POSTURAL SWAY AND ANTEROPOSTERIOR ALIGNMENT DURING ONE MINUTE ERECT STANDING

Thesis for the Degree of M. A.

MICHIGAN STATE UNIVERSITY
Betty Ann Haynes

1966

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DURING ONE MINUTE ERECT STANDING

By

Betty Ann Haynes

AN ABSTRACT OF

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF ARTS

Department of Health, Physical Education and Recreation

1966

Approved Janet A. Wessel

ABSTRACT

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Statement of the Problem

The purpose of this study was to investigate (1) the constancy of body sway during one minute standing and (2) the relationship of body sway to postural alignment.

Procedure

The Massey technique was employed to assess body alignment and the method described by Williams and Lissner to determine center of gravity.

Nineteen senior college women, all physical education majors, comprised the sample. The range, mean and standard deviation were obtained for all variables. The Pearson Product Moment Coefficient of Correlation was employed to determine correlations between all variables and reliability coefficients for test-retest scores.

Conclusions

Within the limits of this study postural alignment was highly similar regardless of the time it was taken during the one minute of erect standing. In addition,

Angle III appeared to be the more important body segment in postural adjustment to body sway. It is also evident that the longer the subject stands the more nearly she assumed her habitual standing posture or more stable postural position.

1. Statistically significant correlations were found for each postural variable between exposure times (5) during one minute of standing. The high correlations found seem to indicate that the body sway during one minute of erect standing had little influence on postural alignment.
2. Angle III, the hip-knee segment was found to be significantly positively related to the gravital line, i.e., the greater the distance anteriorly to the center of the lateral malleolus the greater the degrees.
3. Total posture was significantly positively related to the gravital line during the last three exposure times.
4. The gravital line was found to intersect the foot at a mean distance of 4.52 centimeters anteriorly to the center of the lateral malleolus during one minute of erect standing posture.
5. Test-retest correlations showed greater reliability the closer the subjects came to a

full minute of standing. Although the reliability coefficients were in general low, the qualitative grades awarded total posture were identical. No significant mean differences were found for the mean values of each exposure time.

Recommendations

1. Repeat the study with large sample randomly selected.
2. Standardize the time of each exposure time in five or ten second intervals using a continuous photographic procedure to assess postural sway.
3. Body type all subjects.

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CHAPTER I

INTRODUCTION

Numerous publications contain illustrations of sideviews of erect standing posture with a plumbline passing through the lobe of the ear, the tip of the acromion process, middle of the trochanter, head of the fibula, and lateral malleolus (1:335, 6:365). Furthermore, it has often been stated that in good standing posture all the above points should be aligned vertically (1:334-5, 2:319). This "perpindicular" posture standard, although without scientific basis, has been widely accepted and taught (5, 7, 10, 17).

Hellebrandt and co-workers have made extensive studies on the location of the center of gravity line in relation to the base of support in erect standing posture (13). They found that in erect standing posture the body sways continually and suggest that posture in reality is "movement upon a stationary base." Hellebrandt, *et al.*, found that anteroposterior oscillations were of larger amplitude than lateral ones, and that individuals displayed a very definite and constant pattern of sway (19). Such evidence seems to indicate that it might be fallacious to judge standing posture in terms of the relation of certain anatomic landmarks to the body's gravitational line. It would seem worthwhile to investigate the relationship of postural sway to the "perpindicular" posture standard. In a recent study Kalenda (24) found a significant negative correlation between the Massey Posture Test and center of gravity in college women. That is, the better the posture grade, the more likelihood the gravital line fell anteriorly to the ankle joint.

Statement of the Problem

The purpose of this study was to investigate (1) the constancy of body sway during one minute standing and (2) the relationship of body sway to postural alignment.

Limitations of the Study

1. Size and selection of sample.
2. There was possible error, due to visceral shift, in determining the center of gravity in the supine position and assuming this to be the same in the vertical stance.
3. The scales were calibrated but were not calibrated from the angle of the camera for reading of weight from posture picture.
4. Measurement error in assessing angles for Massey technique and other body landmarks on photographs.

5. Accuracy of determining times of pronounced body sway.

Definition of Terms

1. "Perpindicular" or vertical standing posture as defined by Massey (a) descriptively, "The principal segments of the body should be balanced evenly over the base of support" (21:3) and (b) anatomically, "is characteristically described in terms of the relationships of the body and its parts to the line of gravity" (21:4).
2. Postural or body sway is defined as the antero-posterior oscillations of the center of gravity in relation to the base of support in erect standing.
3. Center of gravity is defined by Cureton and Wickens as the "theoretical point which represents the center of weight" (11:93).
4. Line of gravity or gravital line is also defined by Cureton and Wickens as the "theoretical line erected vertically through the center of gravity" (11:95).
5. Angle formed by the gravital line was the angle layed down by a line projected upward through the center of weight from a point on the base of support where the gravital line intersected

the foot and a line from the center of the lateral malleolus to the center of weight.

CHAPTER II

REVIEW OF LITERATURE

In 1909 Reynolds and Lovett (22:86, 87) devised a method for determining the center of gravity of the body in the upright stance. This method was based on an earlier experiment by Borelli which determined the center of gravity in the horizontal position. Reynolds and Lovett corrected possible error caused by anteroposterior sway by steadying the subject by use of a back support. Calculation of the gravital perpendicular was made from the formula presented and in relation to the perpindicular arm used in the experiment, then transferred to the graphic form. This made it possible to place the gravital line in accord with the length of the foot.

Cureton and Wickens (11:97) improved the method of calculating the gravital line placement, but it could not be determined what allowance was made for sway. The gravital line was placed in relation to the internal malleoli, then calculation was made to convert this to percentile scores to set norms for college men. Cureton and Wickens conclude that lean forward from the ankles is determined by this test, and this is indicative of better stance, and the lean forward reduces kyphosis.

Fox and Young (12:282) in a study of 66 college women found the gravital line to be located a mean distance of 5.36 centimeters from the posterior border of the lateral malleolus. A paper on which outlines of the feet were traced was placed on the board on which the frontal and sagital planes of the gravital line was located. At the same instance the reading was taken, a single photographic exposure was made of the side and back views. The gravital line on the photograph was located to be approximately 0.95 centimeters anteriorly to the anterior border of the tibia, close enough to be considered on line with it.

Hellebrandt, Kelso and Fries (17:14) in devising equipment for locating biplane shifts in the center of gravity, allowed for sway by calculating averages from each five second observation during a minimum period of one minute of standing. Hellebrandt and Fries (14:23) reported that the center of gravity is in constant motion even in the most rigid persons, and moves through a comparatively large area, and the oscillations are rhythmic. In another study by Hellebrandt, Riddle and Fries (18:96), single instantaneous observations of posture were found to be of limited diagnostic value due to shifts in the center of gravity. In a further study by Hellebrandt, Riddle, Larsen and Fries (20:149) no relationship was found between the Wellesley posture score and the anteroposterior eccentricity of the center of gravity.

Brunnstrom (10:114) concluded the gravital line should fall anteriorly to the ankle joint.

Kalenda (24:32) found a relationship between the Massey Technique and center of gravity with total posture correlating -.305, Angle II -.279 and Angle III -.257. In conclusion (24:38, 39) the better the posture, the more likelihood of the gravital line passing through the foot anterior to the malleoli.

CHAPTER III

METHODOLOGY

Subjects

Nineteen senior college women comprised the sample. The subjects were volunteers majoring in physical education.

General Procedure

All testing was done from 12:00 to 5:30 in the afternoon. Measurements were taken by three investigators. Each investigator was responsible for a specific measurement on each subject. Retests were taken two days later on eleven subjects. Each subject was retested at the same time of day as the initial test.

Upon reporting for the study, the subject's name and age were recorded and a number assigned to her. The subject was then weighed. Height and foot length were then measured and recorded. Markings for the Massey Technique were applied with the exception of the lumbar marker. The subject then mounted the center of gravity apparatus, and the scale reading was recorded. This measurement was used to calculate the center of gravity. The lumbar marker was applied. The subject then mounted the board for anteroposterior posture pictures. Time of each exposure was recorded during the one minute of stance. These procedures took approximately ten minutes per subject.

Specific Procedures

Measurement Procedures

Age.--Date of birth, month, day and year was recorded and later converted to age in months to the nearest one-half month. Fifteen days was used to denote one-half month. If this number occurred in the subject's age, the age was carried to a whole month. Age was recorded in years and months.

Weight.--The subject was weighed barefooted with underclothing, on a calibrated Toledo human weight scale. The reading was recorded to the nearest one-quarter pound.

Height.--A wall at 90 degrees to the footboard was measured and notated in centimeters. Metric paper was placed and secured on the footboard with the paper edge against the wall at zero centimeters. The subject stood as tall as possible with feet together, heels, hips, shoulders and head touching the wall. A wooden square was placed against the wall touching the subject's head. The designated reading was recorded to the nearest one-quarter centimeter.

Length of foot.--Immediately after recording height the subject was told to take all weight off one foot, leaving the remaining foot with the heel against the wall. A straight edge was placed against the distal end of the greater toe of the foot on which the subject was standing on the above mentioned metric paper. The designated reading was recorded to the nearest one-tenth centimeter. The same procedure was followed to measure the other foot.

Center of gravity.--Apparatus similar to that described by Williams and Lissner (9:57) was used to obtain the center of gravity (Figure 1). The subject was asked to lie on the board in supine position with arms, hips and knees extended. The investigator aligned the crown of the subject's head, using a straight edge, with the line drawn across the board which designated the position of the fulcrum. The scale reading was recorded to the nearest one-quarter pound. The location of the center of gravity was later calculated from the following formula presented by Williams and Lissner (9:57).

(Total Weight of Subject × X) - (Distance Between Board Supports × Scale Reading) = 0.

Gravital Line

Anteroposterior oscillations of the center of gravity was related to the base of support in erect standing.

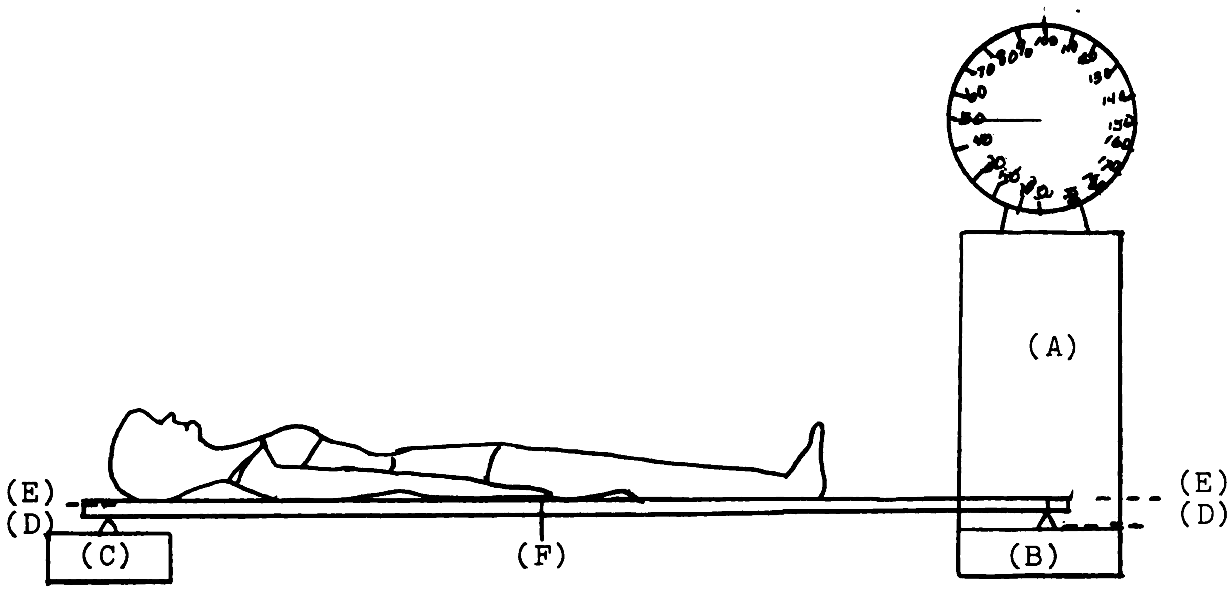

Figure 1.--Apparatus similar to that described by Williams and Lissner (5:57) for obtaining the center of gravity. Board can be leveled by varying the height of the knife edges.

(A) Toledo human weight scale.
(B) Scale platform.
(C) Wooden block.
(D) Wooden knife edge.
(E) Line representing knife edge, continues across face of board and other edge.
(F) Board, width = 24", length = 79$\frac{1}{8}$", thickness = 1 1/4".

Angle Formed by Gravital Line, Center of Weight and Lateral Malleolus

This was an angle formed by the gravital line and a line from the center of gravity to the point of the marker of the center of the lateral malleolus.

Massey Posture Technique (Figure 2)

Massey (21) used the total of four angles which deviated from a straight line, totaled these and then converted the total to a letter grade as follows:

Sum of Angles I-IV	Grades
8° - 22°	A
23° - 36°	B
37° - 51°	C
52° - 65°	D
66° - 78°	E
79° - 93°	F

The landmarks of the body used were (a) tragus of the ear, (b) suprasternal, (c) fourth lumbar, (d) upper tip of the greater trochanter, (e) center of the knee joint, and (f) the external malleolus:

(a) Angle I was formed by lines drawn from the tragus of the ear to the mid-point of horizontal line from the suprasternal to the spine and the mid-point bisecting a horizontal line drawn from fourth lumbar to abdomen.

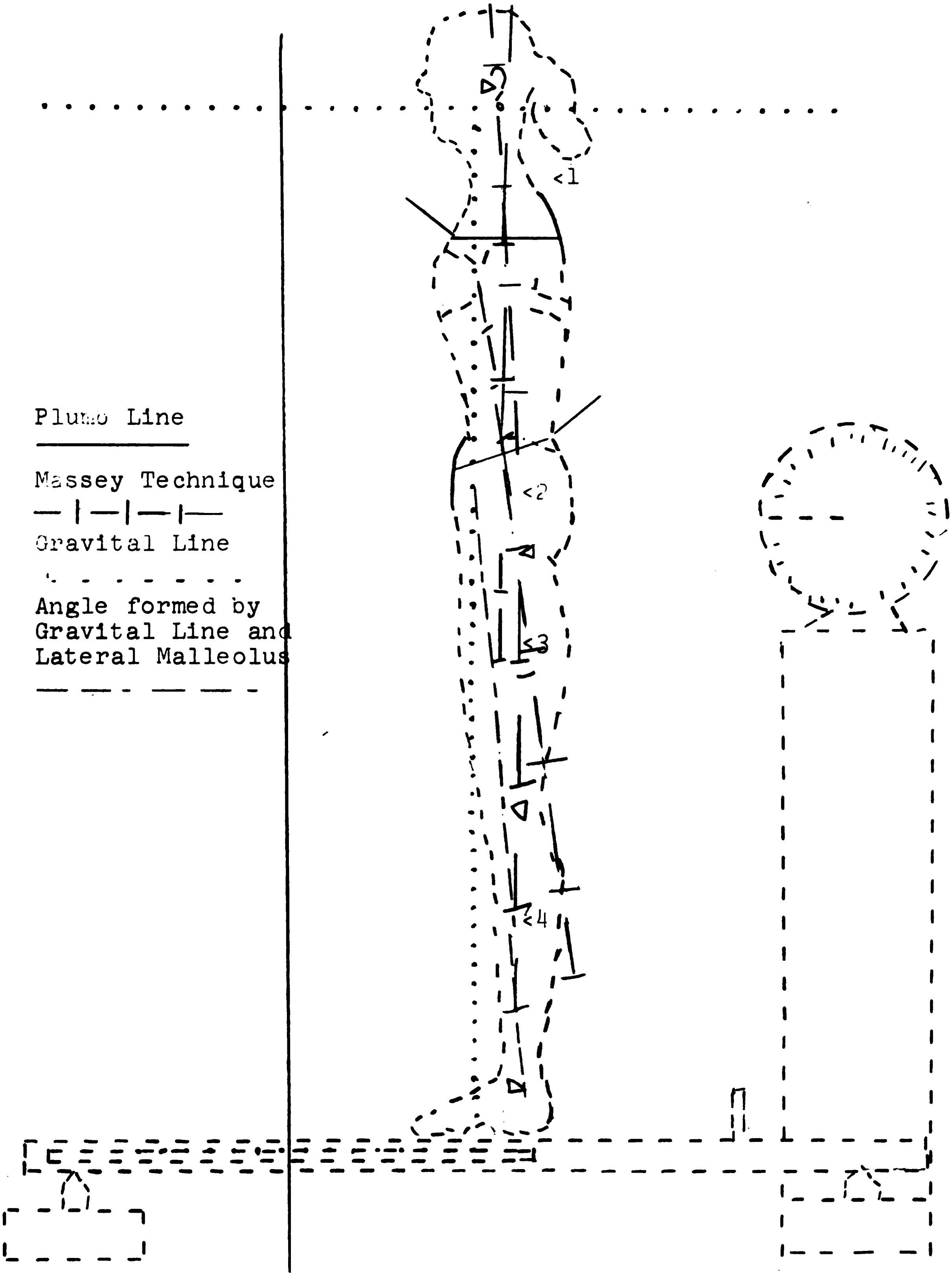

Figure 2.--Posture Technique (Dotted lines indicate subject and apparatus superimposed for descriptive purpose, but not traced in actuality).

(b) Angle II was formed by lines connecting mid-points of suprasternal-spine line, mid-point of lumbar-abdominal line, and the upper tip of the greater trochanter.

(c) Angle III was formed by lines connecting the mid-point of the lumbar-abdominal line, the upper tip of the greater trochanter, and the center of the knee joint.

(d) Angle IV was formed by lines connecting the upper tip of the greater trochanter, the mid-point of the knee, and the lowest point of the external malleolus. (This was altered to the center of the external malleolus in this study.)

Photographic Technique

The subject was marked for the Massey technique by applying triangular pieces of adhesive tape with the point of the marker at the landmark. Exception to this was two rods attached by adhesive tape to mark suprasternal and fourth lumbar. The subject then mounted the board of the apparatus (Figure 3) similar to that described by Williams and Lissner (9:58).

The centers of the lateral malleoli were aligned in the center of the board by use of a perpendicular rod which was not attached to the board. (It was decided this would reduce possible parallax error by placing the rod immediately beside the foot for alignment with the pointer of the marker and center of the board.)

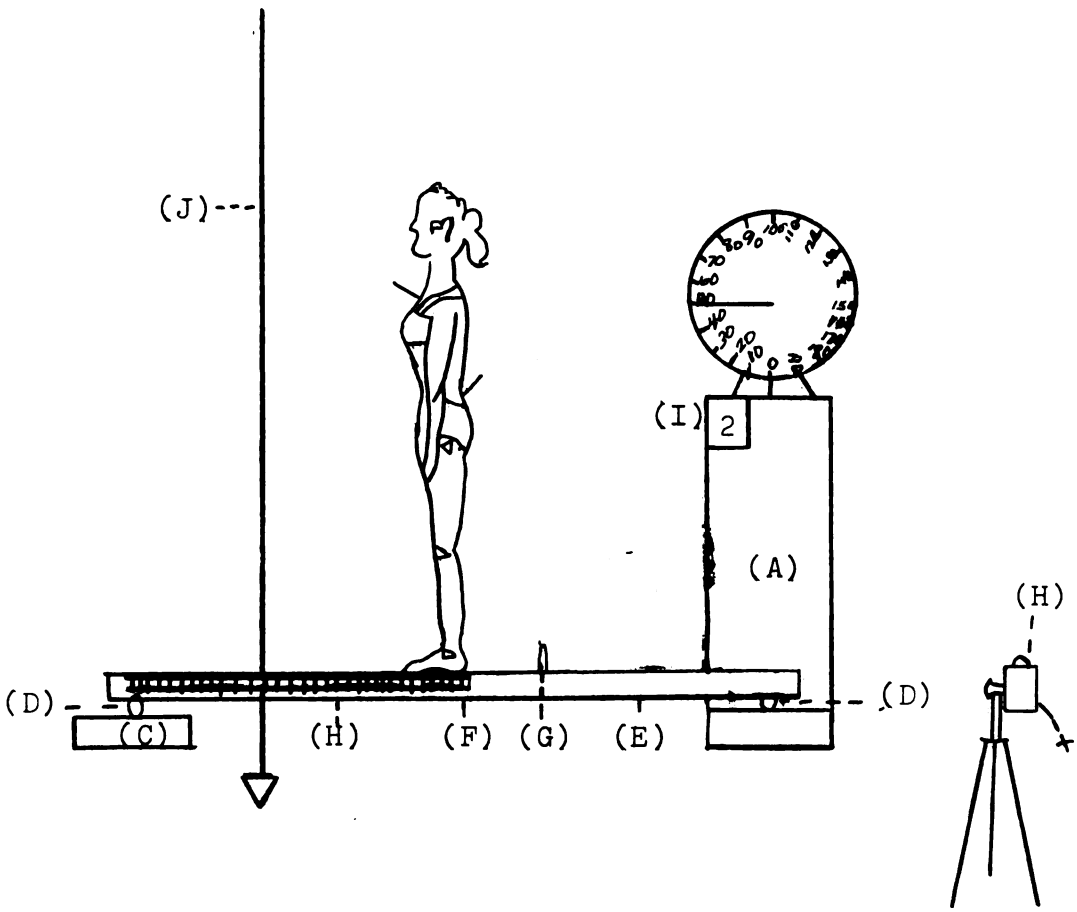

Figure 3.--Apparatus similar to that used by Williams and Lissner (5:58) to project gravital line.

(A) Toledo human weight scale.
(B) Scale platform.
(C) Wooden block.
(D) Knife edge.
(E) Board, width = 9 1/2 ", length = 43", thickness = 1 $\frac{9}{16}$ ".
(F) Line in center of board.
(G) Rod for projection of exposure, known to be 9.3 cm in length.
(H) Meter stick.
(I) Blackboard for subject number.
(J) Plumb line.

The 35 mm camera on tripod was placed at a distance of approximately eleven feet from the scale dial and in profile position to the subject. The camera was adjusted to proper setting of light for the flourescent lights and focused for light and distance on the dial of the left side of the scale. (For correct light meter reading the camera with light meter was held approximately six inches in front of the left side of the dial of the scale.) The distance setting was made from the tripod. Pre-test showed this to be the best procedure to expose film for showing scale gradations. The shutter time of exposure was one-sixtieth second. Kodak, plus X, black and white 35 mm film was used. Thirty-six exposure film prevented frequent reloading. A chain release was attached to the camera to eliminate possible blurr of exposures due to the movement of the camera by pressing the button with the finger.

One investigator focused the camera on the subject and wound the film; the second investigator recorded the time the exposures were made (how many seconds had lapsed) by use of a split second stop watch, while the third investigator watched the scale dial and pointer in an effort to obtain ranges of anteroposterior sway and also made the exposures at the time when the pointer was varying.

Five exposures were taken in a period of one minute for each subject. Negative slides were made of each exposure for all subjects. The slides were then projected one-third actual size on drawing paper. This was done by projecting one-third the size of the known length of the rod shown in Figure 3.

Scale readings were obtained from the projections to calculate the distance the gravital line fell from the fulcrum (wooden block, Figures 1 and 3-C) forward of the subject. The following formula was used for this calculation.

(Scale Reading - Board Weight) × (Board Length) ÷ Weight of Subject

The scale was not returned to zero holding the weight of the board, which was five pounds, but the board supported by the scale was leveled. This figure was subtracted from the weight shown on the scale supporting the subject. The board length was 42 inches. The inches were converted to centimeters for use of the meter stick located in Figure 3-H.

The percent of the height of the subject from the heels to the center of gravity was also calculated then converted to one-third of the height in centimeters for later use. The following formula was used to locate percent height of center of gravity. Distance from heels where center of gravity is located ÷ Height of subject.

Different colored pencils were used to prevent confusion in marking and constructing various lines on the drawing paper. Dots were made on the drawing paper, in blue pencil, at the point on the projection designated by the Massey Technique to determine angles. The point on the meter stick was marked, in red pencil, in accordance with the calculated results of the projection of the gravital line. The plumb line was traced, in black pencil, and used to construct perpindicular and parallel lines. On each photograph the gravital line was projected upward in red pencil; the center of gravity was marked in green pencil, by the measured one-third percent height of this point. The line from the center of gravity to the center of the lateral malleolus was made in green pencil. All angles were then measured and recorded. See Figure 2 for above explanation.

Statistical Method

The Pearson Product Moment Coefficient of Correlation was used to determine all relationships and reliability of measurements used in this study.

CHAPTER IV

ANALYSIS OF DATA

Description of Subjects

A description of the nineteen subjects participating in this study is presented in Table 1.

TABLE 1

DESCRIPTION OF SUBJECTS
(N = 19)

Characteristics	Range	Mean	Standard Deviation
Age (yrs. & mos.)	20 - 29.11	22	2.7
Weight (lbs)	102 - 160.50	127.736	16.886
Height (cm.)	156 - 172	165.486	4.761
Length left ft. (cm.)	22.2 - 27.0	24.621	1.255
Length right ft. (cm.)	22.3 - 27.0	24.552	1.208
Center of gravity in % height	53.39-56.52	55.020	0.874

Results

The reliabilities of each measurement used in the study was determined by test-retest scores for eleven subjects randomly selected. The results are presented in

Table 2. It is readily apparent that reliability on all the variables was greater the closer the subjects came to a full minute of standing. The only exception was for Angle II where low reliabilities were found for all exposures. Perhaps, the longer the subject stood the more nearly she assumed her habitual standing posture. It is difficult to interpret the low reliability found for Angle II which represents the alignment of the trunk to pelvic region.

TABLE 2

RELIABILITY COEFFICIENTS ON VARIABLES USED IN THIS STUDY (N = 11)

Variables	Exposures 1	2	3	4	5
Gravital line anterior to lateral malleolus	.209	.321	.419	.697	.669
Angle formed by gravital line and center of gravity to center of malleolus	.296	.388	.327	.670	.709
Angle I	.834	.902	.869	.895	.928
Angle II	.333	.435	.297	.385	.149
Angle III	.507	.511	.643	.544	.647
Angle IV	.560	.441	.523	.603	.531
Total Posture	.287	.390	.232	.361	.344

The ranges, means and standard deviations of the time of each exposure for the eleven subjects are given in Table 3, and for the nineteen subjects in Table 4.

TABLE 3

RANGES, MEANS AND STANDARD DEVIATIONS
OF EXPOSURE TIMES
(N = 11)

Time in Seconds	Test			Retest		
Exposures	R	M	SD	R	M	SD
1	0	0	0	0	0	0
2	9.0-26.0	15.67	6.02	6.0-21.5	10.91	5.64
3	18.2-36.5	30.61	6.25	19.0-35.0	27.77	5.10
4	35.2-46.0	43.09	3.75	29.0-51.5	39.95	7.93
5	55.2-60.0	58.00	1.72	49.0-60.0	56.00	3.71

TABLE 4

RANGES, MEANS AND STANDARD DEVIATIONS
OF EXPOSURE TIMES
(N = 19)

Time in Seconds Exposures	Range	Mean	Standard Deviation
1	0	0	0
2	5.1-28.4	15.32	6.48
3	13.4-37.0	29.58	6.75
4	18.0-48.8	42.10	6.94
5	45.0-60.0	57.52	3.41

It would appear that the subjects displayed a very definite and constant pattern of sway. This is similar to the rhythmic oscillations found by Hellebrandt and Fries (14). The means of test and retest differ five seconds at the greatest and are quite similar in time lapse.

A t-test of the null hypothesis that there was no difference between means of all five exposures was made with the critical region to reject the null hypothesis for a t greater than +3.17 or less than -3.17 at .01. The null hypothesis was accepted on each exposure, 1-5, from the following respective results; -1.78, -1.60, -1.24, -1.57, -.95. The means, standard deviations and correlations of test-retest for the five exposures for total posture are given in Table 5.

TABLE 5

TOTAL POSTURE MEANS, STANDARD DEVIATION AND CORRELATIONS FOR TEST-RETEST (N = 11)

	Test			Retest	
Exposures	M	S	r	M	S
1	49.77	9.98	.29	44.0	6.68
2	47.55	8.48	.39	43.27	6.49
3	48.55	10.10	.23	44.41	6.16
4	48.50	10.70	.36	43.36	6.21
5	46.18	8.59	.16	43.18	6.98

The ranges, means, and standard deviations of the gravital line, angle formed from center of gravity and malleolus, segmental angles and total posture for the five exposures are given in Table 6. The mean of each of the five posture observations for total body alignment was equivalent to a C rating. The greatest deviations in segmental angulations were found to be Angles II and III in each of the five observations. These findings are similar to results obtained by a previous investigator (19).

The mean location of the gravital line anterior to the center of the lateral malleolus for all five observations was found to be 4.52 centimeters. This finding is comparable to the results by Fox and Young (12) who found the location of the gravital line to be 5.36 centimeters anterior to the posterior border of the lateral malleolus.

Intercorrelations

The total correlation matrix for all variables is given in the appendix. In Table 7 the correlations between exposure times for each postural variable is presented. The high correlations found seem to indicate that the time the measurement was taken in this study had little influence. The scores were highly consistent throughout the one minute period regardless of the time taken.

The postural variables significantly related to the location of the gravital line at the five exposure times

TABLE 6

THE RANGES, MEANS, AND STANDARD DEVIATIONS OF THE GRAVITAL LINE, ANGLE FORMED FROM CENTER OF GRAVITY AND MALLEOLUS, SEGMENTAL ANGLES AND TOTAL POSTURE FOR THE FIVE EXPOSURES (N = 19)

	Exposure I			Exposure II			Exposure III			Exposure IV			Exposure V		
	R	M	S	R	M	S	R	M	S	R	M	S	R	M	S
Gravital line anterior to lateral malleolus	2.06- 8.07	4.556	1.419	3.02- 6.65	4.474	1.059	1.59- 8.68	4.924	1.573	2.06- 8.47	4.519	1.482	2.07- 8.07	4.342	1.416
Angle formed from gravital line and from center of gravity and malleolus (degrees)	1.5 - 5.0	3.000	.849	1.5 - 4.5	2.921	.786	1.0 - 5.5	3.026	1.047	1.0 - 5.0	2.815	1.002	1.5 - 5.0	2.842	.898
Angle I (degrees)	17.0 -29.0	22.315	3.271	16.5 -29.0	22.447	3.299	16.0 -29.0	22.157	3.270	14.0 -29.0	22.315	3.468	15.0 -29.0	22.263	3.481
Angle II (degrees)	4.0 -27.5	13.657	7.168	3.0 -24.0	12.421	7.284	5.0 -26.0	12.921	6.835	0 -27.0	12.894	7.882	2.0 -23.5	12.605	6.402
Angle III (degrees)	0 -22.5	8.210	5.704	.5 -20.5	8.394	5.162	1.0 -24.0	8.421	5.627	0 -22.5	8.473	5.699	1.0 -24.0	7.710	5.647
Angle IV (degrees)	0 - 8.0	3.263	2.513	0 - 8.5	3.315	2.501	0 - 9.0	3.026	2.616	.5 - 8.0	3.078	2.328	0 - 8.0	2.868	2.222
Total Posture (degrees)	37.0 -69.5	47.447	8.197	35.0 -61.5	46.578	7.053	36.0 -65.0	46.526	8.250	33.0 -69.0	46.763	8.833	32.5 -56.0	45.447	7.251

TABLE 7

CORRELATIONS BETWEEN EXPOSURE TIMES FOR EACH POSTURAL VARIABLE
(N = 19)

Variables	Exposure Times									
	1-2	1-3	1-4	1-5	2-3	2-4	2-5	3-4	3-5	4-5
Total Posture	.914	.939	.920	.696	.896	.924	.824	.916	.752	.716
Angle I	.906	.952	.883	.879	.949	.949	.933	.920	.932	.928
Angle II	.951	.952	.901	.911	.965	.963	.904	.952	.867	.842
Angle III	.903	.940	.914	.878	.958	.957	.861	.979	.881	.865
Angle IV	.934	.920	.962	.904	.918	.923	.935	.923	.899	.877
Gravital line anterior to malleolus	.869	.924	.835	.859	.873	.840	.850	.900	.865	.866
Angle formed gravital line malleolus	.831	.936	.749	.819	.846	.843	.787	.785	.846	.814

are presented in Table 8. Since the vertical projection of the center of gravity is also a contributor to the angle formed by this gravital line, it is not difficult to understand the very high correlations presented in Table 8. It should be noted that these were positive correlations. That is, the greater the distance the gravital line fell anteriorly to the center of the lateral malleolus the greater the number of degrees of the angle, and the lesser the distance the lesser the angle.

Angle III correlated significantly in relation to the gravital line with the exception of the second exposure. It is difficult to interpret the lack of significant correlations for the other posture angles although these fell just below the significance level. Perhaps, Angle III, the hip-knee segment, was the more important body segment in postural adjustment to body sway.

Total posture correlated significantly positively as the subject came closer to the full minute of standing. These results do not compare with the results of a previous investigator. Kalenda (14) found total posture correlation -.305 in relation to the location of the gravital line. This might have been due to differences of methodology in obtaining these scores, i.e., in the previous investigation it was taken once the first 10 seconds of erect standing.

TABLE 8

VARIABLES SIGNIFICANTLY CORRELATED WITH GRAVITAL LINE IN RELATION TO THE ANKLE JOINT ANTERIORLY TO CENTER OF LATERAL MALLEOLUS AT DIFFERENT EXPOSURE TIMES
(N = 19)

Variables		Exposure Times 1	2	3	4	5
Angle formed vertical projection and malleolus	1	.974	.831	.905	.750	.828
	2	.841	.892	.875	.782	.827
	3	.919	.797	.963	.771	.847
	4	.838	.824	.910	.920	.913
	5	.843	.768	.860	.711	.952
Angle I						
Angle II						
Angle III	1					.494
	2	.463		.452		.462
	3	.511		.524	.496	.584
	4	.471		.479	.453	.545
	5	.483		.469	.489	.594
Angle IV						
Total Posture	1					
	2					
	3					.478
	4					
	5				.446	.522

P = .561 at .01 level of significance
.444 at .05 level of significance

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of this study was to investigate (1) the constancy of body sway and postural alignment in erect standing, and (2) the relationship of body sway to postural alignment.

Nineteen senior college women volunteered as subjects for the study. All subjects were physical education majors. The Massey Technique was the method used as a test of posture. The Williams and Lissner method was used to obtain the center of gravity. Five anteroposterior profile posture pictures were taken of each subject during one minute of standing.

The Pearson Product Moment Coefficient of Correlation was the statistical technique employed. The test-retest technique was employed for reliability.

Conclusions

Within the limits of this study postural alignment was highly similar regardless of the time it was taken during the one minute of erect standing. In addition, Angle III appeared to be the more important body segment in postural adjustment to body sway. It is also evident that the longer the subject stands the more nearly she assumed her habitual standing posture or more stable postural position.

1. Statistically significant correlations were found for each postural variable between exposure times (5) during one minute of standing. The high correlations found seem to indicate that the body sway during one minute of erect standing had little influence on postural alignment.
2. Angle III, the hip-knee segment was found to be significantly positively related to the gravital line, i.e., the greater the distance anteriorly to the center of the lateral malleolus the greater the degrees.
3. Total posture was significantly positively related to the gravital line during the last three exposure times.
4. The gravital line was found to intersect the foot at a mean distance of 4.52 centimeters anteriorly to the center of the lateral malleolus during one minute of erect standing posture.
5. Test-retest correlations showed greater reliability the closer the subjects came to a full minute of standing. Although the reliability

coefficients were in general low, the qualitative grades awarded total posture were identical. No significant mean differences were found for the mean values of each exposure time.

Recommendations

1. Repeat the study with large sample randomly selected.
2. Standardize the time of each exposure time although using a continuous photographic procedure to assess pronounced body or postural sway.
3. Body type all subjects.

BIBLIOGRAPHY

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Books

1. Amar, J. The Human Motor. N. Y. E. P.: Dutton and Co., 1920.

2. Daniels, Arthus S. Adapted Physical Education. New York: Harper and Brothers, 1954.

3. Kendall, Henry O., Kendall, Florence P., and Boynton, Dorothy A. Posture and Pain. Baltimore: The Williams and Wilkins Company, 1952.

4. Lowman, Charles G., and Young, C. H. Postural Fitness. Philadelphia: Lea and Febiger, 1960.

5. Morton, D., and Fuller. Human Locomotion and Body Form in Man. Baltimore: The Williams and Wilkens Company, 1952.

6. Rasch, Philip J., and Burke, Roger K. Kinesiology and Applied Anatomy: The Science of Human Movement. Philadelphia: Lea and Febiger, 1963.

7. Steindler, A. Kinesiology of the Human Body. Springfield, Illinois: Charles C. Thomas, 1955.

8. Stone, Eleanor B., and Deyton, John W. Corrective Therapy for the Handicapped Child. New York: Prentice-Hall, Inc., 1953.

9. Williams, Marion, and Lissner, Herbert R. Biomechanics of Human Motion. Philadelphia and London: W. B. Saunders Company, 1962.

Periodicals

10. Brunnstrom, Signe. "Center of Gravity Line in Relation to Ankle Joint in Erect Standing," The Physical Therapy Review, 34:109-115, March, 1954.

11. Cureton, Thomas Kirk, Jr., and Wickens, J. Stuart. "The Center of Gravity of the Human Body in the Antero-Posterior Plane and Its Relation to Posture, Physical Fitness, and Athletic Ability," Supplement to the Research Quarterly, 6:93-105, May, 1935.

12. Fox, Margaret G., and Young, Olive G. "Placement of the Gravital Line in Antero-Posterior Standing Posture," Research Quarterly, 25:277-285, October, 1954.

13. Hellebrandt, F. A., and Franseen, Elizabeth Brogdon. "Physiological Study of the Vertical Stance of Man," Physiological Review, 23:220-249, 1943.

14. Hellebrandt, F. A., and Fries, E. Corinne. "The Constancy of Oscillographic Stance Patterns," Physiotherapy Review, 22:17-23, 1942.

15. Hellebrandt, F. A., and Fries, E. Corinne. "The Eccentricity of the Mean Vertical Projection of the Center of Gravity During Standing," Physiotherapy Review, 22:186-192, 1942.

16. Hellebrandt, F. A., and Kelso, L. E. A. "Synchronizing Biplane Stance Photography with Center of Gravity Observations," Physiotherapy Review, 22:83-87, 1942.

17. Hellebrandt, F. A., Kelso, L. E. A., and Fries, E. Corinne. "Devices Useful to the Physiological Study of Posture," Physiotherapy Review, 22:10-16, 1942.

18. Hellebrandt, F. A., Riddle, Kathryn S., and Fries, E. Corinne. "The Influence of Postural Sway on Stance Photography," Physiotherapy Review, 22:88-96, 1942.

19. Hellebrandt, F. A. "The Influence of Sex and Age in the Postural Sway in Man," American Journal of Physiology and Anthropology, 24:347-360, 1939.

20. Hellebrandt, F. A., Riddle, Kathryn S., Larsen, Eleanor M., and Fries, E. Corinne. "Gravitational Influences on Postural Alighment," Physiotherapy Review, 22:143-149, 1942.

21. Massey, Wayne W. "A Critical Study of Objective Methods for Measuring Anterior Posterior Posture with a Simplified Technique," Research Quarterly, 14:3-22, March, 1943.

22. Reynolds, Edward, and Lovett, Robert W. "A Method of Determining the Position of the Centre of Gravity in Its Relation to Certain Bony Landmarks in the Erect Position," American Journal of Physiology, 24:286-293, 1909.

23. Wells, Katherine F. "What We Don't Know About Posture," Journal of Health, Physical Education and Recreation, 29:31-32, May-June, 1958.

Unpublished Materials

24. Kalenda, Lenore May. "Relationships of Body Alignment with Somatotype and Center of Gravity in College Women: A Pilot Study." Unpublished Master's Thesis, Michigan State University, East Lansing, Michigan, 1964.

APPENDICES

TABLE A

RAW DATA ON MEASUREMENTS

Subject Number	Age in Months	Weight in Pounds	Height in Centimeters	Length of Left Foot in Centimeters	Length of Right Foot in Centimeters	Ce[illegible] of Gravity in % Height	Vertical Projection of Center of Gravity Anterior to Center of Malleolus In Five Exposures #1	#2	#3	#4	#5	Angle Formed by Center of Gravity Projection and Malleolus in Five Exposures #1	#2	#3	#4	#5
1	249	117.50	165.00	23.6	23.8	.5480	4.25	3.79	4.47	4.47	3.11	3.0	3.0	3.0	3.0	2.5
2	257	144.75	166.50	24.1	24.2	.5652	3.20	4.12	4.12	3.02	2.65	2.0	2.0	2.0	2.0	2.0
3	268	133.75	164.50	24.5	24.4	.5497	5.84	4.85	5.44	4.85	5.64	4.0	3.0	3.5	3.0	4.0
4	240	111.50	166.00	25.4	25.2	.5451	4.70	4.70	4.23	4.70	3.75	3.0	3.0	3.0	3.5	2.5
5	256	136.25	166.50	23.7	23.6	.5448	3.00	3.19	3.39	3.59	2.61	2.0	2.0	2.0	2.0	2.0
6	281	106.50	165.00	26.7	26.6	.5599	5.42	5.42	5.42	5.42	5.17	3.0	3.5	3.0	3.5	3.5
7	359	160.50	172.00	25.7	25.8	.5376	4.98	5.31	5.48	5.31	4.98	3.5	3.5	3.5	3.5	3.0
8	251	140.50	171.00	25.9	25.5	.5623	4.15	4.72	5.47	4.72	4.91	3.0	3.0	4.0	2.0	3.0
9	255	153.25	168.50	49.9	24.9	.5559	4.77	5.47	4.08	3.90	4.77	3.0	3.5	3.0	2.5	3.0
10	248	130.75	166.00	25.4	25.0	.5454	6.38	5.57	6.52	4.75	5.36	4.0	4.0	4.0	3.0	3.0
11	256	102.00	156.00	22.8	22.3	.5522	3.56	3.82	4.08	4.08	4.08	2.5	2.5	2.5	2.5	2.5
12	248	143.00	169.50	27.0	27.0	.5481	4.45	3.89	4.82	3.52	3.52	3.0	2.0	3.0	2.0	2.0
13	251	122.00	158.50	23.1	23.3	.5527	4.53	4.53	5.41	5.84	4.97	3.0	3.0	3.5	4.0	3.5
14	250	114.50	157.00	22.2	22.5	.5486	5.98	5.98	6.45	6.91	5.52	4.0	4.5	4.5	5.0	4.0
15	266	122.00	162.00	24.3	24.4	.5339	2.06	3.02	1.59	2.06	2.78	1.5	1.5	1.0	1.0	1.5
16	336	107.50	161.00	24.5	24.5	.5575	2.89	3.38	3.14	3.88	4.38	2.0	2.5	2.0	2.5	3.0
17	244	131.50	172.00	24.8	24.4	.5367	8.07	6.65	8.68	8.47	8.07	5.0	4.0	5.5	4.5	5.0
18	252	140.50	169.25	25.1	25.0	.5610	4.91	3.39	4.15	3.39	4.15	3.0	2.5	2.5	2.0	2.5
19	250	118.75	168.00	24.1	24.1	.5493	3.42	3.19	2.74	2.97	2.07	2.5	2.5	2.0	2.0	1.5

Massey Exposure #1					Massey Exposure #2					Massey Exposure #3				
Angle I	Angle II	Angle III	Angle IV	Total	Angle I	Angle II	Angle III	Angle IV	Total	Angle I	Angle II	Angle III	Angle IV	Total
21.0	4.0	13.0	7.5	45.5	24.5	4.0	14.0	8.0	50.5	23.5	5.5	12.0	7.0	48.0
21.0	4.0	8.0	5.0	38.0	20.0	4.5	7.0	5.0	36.5	21.0	6.5	4.5	6.0	38.0
24.0	7.0	11.5	2.5	45.0	22.5	7.0	10.5	3.0	43.0	23.5	7.5	10.0	2.5	43.5
22.0	14.0	3.0	5.0	44.0	21.5	13.0	3.5	5.0	43.0	21.0	12.0	3.0	2.0	38.0
23.0	9.0	4.0	3.0	39.0	23.0	7.0	7.5	4.0	41.5	22.0	6.5	6.5	2.5	37.5
17.0	24.5	12.0	1.0	54.5	16.5	23.0	11.0	.0	50.5	16.0	22.0	10.0	.0	48.0
29.0	20.0	.0	8.0	57.0	29.0	18.5	.5	8.5	56.5	29.0	18.0	1.0	9.0	57.0
19.5	21.0	10.0	1.0	51.5	22.0	22.0	10.5	.0	54.5	19.0	21.0	10.5	1.0	51.5
24.0	5.0	11.5	3.0	43.5	24.0	5.0	12.0	5.0	46.0	24.5	5.0	12.0	4.5	46.0
27.0	12.0	6.0	2.5	47.5	26.5	3.0	14.0	2.5	46.0	27.0	5.0	12.0	3.0	47.0
27.0	27.5	15.0	.0	69.5	25.5	24.0	11.0	1.0	61.5	25.0	26.0	14.0	.0	65.0
23.5	16.0	2.0	4.5	46.0	25.0	15.0	2.0	4.0	46.0	24.0	14.5	2.5	3.0	44.0
22.0	21.0	13.0	3.5	59.5	20.0	19.5	11.0	2.5	53.0	21.5	23.0	13.5	2.5	60.5
22.0	16.5	1.5	1.0	41.0	23.0	16.0	1.0	1.5	41.5	22.0	16.5	2.0	.0	40.5
23.5	19.5	5.0	.5	48.5	24.0	21.0	6.0	1.0	52.0	22.5	17.5	5.0	1.0	46.0
24.0	13.5	3.5	1.0	42.0	25.0	13.5	3.0	.5	42.0	24.5	12.5	4.0	1.0	42.0
17.5	10.0	22.5	.5	50.5	19.0	7.0	20.5	1.5	48.0	19.0	12.0	24.0	1.0	56.0
18.5	7.0	10.0	6.5	42.0	17.5	6.5	9.0	5.0	38.0	17.5	7.5	8.5	6.0	39.5
18.5	8.0	4.5	6.0	37.0	18.0	6.5	5.5	5.0	35.0	18.5	7.0	5.0	5.5	36.0

Massey Exposure #4					Massey Exposure #5					Time of Exposures in Seconds				
Angle I	Angle II	Angle III	Angle IV	Total	Angle I	Angle II	Angle III	Angle IV	Total	#1	#2	#3	#4	#5
24.0	6.0	12.0	7.5	49.5	23.0	6.0	11.0	7.5	47.5	.0	15.0	25.0	36.0	45.0
20.5	3.0	4.5	5.0	33.0	20.5	4.5	4.5	4.0	33.5	.0	12.5	34.5	45.0	56.2
23.0	7.5	9.5	2.0	42.0	23.0	7.0	10.0	2.0	42.0	.0	9.2	27.4	35.2	55.2
22.0	12.0	3.5	3.5	41.0	22.5	13.5	2.0	4.5	42.5	.0	10.5	18.2	37.5	55.5
23.0	7.5	6.0	3.0	39.5	21.5	10.0	4.0	3.5	39.0	.0	28.4	33.6	48.8	57.0
14.0	21.5	11.5	2.0	49.0	15.0	23.5	12.0	.0	50.5	.0	19.9	34.8	45.5	57.8
29.0	16.0	3.0	8.0	56.0	29.0	16.0	2.5	8.0	55.5	.0	19.8	31.5	45.0	58.8
20.0	22.0	11.0	1.0	54.0	19.5	23.0	12.5	1.0	56.0	.0	11.5	19.7	40.2	58.5
24.0	4.0	12.0	3.0	43.0	24.0	2.0	13.0	3.0	42.0	.0	14.5	23.0	45.5	56.5
24.0	.0	13.5	1.5	39.0	28.0	11.5	6.0	3.0	48.5	.0	5.1	13.4	18.0	59.7
26.5	27.0	14.5	1.0	69.0	24.0	16.0	5.0	1.0	46.0	.0	15.5	35.0	45.5	59.5
25.0	17.0	.0	4.5	46.5	24.0	16.5	1.0	2.5	44.0	.0	20.2	31.5	48.1	59.7
19.5	23.0	14.0	2.5	59.0	19.0	20.0	12.5	2.5	54.0	.0	24.5	34.0	44.5	60.0
23.5	16.5	.5	.5	41.0	25.0	15.0	1.0	.0	41.0	.0	26.0	33.2	43.6	59.0
25.0	20.0	6.0	.5	51.5	24.5	20.5	7.0	2.0	54.0	.0	11.0	28.4	44.6	59.5
24.5	19.0	3.0	1.0	47.5	24.0	12.5	4.5	1.0	42.0	.0	17.6	37.0	42.5	57.5
20.0	8.5	22.5	1.0	52.0	20.5	9.0	24.0	1.0	54.5	.0	9.0	36.5	46.0	60.0
18.0	7.5	8.0	5.0	38.5	18.0	7.0	8.5	5.0	38.5	.0	7.0	33.5	42.5	60.0
18.5	7.0	6.0	6.0	37.5	18.0	6.0	5.5	3.0	32.5	.0	14.0	32.0	46.0	57.5

TABLE B

INTERCORRELATION MATRIX

OF ALL VARIABLES

				Foot Length			Center of Gravity Vertical Projection Intersection of Foot Forward of Center of Lateral Malleolus in Five Exposures					Angle of Center of Gravity Projection and Malleolus Five Exposures					Massey Technique Exposure #1				
																	Angles				
	Age	Weight	Height	Left	Right	% Height of Center of Gravity	#1	#2	#3	#4	#5	#1	#2	#3	#4	#5	1	2	3	4	Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	1.00	.140	.069	.188	.236	-.086	-.171	-.023	-.126	-.025	.076	-.142	.088	-.161	.021	.061	.438	.239	-.362	.129	.171
2		1.00	.720	.367	.393	.040	.185	.206	.239	-.037	.097	.214	.039	.199	-.146	.010	.185	-.387	-.107	.450	-.201
3			1.00	.698	.684	.071	.266	.175	.212	.008	.100	.254	.207	.208	-.190	-.025	-.234	-.380	.015	.435	-.282
4				1.00	.984	.073	.192	.155	.131	-.082	.129	.122	-.023	.084	-.213	-.039	-.110	.092	-.125	.142	-.006
5					1.00	.072	.149	.127	.032	-.111	.072	.081	-.042	.038	-.202	-.071	-.117	.054	-.207	.225	-.074
6						1.00	.180	.136	.106	.214	.136	-.248	-.096	-.145	-.186	-.053	-.341	-.090	.136	-.009	-.123
7							1.00	.869	.924	.835	.849	.974	.831	.904	.750	.828	.160	.078	.410	.087	.126
8								1.00	.873	.840	.850	.841	.892	.875	.782	.827	.024	.095	.307	.239	.214
9									1.00	.900	.865	.919	.796	.962	.771	.847	.118	.067	.422	.163	.255
10										1.00	.866	.838	.824	.910	.920	.913	.176	.178	.417	.250	.299
11											1.00	.843	.768	.860	.711	.951	.052	.181	.494	.411	.355
12												1.00	.831	.936	.750	.819	-.070	-.073	.358	-.045	.143
13													1.00	.846	.843	.787	-.017	.056	.208	-.129	.148
14														1.00	.785	.846	-.108	.068	.373	-.161	.227
15															1.00	.814	-.070	.147	.218	-.095	.223
16																1.00	-.138	.092	.503	-.374	.261
17																	1.00	.209	-.401	.043	.316
18																		1.00	-.050	-.456	.783
19																			1.00	-.306	.398
20																				1.00	-.288
21																					1.00
22																					
23																					
24																					
25																					
26																					
27																					
28																					
29																					
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31																					
32																					
33																					
34																					
35																					
36																					
37																					
38																					
39																					
40																					
41																					

	Massey Technique Exposure #2					Massey Technique Exposure #3				
	Angles					Angles				
	1	2	3	4	Total	1	2	3	4	Total
	22	23	24	25	26	27	28	29	30	31
1	.428	.275	-.432	.126	.213	.442	.202	-.377	.253	.166
2	.199	-.363	-.019	.510	-.115	.252	-.364	-.067	.619	-.051
3	-.103	-.369	.144	.412	-.178	-.131	-.398	.063	.502	-.180
4	-.039	.074	-.033	.027	.043	-.100	-.013	-.100	.107	-.085
5	-.037	.066	-.128	.101	-.006	-.089	-.036	-.202	.180	-.146
6	-.407	-.012	.027	-.173	-.245	-.390	.001	-.032	-.008	-.179
7	.143	.218	.463	.046	.030	.065	.075	.511	.089	.232
8	.000	.010	.340	.134	.191	.053	.102	.396	.174	.321
9	.060	.071	.452	.135	.181	.017	.102	.524	.145	.389
10	.111	.089	.363	.198	.235	.083	.253	.496	.277	.427
11	.034	.084	.462	.355	.283	.006	.219	.584	.331	.478
12	-.025	-.202	.405	.006	.079	.040	.060	.470	-.044	.273
13	.030	-.071	.282	-.064	.124	.075	.035	.331	-.107	.251
14	-.008	-.043	.401	-.120	.203	.003	.111	.493	-.162	.378
15	-.070	.060	.152	-.047	.124	.009	.206	.270	-.183	.301
16	-.120	.034	.433	-.316	.184	-.062	.176	.547	-.329	.390
17	.906	.108	-.318	.209	.377	.952	.071	-.267	.156	.297
18	.154	.951	-.187	-.531	.728	.043	.952	-.037	-.522	.615
19	-.404	-.079	.903	-.251	.301	-.347	.097	.940	-.202	.520
20	.049	-.419	-.263	.934	-.271	.138	-.434	-.359	.920	-.258
21	.229	.691	.257	-.269	.914	.218	.795	.401	-.253	.939
22	1.00	.088	-.290	.229	.428	.949	.031	-.261	.161	.274
23		1.00	-.293	-.501	.682	-.051	.965	-.143	-.490	.527
24			1.00	-.193	.226	-.237	-.139	.958	-.133	.401
25				1.00	-.197	.326	-.513	-.281	.918	-.197
26					1.00	.334	.727	.331	-.203	.896
27						1.00	-.070	-.209	.272	.282
28							1.00	.040	-.495	.671
29								1.00	-.240	.556
30									1.00	-.149
31										1.00
32										
33										
34										
35										
36										
37										
38										
39										
40										
41										

	Massey Technique Exposure #4					Massey Technique Exposure #5				
	Angles					Angles				
	1	2	3	4	Total	1	2	3	4	Total
	32	33	34	35	36	37	38	39	40	41
1	.377	.262	-.316	.207	.232	.353	.179	-.232	.221	.214
2	.189	-.445	-.078	.438	-.258	.216	-.335	.065	.455	-.001
3	-.139	-.457	.067	.460	-.298	-.090	-.249	.277	.404	.076
4	-.184	-.033	-.077	.163	-.108	-.091	.236	.075	.079	.247
5	-.176	-.040	-.181	.242	-.158	-.085	.226	.021	.137	.218
6	-.496	.035	-.044	-.011	-.195	-.523	-.083	.007	-.200	-.380
7	.187	.256	.471	.132	.033	.040	.091	.483	.122	.277
8	.075	.106	.391	.245	.064	.157	.062	.421	.214	.393
9	.136	.097	.479	.178	.122	.056	.072	.469	.170	.404
10	.140	.100	.452	.254	.259	.004	.159	.489	.241	.446
11	.085	.080	.545	.431	.276	.082	.145	.594	.353	.522
12	-.056	-.228	.427	-.091	.026	.145	-.094	.434	-.073	.302
13	-.072	-.129	.340	-.163	.033	.175	.002	.313	-.133	.289
14	-.075	-.060	.445	-.194	.152	.101	.076	.464	-.171	.425
15	-.086	.068	.244	-.130	.150	.070	.094	.240	-.130	.264
16	-.157	.060	.495	-.392	.208	-.013	.073	.579	-.352	.402
17	.883	.071	-.231	.033	.270	.879	.029	-.501	.264	.138
18	.072	.901	.026	-.398	.744	.025	.911	-.121	-.406	.598
19	[illegible]	-.008	.914	-.239	.371	-.425	-.131	.878	-.232	.293
20	.081	-.441	-.320	.962	-.315	.055	-.420	-.274	.904	-.281
21	.177	.676	.468	-.206	.920	.094	.588	.221	-.134	.696
22	.949	.069	-.244	.069	.294	.933	.054	-.426	.300	.256
23	.045	.963	-.095	-.352	.723	-.063	.904	-.121	-.388	.555
24	-.340	-.264	.957	-.228	.188	-.289	-.204	.861	-.138	.310
25	.297	-.532	-.252	.923	-.277	.256	-.557	-.240	.935	-.269
26	.347	.645	.398	-.170	.924	.251	.612	.221	-.030	.824
27	.920	-.063	-.185	.142	.223	.932	-.103	-.396	.358	.158
28	-.003	.952	.078	-.364	.802	-.105	.867	.008	-.411	.596
29	-.277	-.082	.979	-.316	.367	-.263	-.110	.881	-.243	.388
30	.189	-.529	-.188	.923	-.276	.171	-.528	-.142	.899	-.219
31	.233	.540	.599	-.168	.916	.157	.435	.406	-.079	.751
32	1.00	.050	[illegible]	.100	.280	.928	-.072	-.442	.324	.138
33		1.00	[illegible]	-.374	.770	-.102	.842	-.085	-.430	.494
34			1.00	-.274	.400	-.255	-.058	.865	-.182	.444
35				1.00	-.208	.028	-.398	-.227	.877	-.246
36					1.00	.111	.580	.249	-.142	.716
37						1.00	-.078	-.421	.288	.172
38							100	-.075	-.390	.667
39								1.00	-.208	.446
40									1.00	-.062
41										1.00