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College Freshman

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THE COMPARISON OF TWO TRAINING PROGRAMS, ISOMETRIC
CONTRACTIONS AND CALISTHENICS, ON STRENGTH AND
SELECTED BODY MEASUREMENTS OF FEMALE
COLLEGE FRESHMAN

BY

WILLIS R. KELLY

A thesis submitted
in partial fulfillment of the requirements for the
degree Master of Science, Department of
Physical Education, South Dakota
State College of Agriculture
and Mechanic Arts

1964

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THE COMPARISON OF TWO TRAINING PROGRAMS, ISOMETRIC
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COLLEGE FRESHMAN

This thesis is approved as a creditable and 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.

Thesis Adviser

Jan. 16, 1964

Date

Head
Physical Education Dept.

Jan. 17, 1964

Date

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WRK

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CHAPTER I

INTRODUCTION

The importance of physical fitness is constantly brought before the public by means of books, magazines, newspapers, radio, and television. It would be unusual for a day to go by without some reminder on physical fitness reaching us by some information medium.

During times of national emergencies the need for strength and fitness is stressed. The idea of physical efficiency for military purposes is not new. The ancient Greeks considered physical education training for warfare (1). During and immediately after World War II there was a great deal of interest in fitness. Often after the cessation of hostilities the concern is no longer felt, therefore, the present emphasis on fitness is not the usual pattern.

The Kraus-Weber test results did much to revitalize an interest in physical fitness (2). The outgrowth of these findings led to the Conference on Fitness of American Youth, called by President Eisenhower in June, 1956. This in turn led the American Association for Health, Physical Education, and Recreation to develop the Youth Fitness Test battery. From the results of this battery attention was again focused upon the soft American youth. It is the

belief of President Kennedy that today's youth are healthier than previous generations but the majority lack strong, agile bodies (3).

Need for the Study

Strength is an important item in the total concept of physical fitness. Therefore, the development of muscular strength in women, as well as men, demands encouragement and investigation. The idea of women possessing muscular strength as well as being physically attractive is incongruous to many people. Far too often we think of strong women as unattractive women with bulging muscles.

The author believed there was a need for a study to investigate programs designed to increase strength and to learn what effect such programs would have on the body measurements of women. If such a training program could increase strength and not result in increased body measurements it would be of value because of its appeal to women.

Statement of the Problem

The purpose of this study was to determine which of two training programs, isometric contractions or calisthenics, was superior in producing changes in strength and in selected body measurements of female freshman students.

Delimitations

1. This study was limited to two freshman service classes in basketball at South Dakota State College, Brookings, South Dakota. One group used isometric contractions with basketball; the second group used calisthenic exercises with basketball.

2. Six weeks of training, with two class sessions each week, was administered to the two groups between the initial and final testing periods.

3. The subjects were instructed not to engage in any other form of exercise during the study.

4. The subjects were not familiar with the testing instruments and methods.

5. Most of the subjects in the isometric group were totally unfamiliar with this type of training.

Definition of Terms

1. Health--The freedom from disease and organic disturbance (4).

2. Physical fitness--The ability to adapt to the added demands of activity which includes strength, endurance, flexibility, neuromuscular control, and ability to relax (5).

3. Muscular strength--The maximum tension a muscle can apply in a single contraction (6).

4. Isometric contraction--A contraction in which a muscle is unable to shorten, the total tension developed eventually being dissipated as heat. No movement is produced and no work is performed (7).

5. Calisthenics--Conditioning exercises that require no apparatus, and are for body development and flexibility.

CHAPTER II

REVIEW OF RELATED LITERATURE

It was difficult to find background material for this study. There was a wealth of information directly related to the effect of isometrics on the strength of men and boys. The results of programs to increase the strength of men would not necessarily be of value in a similar program for women.

Larson's report on the International Conference on Fitness held in Rome stated that British boys and girls were superior in physical fitness over similar groups in the United States. It was also reported that American girls were not only inferior but tended to retrogress with age (8).

Hettenger made the following statements concerning strength differences in relation to age and sex. On an average the general muscle strength in women is about two-thirds that of men. When men and women are given the same kind of training the strength increases are more and faster in men. In boys and girls up to the age of 10 there is no difference in muscle strength; after this age muscle strength increases much faster in boys than in girls. In the years between 20 and 30 both men and women reach their maximum muscular strength. When men reach the age of about

65 their strength is approximately 80 per cent of their maximum strength, therefore, women would have about two-thirds of the strength of men at the age of 65 (9).

Values of Muscular Strength

Wessel stated that values such as body shape, poise, grace of movements (10), and a normal menstrual period all depend upon sufficient muscular strength (11).

The reasons Hettinger gives for increasing muscular strength are:

1. Our "normal" performance capacity, with which we are so well satisfied, is kept at the level of daily requirement only by our customary daily activity. Any additional stress will severely tax our reserves.

2. Whatever we do is less fatiguing if we are in generally good physical condition.

3. We have greater resistance against various types of illness.

4. If illness should come, the body can put up a better fight against it, and speed the process of recovery.

5. Last but not least, life becomes more enjoyable when we are in good physical condition. It is clear that man's professional and physical specialization must be accompanied by general physical fitness if he is truly to enjoy the fruits of these labors (12).

McCloy stated that adequate muscle strength is needed for a youthful carriage, graceful posture, poise, and body balance. Undue fatigue and lack of energy are signs of poor muscular development (13).

Development of Muscle Strength

In a study to determine the effect of a program of static contraction, isometric, and isotonic exercises Kittleson found that girls made significant improvements in the right hand grip, leg lift, and arm strength tests. The 13 girls were sixth grade students enrolled in two public schools in South Dakota. The exercises were administered by the classroom teacher for five minutes a day for ten weeks. The McCloy Strength Test, given at the beginning and at the end of the training period, was used to measure the amount of strength (14).

Salter in her study to determine the most effective method of producing a rapid increase in muscle strength used 12 males and eight females, between the ages of 17 and 48, as subjects. The subjects were divided into five groups and all groups trained four days per week for four weeks. One isometric group had 15 exercises per minute, the other isometric group had two exercises per minute. The same procedure was followed by the two isotonic groups. One group served as the control group. Although the rate of contractions was different, all groups completed 30 contractions per bout. All training procedures produced strength increases that were statistically significant with no significant difference between the different training methods (15).

Effect of Isometrics on Body Measurements

The effect of isometric contractions of the abdominal wall upon the waistline measurements of women was investigated by Day.

The subjects were 38 women students enrolled in golf and archery classes. The waistline was measured with a steel tape against the skin at the smallest circumference; the weight was also taken and recorded. The training period lasted six weeks with three class periods each week. The subjects were instructed to force in the abdominal wall as much as possible for 6 six-second intervals for a total of 36 seconds each day. At the same time the subjects were to strongly contract the gluteus muscles. They were also asked to continue the exercise each day when not in class.

After six weeks the waistline was again measured and an average reduction of 1.24 inches was recorded. The results also showed that there was not a significant change in the weight (16).

CHAPTER III

PROCEDURE

Source of Data

This study dealt with the changes in strength and selected body measurements following six weeks of an isometric contraction training program and a calisthenics program. The two experimental groups were two basketball classes enrolled in freshman physical education at South Dakota State College during the 1962-63 winter quarter.

For the purpose of this study all students who registered for either of the two classes were used as subjects. The 35 subjects enrolled in the eleven o'clock class on Monday and Wednesday were designated as the calisthenic group. The 41 subjects enrolled in the eleven o'clock class on Tuesday and Thursday were designated as the isometric group. All of the 76 subjects were able to complete the training and to participate until the study was completed.

Testing Procedure

When the classes met for the first time the author gave an explanation of the study. The testing procedure was explained and demonstrated and the procedure that would be used in taking the body measurements was explained.

The author, with the help of six graduate students in the physical education department, administered the McCloy Strength Test (17). The same persons gave the same strength test items both initially and finally. All weight and height measurements were taken by one person, a women's physical education department faculty member.

Items of the McCloy Strength Test are: height, weight, pull-ups, push-ups, right grip, left grip, back lift, and leg lift. A description of these tests can be found in Appendix A.

Sit-ups were also included as an additional item to measure abdominal strength. The author used the procedure for sit-ups as described in the AAHPER Youth Fitness Test Manual (18). The author used this method because the subjects had previous experience in this way of doing sit-ups. To expedite the administration of this test, the subjects were asked to count and record the number of sit-ups for their partners. A description of the sit-up test can be found in Appendix B.

The girth body measurements were taken with a linen tape equipped with a Gulick handle. The measurements of the bust, hips, thigh, waist, and arm are of general importance to most women, therefore, chosen for the study. All of these measurements were taken by the author. The thigh, waist, and arm measurements were taken against the

skin; the bust measurements with brassiere on, and the hip measurements with underwear worn. A full description of how these measurements were taken appears in Appendix C.

The initial testing and measuring was completed in one week prior to the training program. The final testing and measuring was completed in one week at the close of the training program. All of the testing and measuring could not be completed during two class periods, therefore, the subjects were scheduled to report in their free time to complete any unfinished items.

Training

Calisthenic Group

The training program began the second week classes were in session for the winter quarter and lasted for six weeks. Class periods were begun with 12 minutes of calisthenics followed by the class activity of basketball. The author taught this class and personally directed all of the training.

An exercise plan devised by the Royal Canadian Air Force was the basis of the calisthenic program (19). A description of these exercises can be found in Appendix D.

Isometric Group

The training program began the second week classes were in session for the winter quarter and lasted for six weeks. Class periods were begun with 12 minutes of isometrics followed by the class activity of basketball. The author taught this class and personally directed all of the training.

In this group the subjects were paired with partners of about the same height and weight. Before training could begin there was a need for explanation, demonstration, and practice because the subjects were unfamiliar with isometric contractions. The subjects were constantly encouraged and checked to make certain that they exercised fully for the prescribed six seconds.

Johnson, in his plan for junior high school boys, used a series of isometric contractions and dual resistance exercises (20). The author chose from this group exercises to develop muscles of the arms, back, shoulders, abdomen, and legs. A detailed explanation of these exercises can be found in Appendix E.

CHAPTER IV

TREATMENT AND ANALYSIS OF DATA

Introduction

The primary purpose of this study was to determine which of two training programs, isometric contractions or calisthenics, was superior in producing changes in strength and selected body measurements of female freshman students. In addition, the author attempted to determine if the changes in strength and selected body measurements were statistically significant for either of the programs.

Converting the Data

Raw scores were used for all test items except arm strength. To determine arm strength, the author used the following formula (21):

$$(\text{Push-ups} + \text{Pull-ups}) \left(\frac{\text{Weight}}{10} + \text{Height} - 60 \right)$$

Reliability

Reliabilities of the body measurements were determined by the test re-test method using 10 women as subjects. The rho-formula was used to calculate the following correlations: bust .95, hips .95, thigh .94, waist .83, arm .96. No attempt was made to determine the reliability of the strength tests. However, all persons involved in

the strength testing were made thoroughly familiar with the correct procedures and precautions were taken in an attempt to assure the maximum reliability possible.

Analysis of Data

To solve the primary problem of this study, an analysis was made to determine whether the gains or losses of one group were significant over the gains or losses of the other group. As suggested by McCloy (22) the following procedures were employed for each test item. Using raw scores, the difference from initial to final scores was found. The mean gains or losses, the standard deviation of the mean gains or losses, and the standard error of the mean gains or losses were found for each group. Using this information, the standard error of the difference between the mean gains or losses of each group, was computed. A t or critical ratio was then determined and it was compared with a table of t values (23). For this analysis between groups, a t ratio of 2.65 was needed to reject the null hypothesis at the .01 per cent level of confidence.

In an attempt to determine if either the isometric or calisthenic programs produced statistically significant changes, the author analyzed for each group, the gains or losses from the initial to final testing period. The following procedure, as suggested by McCloy, was employed

for each test item. The initial and final means were determined. Then the difference between the initial and final means was computed for each group. After determining the standard error of the difference between the initial and final means for each group (24), a t ratio was calculated.

Findings

Mean Gain or Loss Comparisons Between Groups

Body Measurements

Bust--The isometric group showed a mean loss of .35 centimeters over the calisthenic group. A t ratio of .949 was computed and the null hypothesis was accepted that there was no significant difference between the two groups.

Hips--The isometric group showed a mean loss of .03 centimeters over the calisthenic group. A t ratio of .097 was computed and the null hypothesis was accepted that there was no significant difference between the two groups.

Thigh--The isometric group showed a mean loss of .34 centimeters over the calisthenic group. A t ratio of 1.09 was computed and the null hypothesis was accepted that there was no significant difference between the two groups.

Waist--The isometric group showed a mean loss of .82 centimeters over the calisthenic group. A t ratio of 1.70 was computed and the null hypothesis was accepted that

there was no significant difference between the two groups.

Arm--The isometric group showed a mean loss of .19 centimeters over the calisthenic group. A t ratio of 1.92 was computed and the null hypothesis was accepted that there was no significant difference between the two groups at the .01 level.

Table 1 summarizes the mean loss comparison between the isometric and calisthenic groups. It is interesting to note that both groups made losses rather than gains on each of the five body measurements.

Table 1. Body Measurement Mean Losses, t Ratios Between the Isometric and Calisthenic Groups, and Levels of Significance

Body measurement*	Mean loss isometric	Mean loss calisthenic	t ratio	Level
Bust	- .94	- .59	.95	.40
Hip	- .42	- .39	.097	.90
Thigh	-1.09	- .75	1.09	.40
Waist	-1.94	-1.12	1.70	.10
Arm	- .52	- .33	1.92	.10

*All body measurements are reported in centimeters.

Strength Measurements

Arm--The calisthenic group showed a mean gain of 122.01 pounds over the isometric group. A t ratio of .79 was not

significant and the null hypothesis accepted.

Grip--The isometric group showed a mean gain of 1.70 pounds over the calisthenic group. A t ratio of .68 was not significant and the null hypothesis accepted.

Back lift--The isometric group showed a mean gain of 8.96 pounds over the calisthenic group. The t ratio of 1.48 was not significant and the null hypothesis accepted.

Leg lift--The calisthenic group showed a mean gain of 12.02 pounds over the isometric group. The t ratio of 1.25 was not significant and the null hypothesis accepted.

Abdominal strength (sit-ups)--The calisthenic group showed a mean gain of 7.96 sit-ups over the isometric group. The t ratio of 2.50 was not significant and the null hypothesis was accepted at the .01 level of confidence. However, this t ratio was statistically significant at the .05 level of confidence.

Table 2 reveals that both the isometric and calisthenic groups made mean gains on the five strength tests. The only mean gain difference, that even approached statistical significance for this investigation, was made by the calisthenic group on the sit-up test item.

Isometric Group--Initial to Final Mean Gains or Losses

For the isometric group a t ratio of 2.71 was needed to show significance at the .01 per cent level of confidence.

Table 2. Strength Test Mean Gains, t Ratios
Between the Isometric and Calisthenic
Groups, and Levels of
Significance

Test items strength	Mean gain isometric	Mean gain calisthenic	t ratio	Level
Arm*	392.66	514.67	.79	.50
Grip*	6.	1.41	.68	.50
Back lift*	21.25	12.29	1.48	.20
Leg lift*	8.70	20.72	1.25	.30
Abdominal** (sit-ups)	5.92	13.89	2.50	.05

*Pounds

**Number

Body Measurements

Bust--The mean loss was .94 centimeters. The t ratio of 4.48 was significant and the null hypothesis was rejected.

Hips--The mean loss was .42 centimeters. The t ratio of 2.03 was found to have no statistical significance at the .01 per cent level of confidence and the null hypothesis was accepted. However, at the .05 per cent level of confidence this item did show statistical significance.

Thigh--The mean loss was 1.09 centimeters. The t ratio of 6.65 was significant and the null hypothesis was rejected.

Waist--The mean loss was 1.94 centimeters. The t ratio of 8.12 was significant and the null hypothesis was rejected.

Arm--The mean loss was .52 centimeters. The t ratio of 5.53 was significant and the null hypothesis was rejected.

Table 3 summarizes the mean losses for the isometric group on each body measurement item.

Table 3. Mean Losses for the Isometric Group
for Body Measurements, t ratios, and
Levels of Significance

Body measurement*	Initial mean	Final mean	Mean loss	t ratio	Level
Bust	85.80	84.86	- .94	4.48	.001
Hips	95.07	94.65	- .42	2.03	.05
Thigh	55.27	54.18	-1.09	6.65	.001
Waist	65.09	63.15	-1.94	8.12	.001
Arm	25.17	24.65	- .52	5.53	.001

*All body measurements are reported in centimeters.

Strength Measurements

Arm--The mean gain was 392.66 pounds. The t ratio of 6.17 was statistically significant beyond the .01 level and the null hypothesis was rejected.

Grip--The mean gain was 6 pounds. The t ratio of 3.64 was significant and the null hypothesis was rejected.

Back lift--The mean gain was 21.25 pounds. The t ratio of 5.76 was significant and the null hypothesis was rejected.

Leg lift--The mean gain was 8.70 pounds. The t ratio of 1.29 was not significant at the .01 level and the null hypothesis was accepted.

Abdominal strength (sit-ups)--The mean gain was 5.92 sit-ups. The t ratio of 4.20 was significant and the null hypothesis was rejected.

Table 4 summarizes the mean gains made by the isometric group on the five strength test items.

Table 4. Mean Gains for the Isometric Group for Strength Tests, t Ratios, and Levels of Significance

Strength test	Initial mean	Final mean	Mean gain	t ratio	Level
Arm*	723.53	1116.19	392.66	6.17	.001
Grip*	147.	153.	6.	3.64	.001
Back lift*	164.13	185.38	21.25	5.76	.001
Leg lift*	212.38	221.08	8.70	1.29	.40
Abdominal** (sit-ups)	21.68	27.60	5.92	4.20	.001

*Pounds

**Number

Calisthenics Group--Initial to Final
Mean Gains and Losses

For the calisthenic group a t value of 2.72 was needed to show statistical significance at the .01 per cent level of confidence.

Body Measurements

Bust--The mean loss was .59 centimeters. The t ratio of 2.40 was not significant and the null hypothesis was accepted. However, this t ratio was statistically significant at the .05 level of confidence.

Hips--The mean loss was .39 centimeters. The t ratio of 1.80 was not significant at the .01 level and the null hypothesis was accepted.

Thigh--The mean loss was .75 centimeters. The t ratio of 4.49 was significant and the null hypothesis was rejected.

Waist--The mean loss was 1.12 centimeters. The t ratio of 5.23 was significant and the null hypothesis was rejected.

Arm--The mean loss was .33 centimeters. The t ratio of 4.76 was significant and the null hypothesis was rejected.

Table 5 summarizes the mean losses for the calisthenic group on the five body measurement items.

Strength Measurements

Arm--The mean gain was 514.67 pounds. The t ratio of 7.04 was significant and the null hypothesis rejected.

Table 5. Mean Losses for the Calisthenic Group for Body Measurements, t ratios, and Levels of Significance

Body measurement*	Initial mean	Final mean	Mean loss	t ratio	Level
Bust	86.11	85.52	- .59	2.40	.05
Hips	94.18	93.79	- .39	1.80	.10
Thigh	54.89	54.14	- .75	4.49	.001
Waist	64.57	63.45	-1.12	5.23	.001
Arm	25.21	24.88	- .33	4.76	.001

*All body measurements reported in centimeters.

Grip--The mean gain was 1.14 pounds. The t ratio of .86 was not significant and the null hypothesis was accepted.

Back lift--The mean gain was 12.29 pounds. The t ratio of 4.25 was significant and the null hypothesis was rejected.

Leg lift--The mean gain was 20.72 pounds. The t ratio of 3.53 was significant and the null hypothesis was rejected.

Abdominal (sit-ups)--The mean gain was 13.89 sit-ups. The t ratio of 10.18 was significant and the null hypothesis was rejected.

Table 6 summarizes the mean gains for the calisthenic group on each of the five strength test items.

Table 6. Mean Gains for the Calisthenic Group for Strength Tests, t ratios and Levels of Significance

Strength tests	Initial mean	Final mean	Mean gain	t ratio	Level
Arm*	930.3	1444.97	514.67	7.04	.001
Grip*	156.03	157.43	1.41	.86	.40
Back lift*	173.	185.29	12.29	4.25	.001
Leg lift*	192.71	213.43	20.72	3.53	.002
Abdominal** (sit-ups)	20.74	34.63	13.89	10.18	.001

*Pounds

**Number

Summary of Findings

The author found that there was no statistically significant difference between the isometric group and the calisthenic group in either the reduction of body measurements or in increased strength.

When considering body measurements, the isometric group made statistically significant losses in four of the five areas measured. The calisthenic group made statistically significant losses in three of the five body measurements.

For strength measurements, both the isometric and calisthenic groups made statistically significant gains on four of the five test items.

Discussion of Findings

The author gives a possible explanation as to why there could be an increase in muscular strength and not have it result in increased body measurements. Muscles tend to hypertrophy in direct proportion to the amount of work done in a given unit of time. Likewise, during training, the adipose tissue decreases. It is possible that the exercises did not tax the subjects enough to cause a substantial increase in the size of the muscle fibers; also there is the probability that the training program was not of sufficient duration to cause much of an increase in muscle size. The author believes, that although there was some hypertrophy, the losses recorded for body measurements were due to the decrease in adipose tissue.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The primary purpose of this study was to determine which of two training programs, isometric contractions or calisthenics, was superior in producing changes in strength and selected body measurements in female college freshman. In addition, the data was analyzed to determine if either of the programs caused changes in strength and the selected body measurements.

The subjects used in this study were 76 female freshman students enrolled in physical education service classes at South Dakota State College during the winter quarter of the 1962-63 school year. The students used in this study were chosen from two basketball classes that met twice weekly.

During the six week training period, one group performed the prescribed 12 minutes of isometric exercises followed by participation in the class activity of basketball. The calisthenic group exercised for 12 minutes and then took part in the class activity of basketball.

The McCloy Strength Test was given prior to the training period and again at the end of the six week training program. Height and weight of the subjects were

recorded before and after the training period; as were the bust, hips, thigh, waist, and arm measurements.

Findings

From the data the following facts have been obtained:

1. In the comparison of the isometric and calisthenic groups, there was no significant difference for any of the body measurements.

2. In the comparison of the isometric and calisthenic groups, there was no significant difference on any of the strength test items.

3. In the bust, thigh, waist, and arm measurements the isometric group had a statistically significant loss at the one per cent level of confidence.

4. The isometric group had statistically significant gains in arm, grip, back, and abdominal strength.

5. The calisthenic group had statistically significant losses in the thigh, waist, and arm measurements.

6. In the calisthenic group the gains were significant for arm, back, leg, and abdominal strength.

Conclusions

When the two training programs were compared, the findings indicated no superiority of either the isometrics or calisthenics in producing changes in body measurements and muscular strength.

A training program that included either isometrics or calisthenics would be instrumental in producing losses in body measurements and increases in muscular strength.

Recommendations

The author recommends that a battery of isometric or calisthenic exercises, or both, be included in a women's physical education program to supplement existing activities.

Recommendations for Further Study

1. If any further studies are made, where isometrics are used, care should be taken to make certain the subjects know how to achieve a maximum contraction.
2. That further studies be made to compare groups performing the exercises daily, every other day, three times a week, twice a week, and once a week.
3. That a similar study be made using sliding calipers for some of the body measurements and spreading calipers to measure adipose tissue.
4. That a similar study be made with a longer training period.

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APPENDIX A

Description of the McCloy Strength TestHeight

Each subject wore her gym uniform and socks but no shoes when measured. The height was recorded to the nearest half inch.

Weight

Each subject wore her gym uniform and socks but no shoes when weighed. The weight was recorded to the nearest half pound.

Grip Strength

A hand dynamometer was used to measure the grip strength of both the right and left hands and readings were taken to the nearest pound. Two trials were given and the best of the trials recorded, the right hand being tested first.

The tester placed the hand dynamometer, face down, in the palm of the subject's hand with the rounded edge against the base of the hand and the convex edge between the first and second joints of the fingers.

It was suggested that the subject's elbow be slightly bent and the hand describe a sweeping downward arc as the dynamometer was squeezed. The subject's hands could not touch the body or any other object while the

test was being taken.

The indicator was returned to zero after each trial.

Back Strength

The back and leg dynamometer was used to measure back strength.

The subject was told to stand on the bench with feet parallel and about six inches apart, hands on the front of the thighs with fingers downward. The tester then hooked the chain so that the bar was level or just below the finger tips. The subject then grasped the handle with the palm of one hand forward and the other palm backward. When the subject was in position to lift her hips were slightly bent, legs straight, head up, and eyes straight ahead. The lifter was instructed to lift steadily and the best of two trials recorded.

Leg Strength

The back and leg dynamometer was used to measure leg strength.

The subject was instructed to stand on the bench with her feet in the same position as for the back lift and the hands in the same position on the handle. The handle was held so that it would rest at the junction of the thighs and trunk. The knees were then bent at a 120° angle, the hook fastened in the chain, and the angle of the knees

checked again. The subject was then instructed to lift steadily with her back straight, head erect, and chest up. The best out of the two trials was recorded.

Pull-ups

An adjustable horizontal bar was used for this test. The bar was raised or lowered to accommodate each subject, by adjusting it to the height of the apex of the sternum. The subject would then grasp the bar with palms outward and slide her feet under the bar until the body and arms formed approximately a right angle when the body was held straight. The weight rested on the heels.

The test was to pull up as many times as possible with the body held perfectly straight. Half-credit was given, up to four half-credits, if the subject did not pull completely up or go completely down, if the body sagged, if the hips rose, or if the knees bent in a kip motion. To prevent the subject's feet from sliding, the tester placed his feet under each instep for support.

Push-ups

This test was executed from a stool, 13 inches high by 20 inches long by 14 inches wide. It was placed on a mat about six inches from a wall so that the subject did not take a position too far forward.

The subject grasped the outer edges of the stool at the nearest corners and assumed the front-leaning rest position, with balls of her feet resting on the mat and with her body and arms forming a right angle. The test was to lower the body so that the upper chest touched or nearly touched the near edge of the stool, then raise it to a straight-arm position as many times as possible.

If the body swayed or arched, if the subject did not go completely down or did not push completely up, half-credit was given up to four half-credits.

APPENDIX B

Description of the AANPER Sit-up Test

The subject was lying on her back on the floor, with legs extended and feet about two feet apart. Her hands were placed on the back of the neck with fingers interlaced and elbows retracted. A partner held the ankles down so that the heels were in contact with the floor at all times.

The subject sat up; turned the trunk to the left and touched the right elbow to the left knee and returned to starting position. She then sat up turning the trunk to the right and touching the left elbow to the right knee. The exercise was repeated as many times as possible, one point being scored for each complete movement of touching elbow to knee. The subjects were allowed to set their own pace. They could not rest between exercises and once the exercise was stopped could not begin again.

No score was counted if the fingertips did not maintain contact behind the head, if knees were bent while lying on the floor or beginning the sit-up, or if the subject pushed up off the floor from an elbow.

APPENDIX C

Description of the Body MeasurementsBust

The nipples of the breast were used as a landmark. The tape was placed around the chest in a horizontal plane at nipple level.

Hips

The pubic crest was used as a landmark. The tape was placed around the hips in a horizontal plane at the level of the pubic crest.

Thigh

This measurement was taken on the left thigh. The tape was placed around the thigh in a horizontal plane at the level of the gluteal fold.

Waist

This measurement was taken in a horizontal plane at the level of the most constricted portion of the abdomen.

Arm

A mark was placed on the left arm half way between the acromion process of the scapula and the elbow. Using this point as a landmark, the tape was placed around the arm in a horizontal plane at that level.

APPENDIX D

Description of the Calisthenic Exercises

There was a time limit placed on each of the exercises. The progression was to work up to more repetitions in the given amount of time.

Exercises 1, 2, 3, 4--two minutes

Exercise 5--two minutes

Exercise 6--one minute

Exercise 7--one minute

Exercise 8--two minutes

Exercise 9--one minute

Exercise 10--three minutes

Exercise 1--Toe Touching

Stand erect, feet about 16 inches apart, arms over head. Bend down to touch floor outside left foot. Bob up and down to touch floor between feet. Bob again touching floor between feet once more. Bob and bend to touch floor outside right foot. Return to starting position.

Exercise 2--Knee Raising

Stand erect, feet together, arms at sides. Raise left knee as high as possible, grasping knee and shin with hands. Pull leg against body. Keep back straight throughout. Lower foot to floor. Repeat with right leg. Continue by alternating legs, left then right.

Exercise 3--Lateral Bending

Stand erect, feet 12 inches apart, right arm extended over head, bent at elbow. Keeping back straight, bend sideways from waist to left. Slide left hand down leg

as far as possible, at same time press to left with right arm. Bob up a few inches and press to left again. Return to starting position and change arm positions. Repeat to right.

Exercise 4--Arm Flinging

Stand erect, feet 12 inches apart, upper arms extended sideways at shoulder level, elbows bent, outstretched fingers touching in front of chest. Press elbows backward and upward. Do not let elbows drop. Return arms to starting position and fling hands and arms outward, backward, and upward as far as possible. Return to starting position.

Exercise 5--Sit-ups

Lie on back, legs straight and together, hands behind head. Move to sitting position. Keep feet on floor (support may be used if necessary) and back straight. Lower body to starting position.

Exercise 6--Chest and Leg Raising

Lie face down, legs straight and together, hands behind head. Raise entire upper body and both legs from floor as high as possible. Keep legs straight. Return to starting position.

Exercise 7--Side Leg Raising

With right side to floor, support weight on right hand (arm straight) and side of right foot, using left hand for assistance in balance if necessary. Raise left leg until it is parallel with floor. Lower leg to starting position. Do half number of counts raising left leg. Change to other side and do half number of counts raising right leg.

Exercise 8--Push-ups

Lie face down, legs straight and together, toes turned under, hands directly under shoulders. Push up from hands and toes until arms are fully extended. Keep

body and legs in a straight line. Return to touch chest to floor and repeat.

Exercise 9--Leg-overs

Lie on back, legs straight and together, arms stretched sideways at shoulder level, palms down. Raise both legs until they are perpendicular to floor, keeping them straight and together. Lower legs to left, trying to touch left hand with toes. Raise to perpendicular and lower to right side. Raise again to perpendicular and return to starting position.

Exercise 10--Run and Semi-Squat Jumps

Stand erect, feet together, arms at sides. Starting with left leg, run in place raising feet at least six inches from floor. Each time left foot touches floor counts one. After each fifty counts do ten semi-squat jumps.

Drop to a half crouch position with hands on knees and arms straight. Keep back as straight as possible, one foot slightly ahead of the other. Jump to upright position with body straight and feet leaving floor. Reverse position of feet before landing, return to half crouch, and repeat.

APPENDIX E

Description of Isometric ExercisesExercises with Partner

First one subject performed while her partner supplied the resistance; then partners changed duties and repeated the exercise. Maximum pressure was applied for six seconds.

1. Stand erect with hands at side, partner supplies resistance by grasping wrists. Subject pushes forward with arms.
2. The same as number one except that the pressure is applied from behind. Subject pushes back with arms.
3. Stand erect with arms extended 30 degrees, partner supplies resistance by placing forearms on the outside of subjects forearms. Subject pushes out with arms.
4. Stand erect with arms extended 30 degrees, partner supplies resistance by placing forearms on the inside of subjects forearms. Subject pulls in with arms.
5. Stand erect with arms at side with forearm bent to a 90 degree angle, partner holds subjects wrists. Subject pushes down with arms.
6. The same as number five except that the subject pulls up with arms.
7. Lie on back with legs extended, partner holds subjects instep. Subject pulls back with her toes.
8. Lie on back with legs extended, partner places hands against the balls of subjects feet. Subject pushes with her toes.
9. Lie on back with legs spread 30 degrees, partner places knees between the subject's ankles. Subject presses her legs together.

10. Same as number 9 except that partner places knees on the outside of subject's ankles. Subject presses outward with her legs.

11. Sit in a two-thirds sitting position, partner sits across legs and places hands on subject's chest. Subject pushes forward.

12. Lie face down with legs bent at a 90 degree angle, partner holds back on subject's ankles. Subject pulls legs toward buttocks.

Individual Exercises

1. Stand erect, grasp fingers at chin height, pull.
2. Stand erect, palm against palm at chin height, push.
3. Stand erect, inhale deeply, draw in abdominal wall, and contract gluteus muscles.