	36.3	37.3	38.4	39.4	40.4	
	Total fat, mm	18	22	27	32	38	46	55	66	79	96
68–69.9	Humerus, cm	6.1	6.3	6.4	6.6	6.8	7.0	7.1	7.3	7.5	
	Femur, cm	9.0	9.2	9.4	9.6	9.8	10.0	10.2	10.4	10.6	
	Biceps, cm	27.3	28.4	29.5	30.6	31.7 [1]	32.8	33.9	35.1	36.2	
	Calf, cm	34.3	35.3	36.3	37.3	38.3	39.4	40.4	41.4	42.4	
	Total fat, mm	19	23	27	33	39	47	56	67	81	97
70–71.9	Humerus, cm	6.3	6.5	6.7	6.8	7.0	7.2	7.4	7.5	7.7	
	Femur, cm	9.3	9.5	9.7	9.9	10.1	10.3	10.5	10.7	10.9	
	Biceps, cm	29.6	30.7	31.8	32.9	34.0	35.1	36.2	37.4	38.5	
	Calf, cm	35.6	36.6	37.6	38.6	39.6	40.6	41.7	42.7	43.7	
	Total fat, mm	19	23	27	33	39	47	56	67	81	97
72 +	Humerus, cm	6.6	6.7	6.9	7.1	7.2	7.4	7.6	7.8	7.9	
	Femur, cm	9.5	9.7	9.9	10.1	10.3	10.5	10.7	10.9	11.1	
	Biceps, cm	30.1	31.2	32.3	33.4	34.5	35.6	36.7	37.9	39.0	
	Calf, cm	35.3	36.3	37.3	38.3	39.4	40.4	41.4	42.4	43.4	
	Total fat, mm	19	23	27	33	39	47	56	67	81	97

[1] Although the calf measurement increases from height group 66–67.9 ins. to 68–69.9 ins. the biceps average decreases. This has been checked and is related it seems to there being more mesomorphs in the shorter group.

Men aged 17–24

Height/∛weight 12.50–12.95 inclusive

HEIGHT INCHES	ENDO-MESO ESTIMATE	2	2½	3	3½	4	4½	5	5½	6
< 66	Humerus, cm	6.0	6.2	6.3	6.5	6.7	6.8	7.0	7.2	7.4
	Femur, cm	8.6	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.2
	Biceps, cm	24.5	25.6	26.7	27.8	29.0	30.1	31.2	32.3	33.4
	Calf, cm	31.0	32.0	33.0	34.0	35.1	36.1	37.1	38.1	39.1
	Total fat, mm	18	21	26	31	37	44	53	64	77
66–67.9	Humerus, cm	6.1	6.3	6.5	6.7	6.8	7.0	7.1	7.3	7.5
	Femur, cm	8.7	8.9	9.1	9.3	9.5	9.7	9.9	10.1	10.3
	Biceps, cm	25.8	26.9	28.0	29.1	30.2	31.3	32.4	33.6	34.7
	Calf, cm	31.2	32.3	33.3	34.3	35.3	36.3	37.3	38.4	39.4
	Total fat, mm	19	22	26	31	37	44	53	64	77
68–69.9	Humerus, cm	6.3	6.5	6.7	6.8	7.0	7.2	7.3	7.5	7.7
	Femur, cm	8.9	9.1	9.3	9.5	9.7	9.9	10.1	10.3	10.5
	Biceps, cm	26.5	27.6	28.7	29.9	31.0	32.1	33.2	34.4	35.5
	Calf, cm	32.3	33.3	34.3	35.3	36.3	37.3	38.4	39.4	40.4
	Total fat, mm	19	23	28	33	40	48	58	69	83
70–71.9	Humerus, cm	6.4	6.6	6.8	6.9	7.1	7.3	7.5	7.6	7.8
	Femur, cm	9.2	9.4	9.6	9.8	10.0	10.2	10.4	10.6	10.8
	Biceps, cm	27.8	28.9	30.0	31.1	32.3	33.4	34.5	35.6	36.7
	Calf, cm	33.5	34.5	35.5	36.6	37.6	38.6	39.6	40.7	41.7
	Total fat, mm	20	24	29	35	42	50	60	72	87
72 +	Humerus, cm	6.4	6.6	6.8	6.9	7.1	7.3	7.5	7.6	7.8
	Femur, cm	9.5	9.7	9.9	10.1	10.3	10.5	10.7	10.9	11.1
	Biceps, cm	28.5	29.7	30.8	31.9	33.0	34.1	35.2	36.4	37.5
	Calf, cm	35.3	36.3	37.3	38.3	39.4	40.4	41.4	42.4	43.4
	Total fat, mm	21	25	30	36	43	52	62	75	90

Men aged 17–24

Height/$\sqrt[3]{\text{weight}}$ 13.00–13.45 inclusive

HEIGHT INCHES	ENDO-MESO ESTIMATE	2	2½	3	3½	4	4½	5	5½	6
< 66	Humerus, cm	6.1	6.3	6.4	6.6	6.8	6.9	7.1	7.3	7.4
	Femur, cm	8.5	8.7	8.9	9.1	9.3	9.5	9.7	9.9	10.1
	Biceps, cm	23.5	24.6	25.7	26.8	27.9	29.1	30.2	31.3	32.4
	Calf, cm	29.5	30.5	31.5	32.5	33.5	34.5	35.6	36.6	37.6
	Total fat, mm	17	21	25	30	36	43	52	62	75
66–67.9	Humerus, cm	6.2	6.3	6.5	6.7	6.9	7.0	7.2	7.4	7.5
	Femur, cm	8.7	8.9	9.1	9.3	9.5	9.7	9.9	10.1	10.3
	Biceps, cm	24.5	25.6	26.7	27.8	29.0	30.1	31.2	32.3	33.4
	Calf, cm	30.7	31.7	32.8	33.8	34.8	35.8	36.8	37.9	38.9
	Total fat, mm	18	22	26	32	38	46	55	66	79
68–69.9	Humerus, cm	6.4	6.5	6.7	6.9	7.0	7.2	7.4	7.5	7.7
	Femur, cm	8.9	9.1	9.3	9.5	9.7	9.9	10.1	10.3	10.5
	Biceps, cm	25.0	26.1	27.2	28.3	29.5	30.6	31.7	32.8	33.9
	Calf, cm	31.2	32.3	33.3	34.3	35.3	36.3	37.3	38.4	39.4
	Total fat, mm	19	23	28	33	40	48	58	69	83
70–71.9	Humerus, cm	6.4	6.6	6.7	6.9	7.1	7.3	7.4	7.6	7.8
	Femur, cm	9.1	9.3	9.5	9.7	9.9	10.1	10.3	10.5	10.7
	Biceps, cm	26.3	27.4	28.5	29.6	30.7	31.9	33.0	34.1	35.2
	Calf, cm	32.2	33.3	34.3	35.3	36.3	37.3	38.4	39.4	40.4
	Total fat, mm	19	23	28	34	41	49	59	71	85
72–73.9	Humerus, cm	6.6	6.8	6.9	7.1	7.3	7.5	7.6	7.8	8.0
	Femur, cm	9.3	9.5	9.7	9.9	10.1	10.3	10.5	10.7	10.9
	Biceps, cm	27.0	28.1	29.3	30.4	31.5	32.6	33.7	34.9	36.0
	Calf, cm	33.0	34.0	35.0	36.1	37.1	38.1	39.1	40.1	41.2
	Total fat, mm	20	24	29	35	42	50	60	72	87
74 +	Humerus, cm	6.8	7.0	7.2	7.3	7.5	7.7	7.9	8.0	8.2
	Femur, cm	9.4	9.6	9.8	10.0	10.2	10.4	10.6	10.8	11.0
	Biceps, cm	28.5	29.7	30.8	31.9	33.0	34.1	35.3	36.4	37.5
	Calf, cm	33.8	34.8	35.8	36.8	37.9	38.9	39.9	40.9	41.9
	Total fat, mm	20	24	28	34	41	49	59	71	85

Men aged 17–24

Height/$\sqrt[3]{\overline{weight}}$ 13.50–13.95 inclusive

HEIGHT INCHES	ENDO-MESO ESTIMATE [1]	1	1½	2	2½	3	3½	4	4½	5
< 68	Humerus, cm	5.9	6.1	6.2	6.4	6.6	6.7	6.9	7.1	7.2
	Femur, cm	8.2	8.4	8.6	8.8	9.0	9.2	9.4	9.6	9.8
	Biceps, cm	22.0	23.1	24.2	25.3	26.4	27.5	28.7	29.8	30.9
	Calf, cm	27.9	28.9	30.0	31.0	32.0	33.0	34.0	35.1	36.1
	Total fat, mm	13	16	19	23	28	34	40	49	58
68–69.9	Humerus, cm	6.2	6.3	6.5	6.7	6.9	7.0	7.2	7.3	7.5
	Femur, cm	8.6	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.2
	Biceps, cm	23.2	24.3	25.4	26.6	27.7	28.8	29.9	31.1	32.2
	Calf, cm	29.5	30.5	31.5	32.5	33.5	34.5	35.6	36.6	37.6
	Total fat, mm	14	17	20	24	29	35	42	50	60
70–71.9	Humerus, cm	6.3	6.5	6.6	6.8	7.0	7.1	7.3	7.5	7.6
	Femur, cm	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.2	10.4
	Biceps, cm	23.2	24.3	25.4	26.6	27.7	28.8	29.9	31.1	32.2
	Calf, cm	30.0	31.0	32.0	33.0	34.0	35.1	36.1	37.1	38.1
	Total fat, mm	14	17	20	24	29	35	42	50	60
72–73.9	Humerus, cm	6.4	6.5	6.7	6.9	7.0	7.2	7.4	7.5	7.7
	Femur, cm	9.1	9.3	9.5	9.7	9.9	10.1	10.3	10.5	10.7
	Biceps, cm	24.7	25.9	27.0	28.1	29.2	30.3	31.4	32.6	33.7
	Calf, cm	31.2	32.3	33.3	34.3	35.3	36.3	37.3	38.4	39.4
	Total fat, mm	15	18	21	26	31	37	45	52	64
74 +	Humerus, cm	6.5	6.7	6.9	7.0	7.2	7.4	7.5	7.7	7.9
	Femur, cm	9.3	9.5	9.7	9.9	10.1	10.3	10.5	10.7	10.9
	Biceps, cm	25.3	26.4	27.5	28.6	29.7	30.8	32.0	33.1	34.2
	Calf, cm	31.7	32.7	33.8	34.8	35.8	36.8	37.9	38.9	39.9
	Total fat, mm	15	18	22	27	32	38	46	55	67

[1] When height/$\sqrt[3]{\overline{weight}}$ is 13.80, 13.85, 13.90 or 13.95, reduce each estimate by half a unit. This reduction is a consequence of increasingly dominant ectomorphy and the exclusive effect of this on the other two Sheldonian components.

Men aged 17–24

Height/$\sqrt[3]{\text{weight}}$ 14.00 +

HEIGHT INCHES	ENDO-MESO ESTIMATE	½	1	1½	2	2½	3	3½
< 70	Humerus, cm	6.2	6.3	6.5	6.7	6.8	7.0	7.2
	Femur, cm	8.7	8.9	9.1	9.3	9.5	9.7	9.9
	Biceps, cm	22.6	23.7	24.8	25.9	27.0	28.1	29.3
	Calf, cm	28.4	29.5	30.5	31.5	32.5	33.5	34.6
	Total fat, mm	16	19	23	28	34	40	49
70–71.9	Humerus, cm	6.3	6.5	6.7	6.8	7.0	7.1	7.3
	Femur, cm	8.9	9.1	9.3	9.5	9.7	9.9	10.1
	Biceps, cm	22.6	23.7	24.8	25.9	27.0	28.1	29.3
	Calf, cm	29.5	30.5	31.5	32.5	33.5	34.5	35.6
	Total fat, mm	16	19	23	28	34	40	49
72 +	Humerus, cm	6.5	6.7	6.8	7.0	7.2	7.3	7.5
	Femur, cm	9.1	9.3	9.5	9.7	9.9	10.1	10.3
	Biceps, cm	23.1	24.2	25.3	26.4	27.5	28.7	29.8
	Calf, cm	30.2	31.2	32.3	33.3	34.3	35.3	36.3
	Total fat, mm	16	19	23	28	34	40	49

MORFOLOGIA INFANTIL (CRECIMIENTO). Juan Comas. (Reprinted from Paidologia by Jose Peinado Altable, Chapter VI, pp. 221–349. 136 pp., 17 graphs and figures, 89 tables. Mexico, 1952.) — A summary account of child growth which includes tabular material from the world literature on the subject. Of special interest is the coverage of the Latin American data and literature.

BASIC BODY MEASUREMENTS OF SCHOOL AGE CHILDREN. By W. Edgar Martin. U. S. Department of Health, Education, and Welfare, Washington. 74 pp. 1953.— This free booklet published by the U. S. Department of Health, Education, and Welfare is straight applied physical anthropology and provides normative data on a variety of body measurements under the assumption that they will assist in the proper manufacture of school equipment. Although some anthropologists may object to weighted means and common standard deviations obtained by combining diverse series measured over a 20-year range, it is not likely that today's data would be too very different. And while the definition of nasion as "a point between the eyes" may be inadequate for routine anthropometry, the imprecision should not affect manufacturers of blackboards, windows, or child-size washbasins. Fortunately, all measurements are reported in inches and tenths of an inch.

Mr. Martin carefully distinguishes between the static measurements customarily taken and the dynamic measurements that usually cannot be extrapolated from them. While it is important for manufacturers to realize these limitations of conventional body measurements, it is even more important for them to realize that the arithmetic mean is usually the poorest possible statistic to use when human comfort is concerned. What is not included in this booklet, namely the theory of applied physical anthropology, is missing because it has not been written by applied physical anthropologists themselves. — S. M. GARN.

MAN IN EVOLUTION. M. R. Sahni. (272 pp., $5\frac{1}{2} \times 9$, illustrated by Kamini Sahni. 15 shillings. Longmans Green and Co., London. 1953.) — This account of human evolution by an Indian author is intended mainly for Indian readers, and includes a survey of what is known of the prehistory of India and the neighboring countries. — G. W. LASKER.