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The Effects of a Rebound Tumbling Program Upon Body Weight, Body Measurements, Adipose Tissue, Leg Strength, Explosive Power of the Legs, and the Endurance of College Women

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THE EFFECTS OF A REBOUND TUMBLING PROGRAM UPON BODY WEIGHT, BODY MEASUREMENTS, ADIPOSE TISSUE, LEG STRENGTH, EXPLOSIVE POWER OF THE LEGS, AND THE ENDURANCE OF COLLEGE WOMEN

BY

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This thesis is approved as a creditable, independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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MJHW

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CHAPTER I

INTRODUCTION

George Nissen developed his first model of the trampoline in a garage at Cedar Rapids, Iowa, in 1930. Prior to this time, rebound tumbling had been performed upon catchers' nets in the circus. From this start our present day sport of rebound tumbling has developed.

Trampolines were first introduced into the public schools after World War II, and in the 1950's trampolining became popular as an outdoor sport. The commercial use of rebound tumbling centers began on the west coast and gradually spread eastward. The public rebound tumbling centers have made it possible for both children and adults to participate in this enjoyable activity.

There seems to be little doubt among physical educators that rebound tumbling is enjoyable.

Holzaepfel, varsity gymnastics coach, at the University of Iowa stated:

> As an activity, rebound tumbling is being enjoyed by those from two to seventy . . . and by both sexes. Being a natural, easy and rhythmical activity, pure fun and success are immediately realized by the participants.[1]

Wettstone, gymnastics coach, from the State University of Pennsylvania, said in referring to the values of rebound tumbling:

> Its carry-over values cannot be denied, for its place in the development of basic kinesthetic sense, landing techniques, coordination, mental discipline, and body control has long since been ascertained by the U. S. Naval pre-flight program during World War II.[2]

Holzaepfel emphasized the merit of the activity when he stated:

> Rebound tumbling is an enjoyable activity for all, but as yet there seems to be little proof of its actual benefits. The use of the trampoline as a teaching device has not yet fully been appreciated. The diver, the tumbler, the pole vaulter, the dancer, and even the potential aviator can be given an introduction into time and space relationship which is so vital to a fuller understanding of these activities.[3]

The author hoped to prove that women derived physiological benefits by engaging in this enjoyable activity.

Statement of the problem

The purpose of this study was to determine the effects of a rebound tumbling program on body weight, body measurements, the amount of adipose tissue, leg strength, explosive power of the legs, and the endurance of college women.

Delimitations of the problem

This study was limited to volunteers in the rebound tumbling program at South Dakota State College. There were 60 girls who volunteered for the program and 39 who remained through its completion. Each student was assigned to three of nine classes which ranged in size from 16 to 21 students.

Five minutes were spent on the trampoline per scheduled time for each individual. This amounted to 15 minutes per week or a total of three hours during the 12 week period. A break occurred between the fourth and fifth week of the program because of the two week Christmas vacation.

No attempt was made to control the time spent on other outside activities. During the program the girls were allowed to participate in rebound tumbling only at their regularly scheduled times. No attempt was made to control individual factors; such as diet, rest, smoking or drinking.

Significance of the problem

Administrators and physical educators have been concerned about the relatively high cost of rebound tumbling equipment because a regulation trampoline costs about $500.00. During an hour's time a trampoline will accommodate approximately 25 people. This allows each individual to jump about a minute and a half during this hour. Pleasure alone cannot justify this expenditure. Values must be seen in terms of the physical, social, mental, or emotional development of the participants. The author was primarily interested in the physical aspect of the rebound tumbling program as it related to body weight, body measurements, adipose tissue, explosive power of the legs, and endurance in college women.

Today's women are interested in body build and physical appearance. Morehouse and Pasch stated that body fat accounts for about 28 per cent of the body weight of women.[4] Because of this fact, body weight and body measurements present a problem to some women. This is evidenced by the popularity of the commercial gymnasiums and the Stauffer system. It was of interest to the author to find out what effects a rebound tumbling program had on these measurements.

In the last few years stress has been placed upon complete physical fitness. This is pointed out in President Kennedy's Youth Fitness Program. It was, therefore of interest to the author to find out the effects of the rebound tumbling unit on the physical fitness components of leg strength, explosive power of the legs, and endurance in college women.

Definition of terms

The following definitions were selected from a text by Larson and Yocom for use in this study.

> Leg strength. Muscular strength is the ability to exert single explosive force against an object such as a hand or back and leg dynamometer.[5]

> Endurance. Muscular endurance is the ability to continue successive performance of muscular strength and/or power at a maximum rate of speed over an unlimited time span. The amount of time that the muscular performance is continued will indicate the amount of endurance.[6]

> Explosive power. Dynamic strength is the ability of an individual to lift the body weight or propel it in any direction (upward, as in the vertical jump, forward as in the broad jump).[7]

Clarke's definition of physical fitness was accepted for use in this study.

> Physical fitness. The person with adequate physical fitness should be able to carry out his daily tasks without undue fatigue and should still have an ample reserve of energy to enjoy leisure time and to meet unforeseen emergencies.[8]

> Adipose tissue. The subcutaneous layer of fat which is measurable with skinfold calipers because of very little fiberous connective tissue.

CHAPTER II

RELATED LITERATURE

The author found very little literature concerning the use of rebound tumbling in the physical education program. There was considerable literature on the measures of leg strength, explosive power of the legs, and endurance; but little was applied directly to the use of the trampoline and its effect on these physical capacities.

Leg strength

Larson and Yocom have stated the following in regard to leg strength:

> Leg strength has little relationship with athletic ability. This was indicated by the Anderson strength tests for girls. The correlation of strength with athletic ability for girls is .55. Therefore; strength can be considered as only a moderately significant factor in athletic performance for girls.[9]

Leg strength is important, however, because an under-muscled individual will tire easily. This fatigue may build up to complete exhaustion. An overweight individual carries too great a load for the muscular structure of his body. Thus, muscular efficiency is lessened because the efficiency of the muscle contraction is related to the muscle load.[10]

Sargent Jump Test

Clarke has recommended four methods for measuring the height of the vertical jump.

The "leapometer" consists of an upright stand with an operating lever arm. A cap or harness is suspended from the arm and any motion by the cap or harness causes a guide holding a pencil to record the height in reduced size. The second way suggested made use of wrapping paper five feet long and two feet wide. Horizontal marks one centimeter apart were ruled on the paper, and the paper attached to the wall. The distance between the standing height and the top of the head at the height of the jump was recorded. The third method suggested by Clarke used an elastic band attached to the subject's ankles upon which a button was secured. The button was adjusted to the zero mark on the paper. The point reached by the button when the subject jumped was recorded. The final method suggested by Clarke, is best known as the "chalk jump." The subject marks his standing reach on the chalk board. He then makes a mark at the height of his jump. The distance between the two marks is recorded.[11]

Val Dalen did a study on the Sargent Jump. In his study there were 106 senior high school boys ranging in age from 15 to 17 years. These boys were taught to execute the Sargent Jump and track and field events correctly. After

they became proficient in these activities, they were tested and the results of the tests compared. Val Dalen made the following conclusions concerning the Sargent Jump. The Sargent Jump, when standardized, practiced, and correctly administered, is undoubtedly a valuable test for predicting the ability to develop power. Val Dalen also found the chalk and wall jumps to be inaccurate when a piece of chalk was used.[12]

Harvard Step Test

Attempts to validate the step test as a measure of physical strength and endurance have failed, but at the present time it is the best test available at a reasonable cost for use under laboratory conditions.

Clarke studied the step test with Radcliffe College women as her subjects. She used a bench 18 inches high and the exercise consisted of 30 steps per minute for four minutes. According to the Harvard men's scale 2 per cent of these women rated excellent, 15 per cent rated good, 31 per cent rated in the high average category, 9 per cent rated in the low average group, and 43 per cent rated in the poor catagory.

Clarke stated that the Harvard-type step test was an accurate means of differentiating between athletes and non-athletes but generally did not correlate well with endurance criteria.[13]

Adipose tissue

In an attempt to find the correct sites for measuring the amount of adipose tissue of women, a letter was written to Thompson, Professor of Health and Physical Education at Mankato State College, Mankato, Minnesota. Thompson has completed several research problems in the use of skinfold calipers.

Thompson believed that one of the best sites for measuring adipose tissue of girls by use of the skinfold calipers was the arm. He also recommended the abdominal site and the scapula site. The gluteal site was not recommended because the fat in this body area is tied in with fiberous tissue making it impossible to measure it accurately.[14]

It is important for women to be conscious of the dangers of excessive adipose tissue. Excessive fat results in the loss of tonus of the abdominal wall which in turn affects the blood supply, circulation, and the elimination of waste products. It also causes dilation of the heart and poor circulation of the blood.[15]

There appears to be a high relationship between the amount of adipose tissue a person has and the scores on such tests as the ponderal index, the calf girth, the vital capacity residuals, the biceps girth, and somatotypes.[16]

Research by Kereilis and Cureton indicated that

uphill treadmill running caused some fat loss in the area of the hips, rear thigh and buttocks, but the loss was not enough to be significant.[17]

In an unpublished master's thesis at South Dakota State College, entitled "Changes in Body Fat as Computed From the Skinfold Measurement of College Track and Field Athletes during a Season of Competition and Training", Walker found significant fat losses at the chest, cheek, abdomen and arm. This study was conducted on 23 subjects and was concerned with the chest, cheek, abdomen, arm sites and body weight. This group was tested four times between January 15, 1959, and May 15, 1959.[18]

Rebound tumbling

The author found that very little research had been done concerning the use of the trampoline. Of those articles written, very few dealt with the trampoline as it related to the physiological development of the body.

At the University of Iowa, an unpublished master's thesis entitled "The Effects of Trampoline Exercise on Selected Physical Capacities" was written by Van Anne. She used three groups of women who were classified according to the amount of time spent on the trampoline. The first group spent 49 or more minutes on the trampoline; the second group spent 31 to 47 minutes on the trampoline; and the

third group spent 30 minutes on the trampoline.

Van Anne found little change in balance and a decrease in ankle flexibility, but this was not enough to be significant. A significant increase was found in ankle extensior strength. The greatest change in these three physical factors was found in the group that had spent the most time on the trampoline.[19]

Another study was conducted at the University of Iowa by Magnusson. Using a control group, Magnusson tested endurance and ankle extensor strength. In her research a gain in endurance was found to be significant at the five per cent level for both groups with a possible superiority in gain for the experimental group. A gain significant at the five per cent level of confidence was also noted in the ankle extensor strength of the experimental group.[20]

In 1953, at the University of Illinois, Gibbons did a research study on the effects of rebound tumbling on the physical fitness status of two adult women.

One woman became pregnant so no definite conclusions could be made regarding some of the tests, but it was found that cardiovascular, respiratory, and circulatory conditions remained unchanged. Strength and flexibility of the trunk increased considerably. There was general loss of body fat and an improvement of muscular tone in both subjects.[21]

In an attempt to learn more about progressions on

the trampoline, the author referred to an article by Scott entitled, "Trampolining is for Girls, Too." These progressions are found in Appendix B.

Scott also explained why the front prone was not taught in this sequence. She did not recommend the prone fall short of a very advanced stage of performance. She suggested that the front prone be omitted entirely from all forms of class work. The criticism of the front prone lies in the tendency inherent in the position and in the give of the trampoline to cause hyperextension of the back.[22]

CHAPTER III

PROCEDURE

It was the purpose of this study to determine the effects of a rebound tumbling program on body build and the physical properties of leg strength, explosive power of the legs, and endurance in college women. Prior to starting the rebound tumbling program the following measurements were taken:

Body weight

The girls were weighed in their underclothing on a doctor's scale manufactured by the Continental Scale Corporation of Chicago, Illinois. Body weight was recorded to the nearest 1/2 pound.

Body measurement

Body measurement was taken in centimeters. Body girth was recorded at the following points:

Right and left arm. Measurement was taken half way between the olecranon and acromial processes.

Bust. Measurement was taken with the tape measure running directly over the nipples and laterally around the back.

Waist. The location of the measurement was approximately 5 centimeters above the ilium.

Right and left thigh. This measurement was taken half way between the patella and the gluteral fold.

Right and left calf. Measurement was taken laterally around the largest part of the gastrocnemius.

Adipose tissue

Adipose tissue was measured in millimeters by the use of the MNL-Medical skinfold calipers. Skinfold measurements were taken in the following sites:.

Cheek. Measurement was taken on the right cheek, level with the lower part of the nose at the center of the cheek.

Chest. The measurement was taken 5 centimeters from the right nipple on a line toward the uppermost point of the axillary fold with the skinfold parallel to this line.

Upper arm. The measurement was taken over the right triceps, half way between the olecranon and acromial processes. The skinfold was taken parallel to the long axis of the arm, with the arm held at a 90 degree angle.

Back. The measurement for the back was taken under the scapula, parallel to the vertebral column.

Abdomen. The measurement was taken 5 centimeters to the right of the umbilicus. The skinfold was oriented laterally.

Hips. The skinfold was taken above the ilium on the right hip for this measurement.

Front thigh. A skinfold was taken half way between the patella and the junction of the thigh and hip. The rear thigh measurement was attempted but was not used in the study because of the fiberous tissue in the skinfold.

Leg strength

Leg strength was tested by use of the leg dynamometer and the belt method was employed.

Explosive power of the legs

Explosive power of the legs was determined through the use of the Sargent Vertical Jump.

Endurance was tested by use of the Harvard Step Test.

After all tests were completed the college women started the rebound tumbling program. Classes were scheduled with 16 to 21 students enrolled in each group and two trampolines were used. The students attended these sessions three hours a week for 12 weeks. The average time spent on the trampoline was 5 minutes per individual during each scheduled period.

Throughout the unit the girls jumped in rotation in assigned order. During the first four weeks the girls took

five turns of 1 minute each during their scheduled classes. In the fifth and sixth weeks the students jumped in turns of 2 minutes, 2 minutes and 1 minute, and from this point their sequence of time changed every two weeks. During the seventh and eighth weeks the time was based upon three and two minute sessions. In the ninth and tenth weeks the time was divided into four and one minute turns. During the last two weeks each girl jumped continuously for five minutes.

A strict attendance record was kept and all classes missed were made up. All of the time spent on the trampoline was charted in terms of minutes for each individual.

The women were retested immediately following the completion of the twelve weeks. The original procedure was used in administering the final tests.

Progressions taught on the trampoline appear in Appendix A.

Because the use of the front prone drop for women was controversial, this particular drop was not used in this study.

TECHNIQUES USED

Skinfold test

A skinfold was taken with the thumb and index finger of the left hand. The skin was pinched and pulled away from the muscles. Time was allowed for the fluids to shift and then the measurements were made by placing the jaws of the calipers below and in line with the tips of the thumb and forefinger. Pressure was placed on the calipers and when the indicators stopped, the result was recorded in millimeters.

Three tests were administered at each site and the mean was used as the raw score.

Leg strength

The leg dynamometer with the belt method was used as pictured in Figure I.

The student was instructed to hold the bar at the junctions of her thighs and hips and the belt was secured. She then was told to step over the dial and to stand with her feet parallel, back straight, head up, and to look straight forward. The angle of the legs was checked to be between 115 and 124 degrees.

The student was then instructed to lift by straightening her legs. She was given three trials and the best of the three trials constituted the raw score.

FIGURE I. LEG AND BACK DYNAMOMETER

The pep talk technique was employed.

Explosive power of the legs

The Sargent Jump Test was used to measure explosive power of the legs, as pictured in Figure II.

First, the subject's standing reach was measured on a chalk board with feet flat on the floor and with arms extended. Next, the girl wet her fingers and from a crouched position was given three trials to jump and reach as high as possible on a chalk board. These three trials were recorded, and the standing reach was subtracted from the best of the three trials to obtain the raw score for the test. The pep talk method was employed.

Endurance

The Harvard Step Test, as pictured in Figure III, was used to test endurance of the women participating in the rebound tumbling program.

A bench 18 inches high was used. The girls were instructed to step up and down on the bench 30 times a minute. A metronome was used to set the pace, and the timer called the cadence "up-two, down, two." The testers made certain that the girls stepped squarely on the bench with their heels as well as their toes. The amount of time the subjects participated in the test was recorded in seconds.

The girls were instructed to sit on the bench

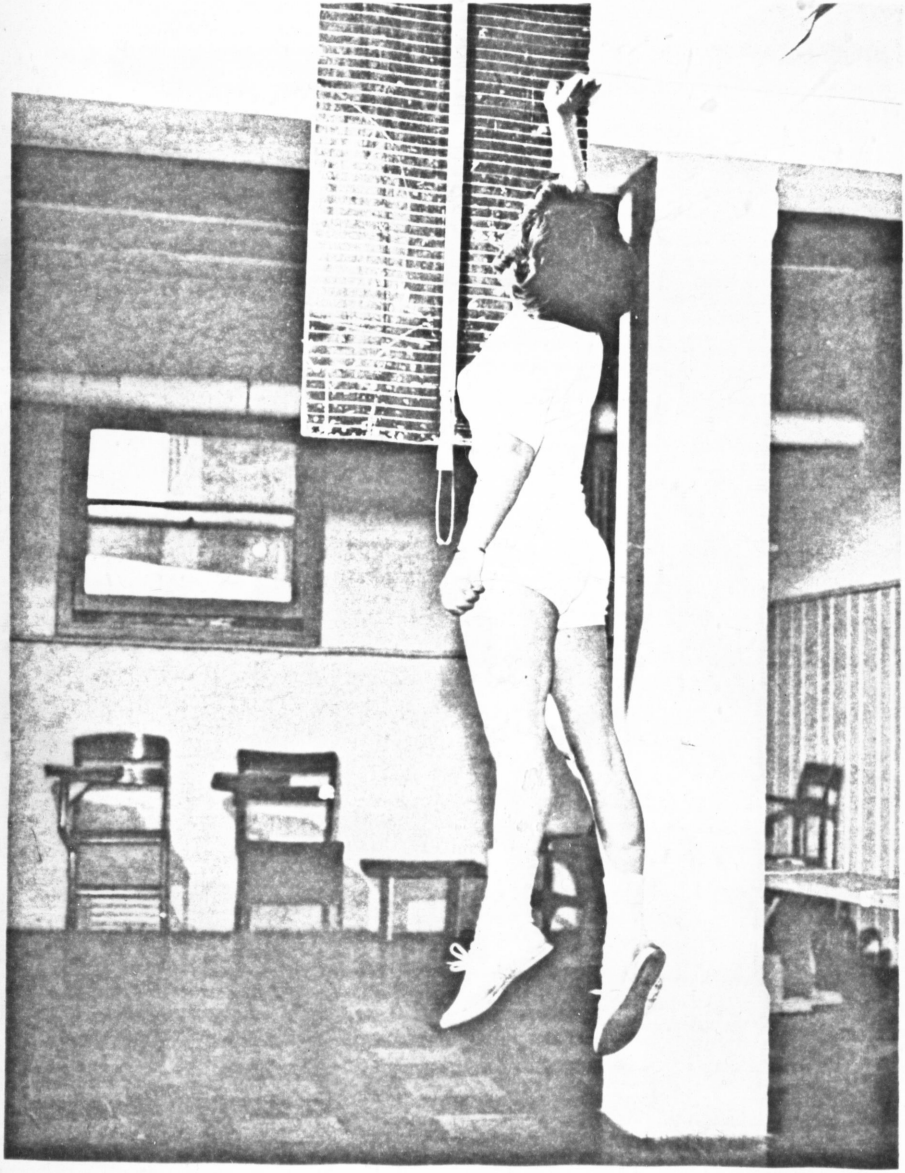

FIGURE II. SARGENT JUMP TEST

FIGURE III. HARVARD STEP TEST

immediately after completing the test to insure no change in pulse rate. The girl's pulse rates were taken from 1 to 1 1/2 minutes after the test, from 2 to 2 1/2 minutes, and from 3 to 3 1/2 minutes after the test.

The physical efficiency index was found by the formula:[23]

$$\frac{\text{Duration of exercise in seconds X 100}}{\text{2 X sum of pulse counts in recovery}}$$

This formula was carried out to six decimal places and rounded off to four decimal places. These numbers were used as the raw scores for the endurance factor of the study.

CHAPTER IV

ANALYSIS AND TREATMENT OF DATA

The basic purpose of this study was to determine the effects of a rebound tumbling program on body weight, body measurement, adipose tissue, leg strength, and explosive power of the legs of college women.

The experimental design employed was the single group method in which the difference between the means was computed from the raw scores of the same tests administered to the same group at different times.

The raw scores were treated statistically. First, the difference between the means was found by subtracting the initial test from the final test and dividing by the number of subjects.[24]

The standard deviation of the mean was determined by the following formula:[25]

$$SD=\sqrt{\frac{X_2}{N-1}}$$

The standard error of the difference between the means was determined by the use of the formula:[26]

$$S_{E_{MD}} = \frac{SD}{\sqrt{N}}$$

The critical ratio was found by the formula:[27]

$$t = \frac{MD-0}{S_{E_{M_D}}}$$

In this study there were 38 degrees of freedom (n-1), except in the body girth measurement. In this area there were only 37 degrees of freedom as one girl became ill just before her final test and could not be tested in this area. The t value for significance at the five per cent level of confidence was 2.42 and the t value at the one per cent level of confidence was 2.71, as indicated in Table D of Garrett.[28] The five per cent level of significance was accepted for this study, and the null hypothesis was accepted or rejected in each case.

Table 1 shows the results from the measurement of weight. This represents the initial testing and the final testing.

Table 1. Difference Between the Means, Standard Error of the Difference, and Critical Ratios Computed from the Initial and Final Scores of the Body Weight

Test Item	Initial test	Final test	$Diff_{md}$ M_1-M_2	S_{em_d}	t	Level of sign.
Weight	4792.25	4809.25	-.4474	.5677	.7880	N.S.

In the body weight factor of the testing program there

was a general gain of weight as indicated by the mean gain of -.4474. The standard error of the difference was .5677, and the critical ratio was found to be .7880. Since a *t* of 2.42 was necessary to be significant at the five per cent level of confidence, the gain was not significant, and the null hypothesis was accepted. The individual results concerning the weight item generally indicated that the overweight participants did loose weight and those who were underweight gained in weight. It was the author's and participants' opinion that appetite increased which probably increased weight on some subjects.

Table 2 shows the results of the body measurements, the measurements were recorded in centimeters. The measurements taken for the right arm showed the following results when treated statistically.

The mean difference for the right arm indicated a loss of 1.7105, and the standard error of the difference was found to be .1567. Thus, the critical ratio was found to be 10.9157, which was significant at the one per cent level of confidence. The null hypothesis was rejected, and the loss was accepted as real.

A loss in girth was also measured on the left arm. The mean difference of the measurement for the left arm was 1.6711, the standard error of the difference was .9427.

A *t* value of 1.7727 indicated a significance at the

ten per cent level of confidence. Since the five per cent level of significance was used in this study this indicated no significance; therefore, the null hypothesis was accepted. The author is unable to explain the loss of girth in the right arm and no significant loss in the left arm.

Table 2. The Difference Between the Means, Standard Error of the Difference, and Critical Ratios Computed from the Initial and Final Scores of Body Measurements

Test Item	Initial test	Final test	$Diff_{md}$ M_1-M_2	SE_d	t	Level of sign.
Right arm	998.5	933.5	1.7105	.1567	10.9157	.01
Left arm	992.5	929.0	1.6711	.9427	1.7727	N.S.
Bust	3279.5	3256.5	.6052	.4499	1.3452	N.S.
Waist	2409.0	2338.5	1.9052	.3238	6.4765	.01
Hips	3569.25	3539.5	.7828	.3739	2.0936	.05
Right thigh	2062.75	1941.5	3.1907	.3711	8.5979	.01
Left thigh	2071.0	1925.0	3.8421	.3694	10.4009	.01
Right calf	1326.5	1320.75	.1514	.2076	.7292	N.S.
Left calf	1332.5	1320.5	.3158	.1733	1.8223	N.S.

The loss indicated in the bust measurement was not significant. The mean difference was .6052, the standard

error of the difference was .4499. The t value was 1.3452, and since a 2.42 was necessary to find a significance, the null hypothesis was accepted and the loss was claimed to be due to chance. This result of no significant gain in bust measurement was probably due to the loss of adipose tissue on the scapula site, which was significant at the one per cent level.

In the waist girth measurement the author found a mean loss of 1.9054. The standard error of the difference was found to be .3238 and the critical ratio was 6.4765. Since only a 2.71 critical ratio was necessary to be significant at the one per cent level of confidence, the null hypothesis was rejected and the loss was accepted as real. This was one of the objectives the author hoped to realize.

A loss in girth was found at the hips. This loss was significant at the five per cent level as indicated by a mean difference of .7828, a standard error of the difference of .3739 and a t value of 2.0936. Therefore, the null hypothesis was rejected and the loss accepted as real. This is one of the objectives the author hoped to realize.

On the right thigh a loss was noted with a mean difference of 3.1907, a standard error of .3711 and a t value of 8.5979. Because a critical ratio of 2.42 was necessary to be significant at the five per cent level,

the loss was accepted as real and the null hypothesis was rejected. In the author's opinion this loss could be attributed to the toning of the muscle in the thigh.

The loss in girth on the left thigh was also significant. The mean difference was found to be 3.8421, the standard error of the difference was .3694, and the critical ratio was 10.4009 which was realized as significant at the one per cent level of confidence. The null hypothesis was rejected, and the loss taken as real. In the author's opinion this could be attributed to toning of the muscle.

On the right calf little change was noted. A loss with a mean difference of .1514, a standard error of the difference of .2076 and a critical ratio of .7292 was not significant. Therefore, the null hypothesis was accepted and the loss attributed to chance.

On the left calf a loss was noted that was significant at the 10 per cent level, but not at the five per cent level as used in this study. On this measurement a mean difference of .3158 was recorded, a standard error of the difference was found to be .1733, and the t value was 1.8223. Since a t value of 2.42 was necessary, the null hypothesis was accepted and the loss attributed to chance. In the author's opinion the loss at the right and left calf could possibly be attributed to the elongating of the muscle.

Table 3 shows the difference between the means, standard error of the difference and critical ratios computed from the initial and final skinfold measurements.

Table 3. Difference Between the Means, Standard Error of the Difference and Critical Ratios Computed From the Initial and Final Skinfold Measurements

Test Item	Initial test	Final test	$Diff_{md}$ M_1-M_2	SE_{md}	$\underline{t}$	Level of sign.
Cheek	61.7988	44.7989	.4358	.0344	12.6686	.01
Arm	86.0984	69.3652	.4291	.0462	9.2879	.01
Chest	47.0321	32.3324	.3770	.0706	5.3399	.01
Back	68.7321	48.2986	.4727	.0404	11.7005	.01
Waist	59.6654	54.1321	.1418	.0861	1.6298	N.S.
Hips	90.4322	59.8654	.7837	.0620	12.6403	.01
Front thigh	129.4654	109.5894	.5094	.0498	10.2289	.01

In the adipose tissue measurement of the cheek, a loss was noted with a mean difference of .4358. The standard error of the difference was found to be .0344 and the $\underline{t}$ value was 12.6686. Therefore, the loss was accepted as real at the one per cent level of confidence, and the null hypothesis was rejected.

The adipose tissue measurement of the arm showed a mean difference of .4291, a standard error of the difference of .0462 and a critical ratio of 9.2879. This was

significant at the one per cent level and the loss was accepted as real. The null hypothesis was rejected.

The measurement of adipose tissue taken on the back showed a significant loss. The application of statistics found a mean difference of .0404 and a t value of 11.7005. This was significant at the one per cent level and the null hypothesis was rejected; thus the loss was accepted as real.

The measurement of adipose tissue at the waist produced a mean difference of .1418, a standard error of the difference of .0861 and a critical ratio of 1.6298 which was not significant, and the null hypothesis was accepted. The author cannot justify this loss being not significant.

The loss of adipose tissue noted at the hips had a mean difference of .7837, a standard error of the difference of .0620 and a t value of 12.6403. This loss was significant at the one per cent level of confidence and the loss was accepted as real. The null hypothesis was rejected.

The loss of adipose tissue at the front thigh showed a mean difference of .5094, a standard error of the difference of .0498 and a critical ratio of 10.2289. This was significant at the one per cent level and the loss was accepted as real. The null hypothesis was rejected. In the author's opinion the loss in adipose tissue was due to the added activity for the girls and the toning of the

muscles. The author cannot account for the fact that the loss at the waist was not significant.

Table 4 shows the results of the leg strength test.

Table 4. Difference Between the Means, Standard Error of the Difference and Critical Ratio of the Initial and Final Test of Foot Pounds of Pressure Indicated by the Leg and Back Dynamometer

Initial test	Final test	$Diff_{md}$ M_1-M_2	SE_{md}	t	Level of sign.
25370	29610	108.7179	22.6683	4.7960	.01

The leg strength measurement showed a gain with a mean difference of 108.7179, a standard error of the difference of 22.6683 and a t value of 4.7960 which was significant at the one per cent level of confidence. The null hypothesis was rejected and the gain accepted as real. The increase in leg strength can be attributed to the increase in use of the legs through rebound tumbling in the author's opinion.

The explosive power of the legs showed an increase with a mean difference of .7115, a standard error of the difference of .1487, and a critical ratio of 4.7848 which was significant at the one per cent level of confidence. The null hypothesis was rejected and the gain accepted as real. In the author's opinion this gain can be attributed to the gain in leg strength and the added activity of

rebound tumbling. These results are shown in Table 5.

Table 5. Difference Between the Means, Standard Error of the Difference and Critical Ratio of the Initial and Final Test of Explosive Power of the Legs as Recorded in Inches

Initial test	Final test	$Diff_{md}$ M_1-M_2	SE_{md}	t	Level of sign.
568.75	596.50	.7115	.1487	4.7848	.01

Table 6 shows the endurance increase which was significant at the one per cent level of confidence. The mean difference was 21.8766, the standard error of the difference was 1.4191 and the t value was 15.4165. The null hypothesis was, therefore, rejected and the gain accepted as real. This increase in endurance in the author's opinion can be attributed to the added activity.

Table 6. Difference Between the Means, Standard Error of the Difference and Critical Ratio of the Initial and Final Test of Endurance as Indicated by the Harvard Step Test Classification

Initial test	Final test	$Diff_{md}$ M_1-M_2	SE_{md}	t	Level of sign.
1518.9434	2372.171	21.8776	1.4191	15.4165	.01

CHAPTER V

IMPLICATIONS AND CONCLUSIONS

The purpose of this study was to determine the effects of a rebound tumbling program on body weight, body measurements, adipose tissue, leg strength, explosive power of the legs, and the endurance of college women.

During a 12 week period, 39 girls participated in the rebound tumbling unit. Each girl spent a total of three hours on the trampoline during this 12 week period.

The following conclusions were drawn from the results of the initial and final tests.

1. There was no significant gain in body weight. The slight gain in the author's opinion could be attributed to increased appetites.

2. There was a significant loss in the girth of the right arm, waist, right thigh, left thigh and hips. In the author's opinion this could be attributed to the added activity and the toning of the muscles.

3. The loss in girth for the left arm, bust, right or left calf was not significant. The author could offer no explanation for the slight change.

4. The loss of adipose tissue at the waist was not significant. The author could offer no explanation for the small change.

5. The loss of adipose tissue on the cheek, arm, chest, back, hip and front thigh was significant. This in the author's opinion could be attributed to the added activity.

6. The increase in leg strength, explosive power of the legs and endurance was significant. This in

the author's opinion could be attributed to the added activity.

7. In the author's opinion trampolining does provide physiological benefits and could be justified as a part of the physical education program.

RECOMMENDATIONS

1. A study should be conducted on the effects of rebound tumbling on the human body and the group should be somatotyped.

2. A reliable endurance test should be developed which is applicable to laboratory conditions at a minimum cost.

3. Research should be conducted to determine at what age level children can best learn progressions on the trampoline.

4. A true bust measurement should be developed that does not measure the adipose tissue under the arms and across the back.

5. A study should be conducted using a control group and using the same physical aspects of this study.

6. A study should be conducted involving reaction time and performance time on the trampoline.

7. A study should be conducted on men athletes and the trampoline as a means of off season training.

LITERATURE CITED

1. Frank LaRue and Jim Norman, Two Seconds Freedom, Cedar Rapids, Iowa: Nissen Trampoline Company, 1960, p. XV.

2. Ibid., p. IX.

3. Ibid., p. XV.

4. L. E. Morehouse and P. J. Pasch, "Kinesiological Factors in Athletics," Scientific Basis of Athletic Training, Philadelphia, Pa.: W. B. Saunders Company, 1958, p. 22.

5. Leonard A. Larson and Rachael Dunaven Yocom, Measurement and Evaluation in Physical Health and Recreation Education, St. Louis, Missouri: The C. V. Mosby Company, 1951, pp. 78-79.

6. Larson and Yocom, Loc. cit.

7. Larson and Yocom, Loc. cit.

8. H. Harrison Clarke, Application of Measurement to Health and Physical Education, Engelwood Cliffs, New Jersey: Prentice-Hall Incorporated, 1959, p. 16.

9. Ibid., p. 107.

10. Ibid., p. 108.

11. Ibid., p. 113.

12. Deobold Van Dalen, "New Studies in the Sargent Jump," Research Quarterly of The American Association for Health, Physical Education, and Recreation, II, May, 1940, pp. 112-115.

13. Clarke, Op. cit., p. 304.

14. Letter from Clem Thompson to author dated November 14, 1961.

15. R. W. Kereilis and Cureton, "The Relationships of External Fat to Physical Education Activities and Fitness Tests," The Research Quarterly of The American Association for Health, Physical Education, and Recreation, XVIII, May, 1949, pp. 123-129.

16. Kereilis and Cureton, Loc. cit.

17. Kereilis and Cureton, Loc. cit.

18. R. A. Walker, "Changes in Body Fat Computed From the Skinfold Measurement of College Track and Field Athletes During a Season of Competition and Training," unpublished Master's thesis, South Dakota State College, Brookings, South Dakota, 1959, p. 31.

19. A. Van Anne, "The Effects of Trampoline Exercise on Selected Physical Capacities," unpublished Master's thesis, University of Iowa, Iowa City, Iowa, 1943.

20. Lucille Magnusson, "The Effect of Trampoline Exercises on Endurance and on Ankle Extensor Strength," unpublished Master's thesis, University of Iowa, Iowa City, Iowa, 1951.

21. John Gibbons, "The Effects of Rebound Tumbling on the Physical Fitness Status of Two Adult Women," unpublished Master's thesis, University of Illinois, Urbana, Illinois, 1952.

22. M. Gladys Scott, "Trampolining is for Girl's, Too," Journal of the American Association for Health, Physical Education, Recreation, XXIII, No. 6, June, 1952, pp. 10, 11, 55.

23. Clarke, Op. cit., p. 304.

24. H. E. Garrett and R. S. Woodworth, Statistics in Psychology and Education, New York: Longman, Green and Co., 1961, p. 227.

25. Ibid., p. 228.

26. Ibid., p. 228.

27. Ibid., p. 229.

28. Ibid., p. 449.

APPENDICES

APPENDIX A

Progressions used in this study

1. Straight bounce and "kill."
2. Tuck bounce and "kill."
3. Pike bounce and "kill."
4. Straight bounce, half turn.
5. Straight bounce, full turn.
6. Tuck bounce, half turn.
7. Tuck bounce, full turn.
8. Pike bounce, half turn.
9. Straight bounce, seat drop.
10. Tuck bounce, seat drop.
11. Knee drop.
12. Knee drop, half turn.
13. Knee; seat combination.
14. Seat; knee combination.
15. Swivelhips.
16. Back drop.
17. Back; knee combination.
18. Rope jumping, straight bounce.
19. Rope jumping, tuck bounce.
20. Couple jumping, partners facing each other, hands joined.
21. Couple jumping, alternating bounce.
22. Couple jumping, hands clasped, half turn.
23. Couple jumping, rope skipping.
24. Couple jumping, alternating seat drops.
25. Couple jumping, alternating knee drops.
26. Couple jumping, alternating back drops.
27. Back pullover.
28. Cradle, back drop, half turn, back drop.
29. Back pullover to seat.
30. Knee drop, front somersault to seat.
31. Knee drop, front somersault to feet.
32. Front somersault with hand spotting.
33. Front somersault to seat.
34. Front somersault to feet.
35. Back somersault (tuck position) with hand spotting.
36. Back somersault.
37. Barani.

APPENDIX B

Progressions as suggested by Scott

1. Straight jump and "kill" the spring by bending the knees.
2. Straight jump and half turn, full turn.
3. Straight jump and heel click.
4. Straight jump and heel slap.
5. Straight jump and run in air.
6. Straight jump legs spread.
7. Straight jump leg lift, jack knife.
8. Straight jump rope skipping.
9. Knee drop.
10. Alternate knee drop and foot bounce.
11. Knee drop, half turn for landing.
12. Half turn into knee drop.
13. Knee drop and rope jumping.
14. Seat drop.
15. Alternate seat drop and knee drop.
16. Seat drop, half turn, seat drop continuing.
17. Seat drop and rope turning.
18. Four point landing.
19. Alternating seat drop and knee drop.
20. Couple jumping, diagonally opposite, alternating bounce.
21. Couple jumping, center, hands clasped, arms straight, jump together.
22. Couple jumping, diagonal corners, alternating seat drop and bounce, partners alternating.
23. Four point landings, half turns.
24. Half turns into four point landings.
25. Couples facing, seat drop, one with feet together, other with feet apart.
26. Back drop.
27. Continuous back drops.
28. Hand stand from knee drop.
29. Back drop half twist.
30. Front somersault from knee drop to seat drop.
31. Front somersault from knee drop to feet.
32. Back somersault (tuck) from tucked seat drop to feet.
33. Front somersault from foot bounce.
34. Back somersault from foot bounce.

APPENDIX C

Raw Scores from Initial and Final Measurement of Weight

Subject No.	Initial Test	Final Test
1.	124.5	123.5
2.	127.0	126.0
3.	128.25	127.5
4.	136.0	133.0
5.	146.25	147.5
6.	106.0	107.0
7.	124.5	126.0
8.	137.0	136.25
9.	108.0	108.0
10.	136.5	139.0
11.	119.0	117.0
12.	110.0	110.5
13.	132.5	138.5
14.	111.0	118.5
15.	116.5	118.0
16.	120.5	119.5
17.	151.0	151.0
18.	155.0	154.0
19.	106.5	107.0
20.	124.5	122.0
21.	121.0	112.0
22.	118.5	118.0
23.	120.5	122.5
24.	122.0	118.0
25.	131.5	136.5
26.	99.0	103.0
27.	119.5	125.25
28.	115.25	116.5
29.	124.5	123.75
30.	137.5	147.0
31.	105.5	107.0
32.	138.0	136.0
33.	133.5	128.5
34.	140.0	143.0
35.	124.5	128.0
36.	147.0	142.5
37.	112.0	110.5
38.	162.0	161.5

APPENDIX D

Raw Scores from Initial and Final Test of Waist Girth

Subject No.	Initial Test	Final Test
1.	64.0	61.5
2.	66.5	64.0
3.	Not used because of illness	
4.	68.0	63.0
5.	70.0	64.0
6.	67.0	67.5
7.	63.0	59.5
8.	65.5	64.0
9.	62.0	61.0
10.	60.0	57.0
11.	63.5	64.0
12.	59.5	58.0
13.	66.5	60.0
14.	66.0	67.5
15.	63.5	60.0
16.	62.5	60.0
17.	72.0	68.5
18.	70.0	67.0
19.	71.0	69.0
20.	62.0	58.5
21.	62.0	62.0
22.	71.0	68.5
23.	57.0	58.0
24.	63.5	63.5
25.	70.5	66.0
26.	63.5	61.0
27.	67.5	67.0
28.	58.0	59.5
29.	59.0	59.5
30.	61.0	62.0
31.	66.0	67.0
32.	59.0	57.0
33.	70.0	66.0
34.	65.0	61.0
35.	73.0	72.0
36.	61.5	60.0
37.	69.0	66.5
38.	Thrown out	
39.	70.0	68.0

APPENDIX D CONTINUED

Raw Scores from Initial and Final Test of Bust Girth

Subject No.	Initial Test	Final Test
1.	88.0	88.0
2.	85.0	86.0
3.	Not used because of illness	
4.	89.5	88.0
5.	91.0	88.0
6.	90.0	89.0
7.	76.5	72.5
8.	88.0	86.0
9.	82.0	82.0
10.	79.5	79.5
11.	82.0	91.0
12.	81.5	80.0
13.	85.5	86.0
14.	84.0	84.0
15.	88.0	85.5
16.	87.0	85.0
17.	91.0	89.0
18.	92.0	91.0
19.	94.5	94.5
20.	84.0	84.0
21.	89.0	87.0
22.	91.5	82.0
23.	89.0	85.0
24.	82.0	81.5
25.	89.5	87.0
26.	89.5	89.0
27.	79.0	81.0
28.	86.5	90.0
29.	86.5	87.5
30.	85.0	84.5
31.	91.5	89.0
32.	77.5	76.0
33.	85.5	87.0
34.	86.5	85.0
35.	89.0	89.0
36.	83.0	84.0
37.	90.5	90.0
38.	79.0	78.5
39.	90.5	94.5

APPENDIX D CONTINUED

Raw Scores from Initial and Final Test of Hips Girth

Subject No.	Initial Test	Final Test
1.	91.0	87.0
2.	89.0	88.5
3.	Not used because of illness	
4.	98.0	96.0
5.	95.0	92.0
6.	99.0	99.0
7.	90.0	91.0
8.	94.0	95.0
9.	99.0	98.0
10.	89.5	87.5
11.	94.0	95.0
12.	91.5	91.0
13.	90.0	87.0
14.	99.75	101.0
15.	92.0	93.0
16.	89.5	91.0
17.	95.5	91.0
18.	101.5	100.5
19.	101.5	101.0
20.	87.0	88.5
21.	93.0	91.0
22.	93.5	89.0
23.	87.0	88.0
24.	97.0	95.5
25.	93.0	91.0
26.	94.5	95.5
27.	84.5	85.0
28.	88.5	95.5
29.	90.5	90.0
30.	96.5	94.5
31.	100.0	100.5
32.	83.5	84.5
33.	98.0	97.0
34.	97.0	91.5
35.	101.0	101.0
36.	93.5	94.0
37.	100.5	99.0
38.	91.0	87.0
39.	100.0	97.0

APPENDIX D CONTINUED

Raw Scores from Initial and Final Test of Right Thigh Girth

Subject No.	Initial Test	Final Test
1.	48.75	47.5
2.	52.5	52.0
3.	Not used because of illness	
4.	53.5	52.0
5.	54.5	52.0
6.	60.5	58.0
7.	53.0	43.5
8.	50.0	49.0
9.	52.0	51.0
10.	50.5	47.0
11.	55.5	52.0
12.	54.0	50.5
13.	51.0	48.5
14.	59.0	56.0
15.	49.0	48.0
16.	50.5	47.5
17.	52.5	50.0
18.	61.0	58.0
19.	61.5	57.0
20.	53.0	48.5
21.	50.0	45.5
22.	52.0	47.5
23.	51.5	53.0
24.	56.0	54.5
25.	55.0	47.5
26.	58.0	56.0
27.	49.5	47.5
28.	53.0	49.0
29.	54.0	50.0
30.	57.5	52.0
31.	60.0	56.0
32.	48.0	48.0
33.	61.5	56.0
34.	55.0	47.0
35.	58.5	51.5
36.	54.0	50.0
37.	63.0	59.5
38.	48.0	46.0
39.	56.0	57.0

APPENDIX D CONTINUED

Raw Scores from Initial and Final Test of Left Thigh Girth

Subject No.	Initial Test	Final Test
1.	50.5	48.0
2.	52.0	50.5
3.	Not used because of illness	
4.	55.5	52.0
5.	55.0	53.0
6.	59.0	57.5
7.	50.5	42.5
8.	54.0	51.0
9.	52.0	50.0
10.	51.0	48.0
11.	55.0	52.5
12.	55.0	49.5
13.	52.0	47.0
14.	59.5	53.0
15.	49.0	48.0
16.	50.0	48.0
17.	54.5	47.0
18.	61.0	56.5
19.	60.5	54.0
20.	52.5	48.0
21.	50.0	44.0
22.	53.0	47.5
23.	55.0	51.0
24.	56.0	55.0
25.	58.0	47.5
26.	60.0	58.5
27.	52.0	47.5
28.	53.0	48.0
29.	52.5	49.5
30.	54.5	51.0
31.	59.5	51.5
32.	47.5	47.5
33.	59.5	57.0
34.	54.0	49.5
35.	59.0	53.0
36.	51.5	49.5
37.	62.0	59.0
38.	49.0	48.0
39.	56.5	54.5

APPENDIX D CONTINUED

Raw Scores from Initial and Final Test of Right Calf Girth

Subject No.	Initial Test	Final Test
1.	36.5	36.0
2.	37.5	36.75
3.	Not used because of illness	
4.	32.5	33.5
5.	37.0	37.0
6.	39.5	38.0
7.	34.0	34.0
8.	33.0	35.0
9.	37.0	37.0
10.	32.0	33.5
11.	33.0	33.0
12.	32.5	32.5
13.	32.5	32.5
14.	36.5	35.5
15.	31.0	32.0
16.	34.5	34.5
17.	33.5	32.5
18.	36.5	35.5
19.	37.5	37.5
20.	35.0	32.0
21.	33.0	33.0
22.	35.0	33.0
23.	35.0	35.0
24.	36.5	36.0
25.	35.5	34.0
26.	35.5	37.5
27.	32.0	30.0
28.	35.5	35.0
29.	33.0	33.5
30.	36.0	35.5
31.	36.5	36.5
32.	29.5	32.0
33.	37.5	37.5
34.	36.5	36.0
35.	36.0	35.5
36.	35.5	35.0
37.	37.0	35.5
38.	33.5	32.5
39.	36.0	39.5

APPENDIX D CONTINUED

Raw Scores from Initial and Final Test of Left Calf Girth

Subject No.	Initial Test	Final Test
1.	37.0	36.0
2.	36.5	36.5
3.	Not used because of illness	
4.	32.0	32.5
5.	37.0	37.0
6.	39.5	38.5
7.	35.0	34.0
8.	34.0	35.0
9.	37.0	37.0
10.	32.5	33.5
11.	35.0	35.0
12.	32.5	33.0
13.	33.0	32.0
14.	36.0	36.0
15.	31.0	32.0
16.	34.0	34.0
17.	32.5	32.0
18.	38.0	36.0
19.	37.0	38.5
20.	32.5	32.0
21.	32.5	33.0
22.	35.0	32.0
23.	35.5	35.0
24.	36.5	36.0
25.	36.5	34.5
26.	35.5	36.0
27.	31.5	31.0
28.	34.0	34.0
29.	34.0	33.0
30.	36.5	35.5
31.	36.0	35.5
32.	31.0	31.5
33.	37.0	37.0
34.	37.5	35.5
35.	38.0	36.0
36.	36.0	36.0
37.	37.5	35.5
38.	33.0	33.0
39.	37.0	39.0

APPENDIX D CONTINUED

Raw Scores from Initial and Final Test of Right Arm Girth

Subject No.	Initial Test	Final Test
1.	25.5	24.0
2.	27.5	26.5
3.	Not used because of illness	
4.	26.0	24.0
5.	26.5	25.5
6.	29.5	27.0
7.	24.0	22.5
8.	25.0	24.0
9.	24.0	23.0
10.	24.0	21.0
11.	29.0	26.0
12.	26.5	23.5
13.	23.5	22.0
14.	28.5	26.0
15.	21.5	22.0
16.	27.0	24.0
17.	26.0	24.0
18.	29.0	28.0
19.	28.5	27.0
20.	25.5	24.0
21.	26.5	23.5
22.	28.0	25.0
23.	24.0	23.0
24.	26.0	24.0
25.	26.0	24.5
26.	27.5	27.0
27.	24.5	22.5
28.	27.5	24.5
29.	27.0	24.5
30.	25.5	22.5
31.	27.5	27.5
32.	22.0	21.5
33.	25.0	25.0
34.	28.5	25.5
35.	28.0	27.0
36.	24.0	23.5
37.	30.0	26.5
38.	24.0	23.0
39.	30.0	29.0

APPENDIX D CONTINUED

Raw Scores from Initial and Final Test of Left Arm Girth

Subject No.	Initial Test	Final Test
1.	24.5	23.0
2.	27.0	26.5
3.	Not used because of illness	
4.	26.0	25.0
5.	27.0	25.5
6.	29.5	27.5
7.	24.0	22.0
8.	26.0	23.5
9.	24.0	23.5
10.	25.0	22.0
11.	28.0	26.0
12.	26.0	23.0
13.	23.5	22.0
14.	27.0	26.0
15.	21.5	22.0
16.	25.0	23.0
17.	25.5	23.5
18.	29.5	28.0
19.	30.0	26.5
20.	24.5	24.0
21.	25.0	23.5
22.	28.0	25.0
23.	24.0	23.0
24.	26.5	24.5
25.	27.5	24.0
26.	28.0	27.5
27.	24.5	22.5
28.	27.5	24.0
29.	27.5	22.5
30.	24.5	23.5
31.	28.5	28.5
32.	22.0	21.0
33.	24.5	24.5
34.	27.0	25.0
35.	28.0	26.0
36.	23.5	23.0
37.	30.0	26.5
38.	23.5	23.0
39.	29.0	28.0

APPENDIX E

Raw Scores for Initial and Final Test of Adipose Tissue of Cheek

Subject No.	Initial Test	Final Test
1.	1.6333	1.1333
2.	1.6333	1.1333
3.	2.0333	1.0666
4.	1.5	1.4
5.	1.6333	1.1666
6.	2.0666	1.1333
7.	1.7333	1.3333
8.	1.6333	1.1333
9.	1.4	.8666
10.	1.1666	.8666
11.	1.7	1.2
12.	1.5	.9666
13.	1.5666	1.2333
14.	1.8333	1.5
15.	1.3333	.9
16.	1.2333	.8
17.	1.8333	1.2333
18.	1.5333	1.0333
19.	2.2333	1.3
20.	1.4666	.9
21.	1.5666	.9333
22.	1.9333	1.5
23.	1.6333	1.1333
24.	1.9666	1.6
25.	1.7	1.2
26.	1.4	.9333
27.	1.5333	1.1666
28.	1.7	1.2
29.	1.5	1.3
30.	1.6333	1.2666
31.	1.3333	1.0666
32.	1.5333	1.1
33.	.8	.9
34.	1.6	1.2333
35.	1.4666	1.2666
36.	1.3	1.0666
37.	1.8666	1.7
38.	1.1333	1.0
39.	1.5333	.9333

APPENDIX E CONTINUED

Raw Scores for Initial and Final Test of Adipose Tissue of Arm

Subject No.	Initial Test	Final Test
1.	1.6333	1.6
2.	2.1666	2.0666
3.	2.3333	1.7333
4.	1.8666	1.5
5.	1.8333	1.8333
6.	2.5	1.6666
7.	2.1333	1.7333
8.	2.6666	1.5333
9.	1.8666	1.6666
10.	1.8333	1.3
11.	2.5333	1.7
12.	2.1666	1.5666
13.	1.5666	1.2333
14.	2.7666	2.6
15.	1.3666	1.1666
16.	2.5333	1.8666
17.	2.5333	2.0666
18.	3.0666	2.5333
19.	3.0666	2.5333
20.	2.4333	1.7666
21.	1.4333	1.7666
22.	2.6	2.0333
23.	1.7666	1.7
24.	2.6	2.1333
25.	2.5333	1.5666
26.	2.5	2.2666
27.	1.9333	1.6333
28.	2.1333	2.1666
29.	2.3	1.6666
30.	2.0666	1.7333
31.	2.3666	2.0666
32.	1.8333	1.4
33.	1.2333	1.2666
34.	2.4	1.5333
35.	2.6333	2.1333
36.	1.9666	1.4333
37.	2.7666	1.9333
38.	1.6666	1.2
39.	2.5	2.3333

APPENDIX E CONTINUED

Raw Scores for Initial and Final Test of Adipose Tissue of Chest

Subject No.	Initial Test	Final Test
1.	1.2333	1.2666
2.	3.3333	.9333
3.	1.3333	.7
4.	1.5666	1.2
5.	1.0	.7
6.	.7666	.4
7.	.9666	.7333
8.	1.9333	1.2
9.	.7333	.7
10.	1.1	.7
11.	1.3666	1.0
12.	1.0333	.7666
13.	1.1	.5666
14.	1.2333	.7
15.	.8	.8333
16.	.6	1.2
17.	1.7	1.2333
18.	1.4333	.7
19.	1.3666	.7
20.	1.3	1.3
21.	.8666	.5666
22.	1.4	.9
23.	.8666	.5666
24.	2.4333	1.4333
25.	1.7	.9333
26.	1.2	1.0
27.	.6666	.4666
28.	.8333	.7666
29.	.8666	.7
30.	1.1666	.6333
31.	1.1666	.4666
32.	.5666	.7666
33.	.4333	.4333
34.	1.2	1.0
35.	1.4	.9333
36.	1.3	.9333
37.	1.3333	.9
38.	.6333	.4666
39.	1.1	1.0

APPENDIX E CONTINUED

Raw Scores for Initial and Final Test
of Adipose Tissue of Back

Subject No.	Initial Test	Final Test
1.	2.2333	1.9
2.	1.5	1.3333
3.	2.2	1.4
4.	1.8	1.7666
5.	1.6666	1.3
6.	1.9666	1.2666
7.	1.6333	1.1
8.	2.7	1.5
9.	1.4	1.3333
10.	1.6333	.8666
11.	1.7666	1.2333
12.	1.8	1.0666
13.	1.5333	.9666
14.	2.4	2.0666
15.	.6666	.6666
16.	1.7	1.3666
17.	2.1333	1.4666
18.	2.1666	1.1
19.	2.3666	1.6
20.	1.7333	1.2333
21.	1.3	.8333
22.	2.1666	1.5666
23.	1.7	.9333
24.	1.9666	1.5333
25.	1.8666	1.1666
26.	2.0333	1.5666
27.	1.3	1.0
28.	2.2	2.2
29.	1.3333	1.0
30.	1.8	1.1
31.	2.4333	2.0333
32.	1.5333	1.0333
33.	.8666	.6333
34.	1.4	1.1333
35.	2.3666	2.0666
36.	1.2333	.7
37.	1.9	1.2666
38.	.8666	.7666
39.	1.4666	1.2333

APPENDIX E CONTINUED

Raw Scores for Initial and Final Test of Adipose Tissue of Hips

Subject No.	Initial Test	Final Test
1.	1.3666	1.4333
2.	2.1666	1.9
3.	2.5	1.2666
4.	2.8333	1.9
5.	1.8333	1.2666
6.	1.9333	1.4333
7.	2.7333	1.5
8.	1.9	1.3666
9.	2.2333	1.4333
10.	2.1	1.0333
11.	2.4	1.1333
12.	2.1	1.0
13.	1.7333	1.2333
14.	2.7	2.0
15.	2.1	1.2666
16.	2.5333	1.6
17.	3.3	2.4333
18.	1.9666	1.9666
19.	3.4666	2.2666
20.	1.9666	1.2
21.	2.5	1.0
22.	2.2333	1.9666
23.	2.3666	1.3333
24.	3.0	1.5666
25.	2.4	1.5666
26.	2.2333	1.4333
27.	1.8	1.2
28.	2.8	3.1
29.	1.9666	1.4
30.	2.0	1.1
31.	2.6	1.5333
32.	2.0666	1.1333
33.	2.0666	1.1333
34.	1.9333	1.5666
35.	3.0666	2.3
36.	2.5	1.4333
37.	2.9666	1.2666
38.	1.8333	1.3666
39.	2.2333	1.8333

APPENDIX E CONTINUED

Raw Scores for Initial and Final Test
of Adipose Tissue of Waist

Subject No.	Initial Test	Final Test
1.	1.8333	1.5
2.	1.2666	1.1
3.	1.2666	1.5666
4.	1.3666	1.2
5.	1.4333	1.1333
6.	1.2666	1.4333
7.	1.6666	1.4333
8.	2.8	1.3333
9.	1.2333	.9333
10.	1.2333	1.0
11.	1.4333	1.5
12.	1.6333	1.5
13.	1.8	1.3333
14.	2.2666	2.5666
15.	1.0333	.9666
16.	1.0	1.1666
17.	2.4333	1.6333
18.	2.2333	2.3333
19.	2.2666	2.0
20.	1.1333	1.3333
21.	.7333	.9
22.	1.0333	1.1666
23.	.9666	1.0666
24.	2.2	2.0333
25.	2.4	1.2333
26.	1.2666	2.0
27.	1.4	1.5333
28.	2.2333	2.9666
29.	.9	1.3
30.	1.2333	.7
31.	1.5	2.9
32.	1.6333	.7
33.	.8666	.6666
34.	1.3333	1.0666
35.	1.7	.9333
36.	1.3	1.0333
37.	2.2	1.1666
38.	.9333	1.1
39.	1.2333	1.0333

APPENDIX E CONTINUED

Raw Scores for Initial and Final Test
of Adipose Tissue of Front Thigh

Subject No.	Initial Test	Final Test
1.	2.3333	1.9333
2.	3.5333	2.5666
3.	3.0	2.5
4.	3.5666	2.8666
5.	3.2333	2.2666
6.	3.4	2.8666
7.	3.6666	3.0
8.	2.5	2.2333
9.	3.0666	2.7666
10.	3.2333	2.3666
11.	3.5333	2.8
12.	3.0666	2.5666
13.	3.5	2.8666
14.	3.5	3.4666
15.	2.3666	2.5333
16.	3.3	2.7
17.	3.4333	2.8666
18.	3.7333	2.9666
19.	4.1	3.7333
20.	3.2333	2.5666
21.	3.1666	2.7333
22.	3.7	3.0333
23.	3.4666	2.5666
24.	4.2333	3.9666
25.	3.7666	2.8333
26.	3.3666	3.9
27.	2.7333	2.3333
28.	3.5333	3.5333
29.	2.9666	2.8
30.	3.0333	2.6333
31.	4.1333	3.9
32.	2.7666	2.4666
33.	2.8	2.4666
34.	3.3666	2.6333
35.	3.9333	3.0333
36.	2.7	2.1666
37.	4.5	3.1666
38.	2.6	2.0
39.	3.4	3.0

APPENDIX F

Raw Scores for Initial and Final Test of Leg Strength

Subject No.	Initial Test	Final Test
1.	510	870
2.	760	700
3.	940	1030
4.	740	600
5.	580	610
6.	850	1000
7.	420	490
8.	500	510
9.	710	890
10.	710	720
11.	710	750
12.	470	700
13.	250	440
14.	700	690
15.	360	680
16.	670	580
17.	820	940
18.	650	840
19.	520	1050
20.	440	460
21.	740	800
22.	770	790
23.	470	640
24.	700	740
25.	420	510
26.	410	800
27.	950	1000
28.	950	1050
29.	650	890
30.	510	560
31.	530	700
32.	650	740
33.	650	750
34.	890	1020
35.	650	660
36.	610	700
37.	1150	1050
38.	700	650
39.	660	1010

APPENDIX G

Raw Scores for the Initial and Final Test for Explosive Power of the Legs

Subject No.	Initial Test	Final Test
1.	18.25	18.5
2.	17.5	16.0
3.	17.0	16.5
4.	12.0	13.0
5.	18.25	19.25
6.	12.25	13.0
7.	13.25	14.0
8.	13.0	15.0
9.	15.0	16.0
10.	15.25	15.0
11.	16.5	15.5
12.	11.5	12.5
13.	11.5	13.5
14.	14.0	16.0
15.	12.25	13.25
16.	14.5	16.5
17.	11.75	12.5
18.	14.5	16.0
19.	13.5	13.0
20.	13.5	15.0
21.	14.75	15.75
22.	13.0	13.0
23.	16.0	16.5
24.	13.0	14.5
25.	13.0	13.0
26.	14.5	16.0
27.	12.0	11.5
28.	12.5	11.5
29.	18.5	17.5
30.	15.5	17.5
31.	12.5	13.0
32.	17.0	18.0
33.	17.5	19.0
34.	16.5	16.5
35.	11.0	12.5
36.	16.5	17.5
37.	13.25	14.25
38.	18.0	19.5
39.	18.5	19.5

APPENDIX H

Raw Scores for the Initial and Final Test for Endurance

Subject No.	Initial Test	Final Test
1.	3.78504	59.4059
2.	33.3333	62.5100
3.	43.9024	65.9340
4.	30.3317	49.6932
5.	51.1627	63.1578
6.	32.0855	64.8648
7.	39.0855	64.5161
8.	22.7272	60.0000
9.	43.6893	67.7966
10.	38.2653	65.5737
11.	55.2995	61.2244
12.	20.6185	38.7323
13.	43.5555	64.8648
14.	22.6519	59.4059
15.	41.0447	61.2244
16.	35.7476	61.4754
17.	24.0963	35.0877
18.	31.1111	66.2983
19.	36.8852	51.6923
20.	34.1981	56.3380
21.	67.7966	82.7586
22.	27.3437	66.6666
23.	59.4059	65.5737
24.	33.5000	59.7014
25.	25.3086	40.6626
26.	26.0309	49.2424
27.	62.1761	65.9340
28.	26.1194	58.2524
29.	60.3015	74.5341
30.	51.9801	62.1761
31.	29.3814	50.9259
32.	43.5897	68.1818
33.	38.2608	49.0120
34.	63.4920	78.9473
35.	19.5852	54.1237
36.	40.5092	61.8556
37.	39.7435	75.0000
38.	48.0295	60.0000
39.	37.9781	62.8272