*Postural Analysis of Yale University Freshmen**

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INTRODUCTION

THE term "body mechanics," which is more inclusive than the word "posture," simply means the alignment of the various segments of the body. Good body alignment—in other words, good body mechanics—is emphasized for the purpose of allowing the vital organs to function at their highest efficiency, because when the various segments of the body are not in good alignment, the individual must use his body at a mechanical disadvantage.

It is readily admitted that correct body mechanics assists in permitting the organs of the body to function more smoothly and more efficiently, but in actual practice this extremely important health value is often overlooked. People as a whole are willing to accept the theory of many health principles, but they are not always willing to practice what they believe. More important still is the fact that many individuals *do not know* what good body mechanics is. When they are told that the weight is carried too far back, or that the pelvic girdle is tilted too far forward, or that the chest is flat, etc., they do not have the least conception of what it is all about, much less knowing the principles involved in overcoming some of these poor postural habits. One of the distinct purposes of "Corrective Classes" at Yale University is to see that each individual knows what is involved in good body mechanics, knows what positions to emphasize or stress in order to attain a good alignment of the various segments of the body, and develop the strength and coordination necessary to assume good mechanical positions of the body.

BODY MECHANICS RATINGS

Subjective ratings which are based solely upon the judgment of the rater serve a distinct purpose in postural appraisal even though they may fail to show the desired degree of consistency among judgments of various raters. It is valuable to determine in this way various deviations from what would appear to be good alignment of the segments of the body. Where the rater has observed the posture of a large number of individuals such an appraisal can be very informative.

For many years attempts have been made to obtain more objective measurements of an individual's standing posture. Photography has been used in many of these studies, but its use has been rather limited in that only one view of a person could be taken at any one time. The photograph was also limited as to the value in postural analysis in that it was difficult to note certain specific points on the body, which are necessary to determine some of the deviations in good body alignment.

In 1932 MacEwan and Howe[1] reported a study on the posture of girls at

* This is one of the papers included in the Report of the Reporter for U.S.A., Commission V, International Society of Photogrammetry.

[1] MacEwan, C. G., and Howe, E. C. "An Objective Method of Grading Posture," *Research Quarterly*, 3: 144 (October) 1932.

Wellesley College. They attempted to determine the actual location of segments of the spine by placing aluminum pointers of known length on every second spinous process from the seventh cervical vertebrae down. In this way when a photograph was taken, the exact curvature of the spine was determined by measuring in from the end of each pointer on the photograph and outlining the contour of the back. Such a procedure enabled the recorder to determine quite accurately the angulation of the dorsal and lumbar spine, the position of the head and neck in relation to the trunk, and the forward or backward tilt of the body.

A study conducted at Yale University by Wickens and Kiphuth[2] in 1937 utilized the general principle of this aluminum pointer technique, but modified it in such a way that the pointers were placed on the spinous processes of the seventh cervical, at the point of greatest convexity in the upper back, at the point of inflection between the dorsal and lumbar curves, at the point of the greatest concavity in the lower back and on the prominence of the sacrum. In addition to these pointers, flesh pencil markings were placed at the tragus of the ear, the tip of the acromion, the greater trochanter, the head of the fibula and the cuboid bone of the foot. By means of these markings, together with the outline of the contour of the back, certain measurements of postural deviations were possible.

Measurement Using PhotoMetric Technique

The PhotoMetric equipment was installed at Yale University in the Spring of 1952. In 1954 a brochure was published which indicated the techniques of measurement to be used which would appear to enable a more complete analysis of the individual's postural alignment. This brochure pointed out the distinct advantages of PhotoMetric photography which may be summarized as follows:

1. Four images of the individual were provided in one exposure, thereby giving the recorder a complete picture of the subject in the front, rear, side and overhead views.

2. The accuracy with which measurements could be made on any part of the body.

3. The fact that a slide could be made of each individual photograph and projected on a screen to half life-size proportions. (This larger image enabled certain measurements to be made that were impracticable on a smaller image.)

Postural Measurements

Members of the Physical Education staff of the University together with the orthopedic physician analyzed the projected image of a subject very carefully in order to determine the body landmarks appearing in the picture which would be conducive to measurement for posture purposes. As a result of this analysis flesh pencil markings and aluminum pointers were placed on the individual so that the following measurements could be made:

1. SIDE VIEW IMAGE

a. hdt Horizontal displacement of tragus from 7th cervical (linear)	NECK
b. t7 Tragus to 7th cervical (linear)	NECK
c. ∠T7H Tragus to 7th cervical to horizontal left	NECK
d. ∠H7Ch Horizontal left to 7th cervical to chest	CHEST
e. ∠7KI 7th cervical to greatest convexity to point of inflection	KYPHOSIS
f. ∠ILS Inflection to greatest concavity to sacrum	LORDOSIS

[2] Wickens, J. Stuart, and Kiphuth, Oscar W. "Body Mechanics Analysis of Yale University Freshmen," *Research Quarterly*, 8: 38 (December) 1937.

g. ∠PAT	Posterior to anterior to trochanter	PELVIS
h. ∠APT	Anterior to posterior to trochanter	PELVIS
i. ∠HLS	7th cervical to the sacrum to horizontal left	OVERCARRIAGE
j. ∠7THL	7th cervical to trochanter to horizontal left	OVERCARRIAGE
k. ∠HrTC	Horizontal right to trochanter to cuboid	LEG THRUST
l. ∠7TC	7th cervical to trochanter to cuboid (*left*) SUM OF 7THL & (180−HrTC)	

2. BACK VIEW IMAGE

a. ∠IL7V	Inferior of left scapula to 7th cervical to vertical	SCAPULA
b. ∠Ir7V	Inferior angle of scapula to 7th cervical to vertical (right	SCAPULA
c. ∠ILRLV	Inferior angle of scapula through left root to vertical (left)	SCAPULA TILT
d. ∠IrRrV	Inferior angle of scapula through right root to vertical (right)	SCAPULA TILT

3. OVERHEAD VIEW IMAGE

a. ∠Ac7Ac	Acromion left to 7th cervical to acromion right	SHOULDER
b. ∠Ac7Mid	Acromion left to 7th cervical to Mid-line	SHOULDER

The aforementioned measurements are taken on each individual upon entrance to the University in the fall of the year. If he is assigned to the corrective classes, as a result of the initial postural analysis, a second photograph, together with the measurements as indicated above, is taken. Since the fall of 1952 slightly over 3,000 men have entered the Freshman class (about 1,000 each fall). A little over 60 per cent have been assigned to the classes in body mechanics. The basis on which these assignments are made is as follows:

GENERAL OVER-ALL POSTURE:

#1—good body mechanics (good alignment with no observable deviations in any segment of the body)

#2—fairly good alignment with more pronounced deviations in specific segments of the body

#3—poor body mechanics (poor alignment with very pronounced deviations in specific segments of the body).

Alignment in specific regions of the body, i.e., head and neck region, kyphosis, lordosis, etc. are based on:

1. mild deviation from good alignment
2. moderate deviation
3. pronounced deviation.

Objective measurements as determined from the photographs (and the slides since the PhotoMetric equipment was installed) indicate the following:

1. HEAD AND NECK POSITION

a) Angle T7H ("c" under Side View Image) indicates that an angle of between 60 and 65 degrees denotes a fairly good position of the head and neck. If the angle is between 55 and 59 degrees there appears to be a slight tilt forward. If the angle is between 51 and 54 degrees the tilt is moderate, and an angle below 50 degrees shows a very pronounced forward tilt.

b) hdt (horizontal displacement—"a" under Side View Image) appears to be closely related to the angle in the neck region in that the greater the displacement the sharper the angle.

2. SHOULDER POSITION

The overhead image appears to be the better means of determining the forward tilt of the shoulder girdle. Using the points of the acromio-clavicular joints together with the spinous process of the seventh cervical vertebra a definite angular measurement of the position of the shoulders can be determined. From measurements, recorded if this angle is less than 150–155 degrees, a forward tilt of the shoulders is apparent.

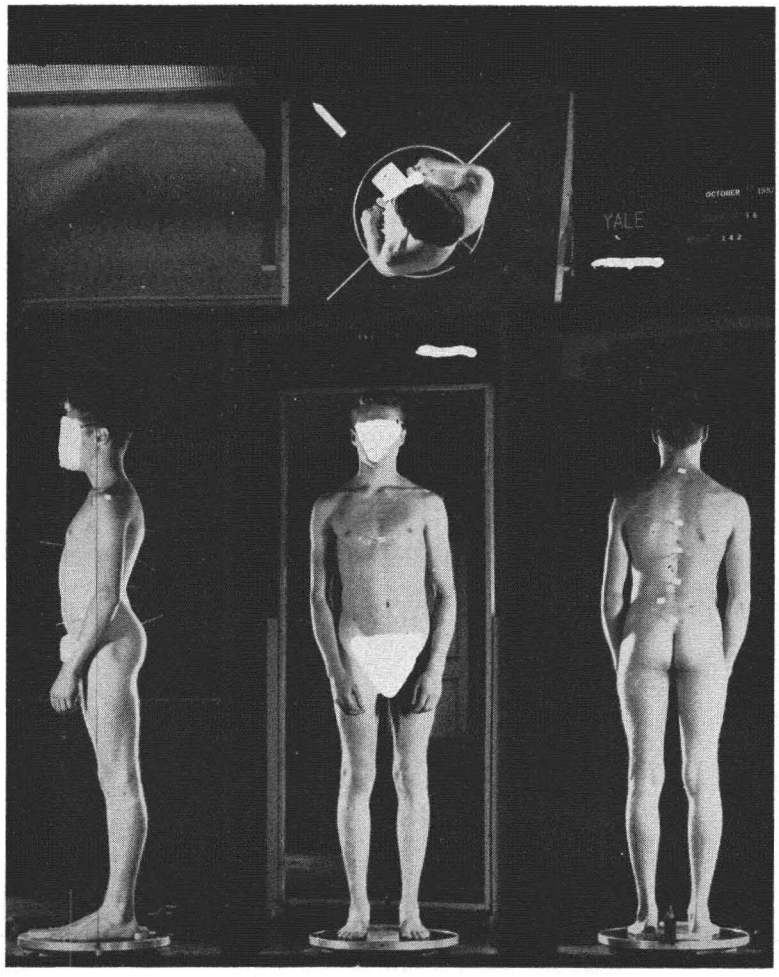

FIG. 1. October 17, 1952. Class of '56. Weight 142.

Measurements as to the position of each scapula, utilizing the angles listed as (a), (b), (c), and (d) under the back view image have been made in an attempt to determine the relationship existing between the abduction of the scapulae, scapular tilt, and the angle of forward tilt. Results of these measurements, however, are very inconclusive, and further analysis as to the landmarks to be used for possible measurement need to be studied.

3. THE POSITION OF OVERCARRIAGE

Two measurements have been used to determine the position of the upper body in relation to the over-all alignment of the body. The first of these, angle 7SHL ("i" under Side Image View) appears to be a more accurate indication of the overcarriage deviation. If the angle measures from 83–87 degrees the position of the body seems to be in fairly good alignment. An angular measurement of 88 degrees and upwards beyond a right angle indicates rather marked tendencies toward an overcarriage position.

4. KYPHOSIS

Angle 7KI("e" under the Side View Image) indicates the extent of roundness in the upper back. Over a large number of measurements an angle of between 165 and 170

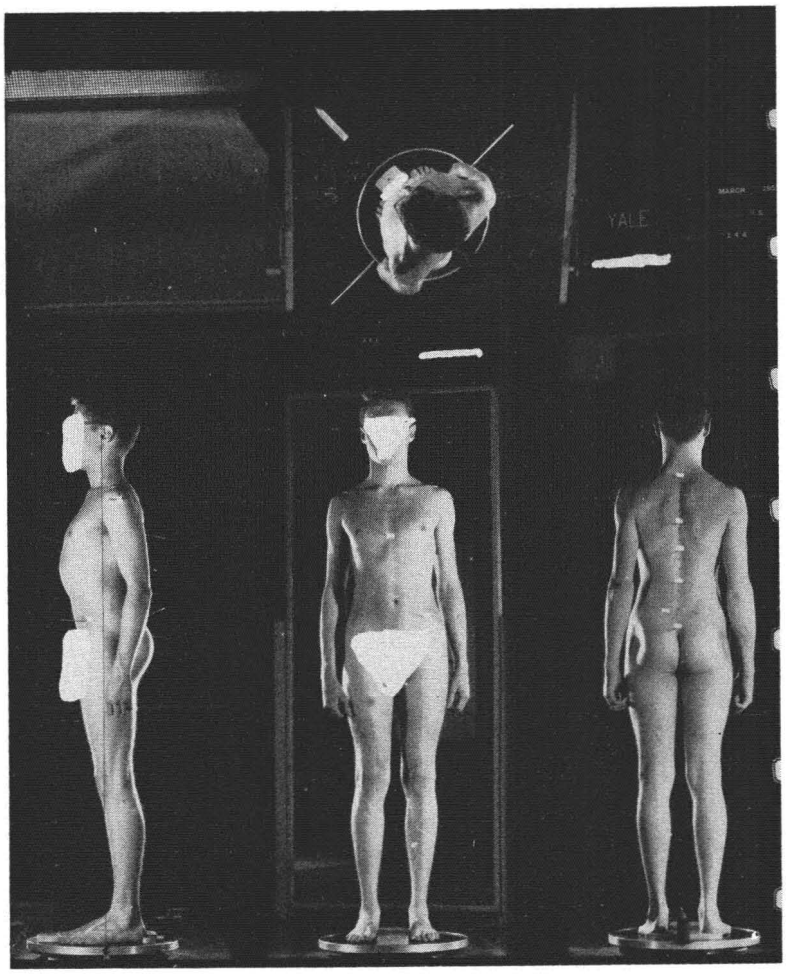

FIG. 2. March 6, 1953. Weight 144.

degrees seems to show a rather good position of the upper back. If the angle is sharper than this (around 145 to 150 degrees) the roundness is quite extensive.

5. LORDOSIS

Angle ILS ("f" under the Side View Image) indicates the extent of hollowness in the lower back. Angular measurements in the region of the back are similar to those in Kyphosis except that they are exactly reversed. In other words, a measurement of 165 to 170 degrees (concave) seems to indicate a fairly good position of the lower back. An angle of less than this will begin to show a rather extensive hollowness in that region.

SOME RELATIONSHIPS WHICH ARE APPARENT

Since the PhotoMetric equipment was installed at the University, studies have been made concerning certain relationships which may exist between the positions in various segments of the body. The first of these relationships which seem to be very obvious is the position of the lower back with relation to the tilt of the pelvic girdle. The more exaggerated the angle of hollowness in the lower back, the more forward appears to be the tilt of the pelvis. In attempting

to measure this relationship angles PAT and APT ("g" and "h" under Side View Image) were used. It appears from the studies made to date that the landmarks used to determine the pelvic tilt need further study, as the change which occurs in the size of the above two angles does not seem to differ greatly in relation to the forward or backward tilt of the pelvis.

A pilot study was conducted on 100 individuals in the Freshman posture class. In each case all postural measurements were made with use of the slide which was projected on the screen. The results of the measurements which seem to indicate real significance in analyzing body mechanics are given in Table I.

TABLE I. RESULTS OF THE MEASUREMENTS

Postural Measurement	Means		Range	
	1st Photograph	2nd Photograph	1st Photograph	2nd Photograph
hdt	3.6 inches	3.2 inches	2.3 to 5.3″	2.3 to 5.3″
∠T7H	56.8°	60.0°	44° to 69°	45° to 69°
∠HLS7	86.9°	85.9°	83.5° to 91°	81.5° to 90°
∠7KI	158.3°	165.0°	131° to 172°	135° to 180°
∠ILS	158.0°	167.9°	131° to 171°	135° to 180°
∠PAT	57.5°	54.3°	40.5° to 77°	36.5° to 80.5°
∠APT	47.0°	42.4°	35° to 62°	33° to 71°
∠Ac7Ac	144.4°	154.1°	130° to 177°	129° to 178°

CONCLUSIONS

There is no question at all that the Photometric method of photography can be a very definite asset to postural measurement because of the fact that an overhead, as well as a side and back view, is available on the same exposure. In the studies conducted at Yale University attempts were made to secure every possible measurement which would appear to have a bearing on the determination of postural alignment. As the studies progressed, however, a number of the measurements taken proved to be of limited value for the analysis of body mechanics. Those reported in Table I seem to indicate the most significance at the present time.

NOTE: The writer acknowledges the help of Oscar W. Kiphuth and Norbert V. Pratt, members of the Physical Education Department of Yale University, in compiling measurements used in this study.

NEWS NOTE

$1,225,000 IN AIR FORCE CONTRACTS AWARDED TO FAIRCHILD CAMERA AND INSTRUMENT

The Reconnaissance Systems Division of Fairchild Camera and Instrument Corporation has been awarded contracts totaling $1,225,000 by the Air Force for additional production of C-6 aerial camera lens cone assemblies and spare parts, and K-38 lens cones. The C-6 contract supplements a previous contract for the C-6 cone assemblies. Fabrication and assembly of the various parts, which are to be used with Fairchild's KA-2 9×9-inch Day Reconnaissance Camera, will be begun in April 1956. The K-38 contract is for 12-inch lens cone assemblies to be used with the Fairchild K-38, 9×18-inch Day Reconnaissance Camera.