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Warn-Up Exercise: Comparing Static and Conventional Methods of Exercise With Freshman Male Studnets at the University of North Dakota

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WARM-UP EXERCISE: COMPARING STATIC AND CONVENTIONAL METHODS OF EXERCISE WITH FRESHMAN MALE STUDENTS AT THE UNIVERSITY OF NORTH DAKOTA

Thomas B. Reynolds, Master of Science

The thesis here abstracted was written under the direction of Walter C. Koenig, and approved by John L. Quaday and Felix J. Vondracek as members of the examining committee, of which Mr. Koenig was chairman.

This study had three purposes: one, to determine the effectiveness of static resistance exercises as compared to conventional exercises while being used in physical education classes; secondly, to provide a series of exercises where-by static resistance exercises may be taught without the use of equipment in physical education classes; thirdly, to compare the arm, leg, and back strength gained as a result of the different warm-up programs.

Thirty-four University of North Dakota freshmen male physical education service students were divided into two groups, equated on the basis of results taken from their American Association of Health Physical Education and Recreation Youth Fitness Test.

Each group was tested the first week, the fourth week and at the end of the eight week program. The tests were the leg and back strength tests using the dynamometer, the arm strength tests using the bent arm hang and bar dips.

The significance of difference between the test-retest-retest within each group and between groups was tested by the "t" technique for paired observations of small samples. Rejection of the null hypothesis was assumed beyond the .05 level of significance.

The conclusions indicated by this study were:
1. Static resistance can significantly increase arm, back, and leg strength in four weeks.
2. The static resistance group showed no significant gain of strength during the last four weeks.
3. The conventional exercise group revealed no significant differences in their test-retest-retest.

This abstract of a thesis submitted by Thomas B. Reynolds in partial fulfillment of the requirements for the Degree of Master of Science in the University of North Dakota is hereby approved by the committee under whom the work of the thesis has been done.

W. C. Koenig
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Dean of the Graduate School

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WARM-UP EXERCISE: COMPARING STATIC AND CONVENTIONAL METHODS OF EXERCISE

WITH FRESHMAN MALE STUDENTS AT THE UNIVERSITY OF NORTH DAKOTA

By

Thomas B. Reynolds

B. S. in Physical Education, North Dakota State University 1962

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CHAPTER I

INTRODUCTION

Because of the interest developed in static resistance exercises, many new programs have been developed and encouraged for use by physical educators and coaches in their professions. It was felt that static resistance exercise could provide the individual with an exercise program equivalent to the conventional exercise program used in today's physical education programs. The exercises selected for the static resistance program were based on the buddy system with the objective of determining the amount of strength gained through participation in warm-up exercises as illustrated in Appendix A on page 38. The exercises selected for the conventional exercise program were popular exercises used in physical education programs. The objective of the conventional program was to determine the amount of strength that could be gained through warm-up exercises as illustrated in Appendix B on page 49.

PURPOSE OF THE STUDY

The purpose of this study was to determine the effectiveness of static resistance exercise as compared to conventional exercise while being used as warm-up exercises for physical education classes. The specific purposes of the study were as follows:

1. To provide a series of exercises where-by static resistance exercises may be taught without the use of equipment in physical education classes.

2. To compare the amount of arm, leg, and back strength gained as a result of the different warm-up programs.

NEED FOR THE STUDY

Due to the amount of interest developed in the last few years for static resistance exercise, it would seem to be of utmost importance to develop and justify the feasibility of static resistance exercise in the physical education program. This basic question can be answered by determining the amount of strength gained in warm-up exercises by comparing the use of static resistance and conventional exercises. Due to the emphasis on physical fitness there seems to be a need for further research in this area.

LIMITATIONS

The study involved two physical education classes comprising a total of forty-seven students. This number was narrowed down to thirty-four so the two classes could be equated on a matched pairs basis with seventeen subjects in each class. The classes were equated and the individuals were paired on the basis of their scores from the American Assocation of Health Physical Education and Research Youth Fitness Test. Although all freshmen students in the physical education service program at the University of North Dakota had an equal chance of being selected in this study, it must be stated here that the final selection was based on the two sections

with mean scores closest to the mean derived from the American
Association of Health, Physical Education, and Research Youth
Fitness Test.

The study was completed during the first semester 1963-1964,
at the University of North Dakota. The study started after a
seven week conditioning program, which was designed to help the
student attain a higher level of physical fitness.

Definition of Terms

Certain concepts are explained below in terms of their meaning
as used in this study.

Warm-up-For this study warm-up is considered the exercising period
        before participation in skilled activity.

Isometric or Static Resistance-Exercises performed using an immovable
        object as resistance. For this study the resistance was
        supplied by another student.

Conventional Exercise-Exercises with a wide range of motion with
        gravity and other body parts acting as resistance.

CHAPTER II

REVIEW OF LITERATURE

With additional emphasis being placed on physical fitness the author has tried to find a physical education program in which warm-up exercises will retain strength. "The topic of the effects of warm-up upon the efficient development of strength has received the attention of some investigators but, as yet, its value has not been fully determined."[1] Some writers have concluded that warm-up is not beneficial as did Karpovich and Hale in their study, Erogogenic Aids in Athletics, in which they stated, "To our surprise, we could not find any beneficial effect of not only massage, but even of preliminary exercise."[2]

From the related literature found for this study the majority of the writers accepted the idea of warm-up exercises. Morehouse and Miller[3] stated that work of great intensity should be preceded either by a warming up period of work progressive in intensity from low to great, or should be commenced at a reduced rate, load, or range of movement and then gradually increased.

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[1] Craig Davis and Gene A. Longan, Warm-up Strength Development and Biophysical Values of Muscular Activity (135 South Locust Street, Dubuque, Iowa: Wm. C. Brown Pub. Co., 1961), p.79.

[2] Peter V. Karpovich, "Erogogenic Aids in Athletics," Exercise and Fitness (University of Illinois, Urbana, Illinois: Athletic Institue, 1960), p. 82.

[3] Laurence E. Morehouse and Augustus T. Miller, Physiology of Exercise (3rd ed. rev.; St. Louis: C.V. Mosby Co., 1959), p. 243.

Miller[4] maintained that the four general advantages of warming-up are: (1) greater safety, (2) physiological economy, (3) mental readiness, and (4) effective coordination. He also implied that warming-up was beneficial for improvement in skill, endurance, strength, and speed activities in track and field events.

Karpovich[5] stated informal movements are the general, free movements (such as swinging the arms about and stationary running) undertaken solely for raising the temperature of the muscles. This is achieved through the liberation of heat during contraction of the muscles and also through an increased blood flow from the inside of the body. A greater blood supply will insure a greater output of energy because more oxygen and nutriments will be transported more rapidly. A warm muscle will also have a lower viscosity which is of a great importance in the rate of speed of biochemical reactions. Miller[6] stated that "observations on the contraction of isolated muscles provide a clue to the nature of the warming-up process. If the muscle is warmed, the speed with which the muscle contracts and relaxes and the force of contraction are all increased. If previously inactive muscles are stimulated repeatedly, the first few contractions are often small and irregular and relaxation is incomplete.

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[4]Richard I. Miller, "The Science and Practice of Warming-up: Part II," Athletic Journal, XXXI (March, 1951), pp. 46-48, 50-59.

[5]Peter V. Karpovich, "The Physiology of Athletics," Scholastic Coach, (September, 1934), pp. 22-23.

[6]Laurence E. Morehouse and Augustus T. Miller, Physiology of Exercise (2nd ed. rev.; St. Louis: C.V. Mosby Co., 1953), pp. 30-31.

After this, the contractions become stronger and relaxation is complete." Morehouse and Miller agree with Karpovich as they stated that "it is possible that the viscosity of the muscle is thereby decreased by a local rise in temperature and the accumulation of metabolic products which allows contraction and relaxation to occur with greater promptness."[7] Woodward[8] investigating injuries and the safety of athletes stated that one of the causes of torn muscles is the habit of taking strenuous exercise suddenly and in unaccustomed ways when the muscles are not tuned up. The average runner requires from twenty to thirty minutes of steady regular exercise.

Davis and Logan[9] stated that they felt more attention should be given to the effects of the "buddy system" of exercise for the application of resistance, one athlete providing resistance for another during conditioning phases of the activity. The above recomendation and Berny Warner's[10] article, "Simple Isometrics," fostered the decision to study the effectiveness of using "buddy system" isometrics as a warm-up exercise for students before participation in skilled activity.

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[7]Ibid., II, 31.

[8]Christopher Woodward, Sports Injuries (London: Max Parris, 1954), p. 117.

[9]Davis and Longan, p. 139.

[10]Berny Warner, "Simple Isometrics," Scholastic Coach, XXXII December, 1962), pp. 22-23.

Research in Isometric Exercises

In the Hettinger and Miller study[1], nine male subjects performed static contraction exercises for a period of eighteen months with seventy-one tests administered to each subject to discover the improvement of maximal static strength. All training was performed by pulling and holding a pre-determined amount of tension against a dynamometer. On Saturday of each week maximal strength was measured.

On the average, the increase of maximal muscle strength per week was 5% of the original starting value for that week. Increases in muscular strength were more rapid with increasing intensity of training loads up to two-thirds of the maximal strength. Increases in the training load from two-thirds to maximal tension had no additional effect. One daily exercise in which the tension was held for six seconds resulted in as much increase in strength as did exercises which involved longer periods and more frequent practices.

Mathews and Kruse[12], in their study, said the purpose of their investigation was to study the effects of isometric type exercises. One hundred and twenty Springfield College male students were tested,

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[11] Bill Morgan, "Static Exercises, Scholastic Coach, Volume XXXII, n. 6, (February, 1963), p. 24, quoting Hettinger, Thomas and E.A. Muller, "Muskelleistung and Muskeltraining," Arbeitsphysiologie, October, 1953.

[12] D.K. Mathews and Robert Kruse, "Effect of Isometric and Isotonic Exercise on Elbow Flexor Muscle Groups," Research Quarterly, XXVIII, n. 1 (March, 1957), pp. 26-38

half exercising isometrically and the other half isotonically.
The 60 subjects in the isotonic unit exercised to exhaustion on
the Kelso-Hellebrandt ergometer with a weight load equal to 3/16
of their maximum strength. The subjects in the isometric unit
exercised by exerting maximum effort in three consecutive six-
second pulls on a strap. The respective groups exercised two,
three, four and five times a week over a period of four weeks.

The following results were obtained: (1) no common regression
line was found in the eight groups, indicating the strength changes
peculiar to the individual, regardless of exercise frequency;
(2) the isometric type exercise caused a greater number of subjects
to significantly gain in strength; and (3) the five-day-a-week
exercise program was most beneficial in terms of strength gains.

Dennison, Howel, and Morford[13] found a slightly different
change in their study as they divided twenty subjects into two
groups of ten, each enrolled in required programs. The groups were
equated on the basis of the scores taken from the Arm Strength Index.
Group I participated in a weight training program and Group II
performed the thirteen exercises taken from the Commander Set.
Both groups met twice a week for eight weeks. The purpose of this
study was to determine the relative effects of an isometric exercise
program known as the Commander Set developed by Commander Crauque,
USN, and Arthur H. Steinhaus.

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[13] J.D. Dennison, M.S. Howell and W.R. Morford, "Effect of
Isometric and Isotonic Exercise Programs Upon Muscular Endurance,"
Research Quarterly, XXXII, n. 3 (October, 1961), pp. 348-352.

The test given to both groups consisted of (1) dipping strength test, (2) chinning strength test, and (3) the arm strength index. From this study the following conclusions were drawn:

1. Both groups showed significant improvement in chinning and dipping ability and the arm strength index.

2. Both exercise programs were significant in improvement of the upper arm.

3. Group I showed improvements at the .01 level of confidence in chinning and .02 level of confidence in dipping.

4. Group II showed improvements at the .05 level of confidence in both chinning and dipping.

Morgan[14] stated, "static exercise is of definite value in the development of strength." Morgan based his study on three sources: (1) scientific research conducted in the United States, England, and Germany; (2) the claims made by athletes and teams employing static exercise; and (3) an experimental study conducted by Bill Morgan at the University of Maryland.

The basic program was very similar to the Hettinger and Mueller study previously discussed. The results found by Morgan were:

1. The pain phenomena - pain must be present to gain strength was the idea of many athletes.

2. Endurance - static exercises developed strength but could not find a correlation with endurance.

3. Static exercises do not develop total fitness.

Morgan took the research material and experience into consideration and then concluded that static exercise permits rapid muscle training with the lowest expenditure of time and energy.

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[14] Morgan, loc. cit.

A great deal of work has been done with comparing isometric and isotonic programs. Thompson[15] stated that the major conclusion that he could draw from his study was that there is no significant difference in training with either isometrics or weights in the development of strength. The study consisted of comparing many studies from leaders in physical education such as: (1) Councilman, (2) Karpovich, (3) Rasch, (4) Pierson, (5) Locback, (6) Asprey, (7) Swegan, and (8) Müller. The studies were made in either isotonic or isometric training and from these Thompson concluded:

1. "Both isotonic and isometric training against resistance cause significant increases in strength development.

2. Isotonic and isometric training programs have been compared in the development of strength with conflicting results. However, the majority of the studies indicate there is no significant difference between the two methods in total strength development.

3. There appears to be no difference in the tension which can be exerted in a single maximum isometric contraction and the maximum weight which can be moved in a single isotonic contraction."

Wolbers and Sills[16] took two groups of students from the State University of Iowa's High School, which served as subjects to determine whether static muscle contractions would result in significant changes in strength. Four tests of strength were administered at the beginning and at the end of an eight week period. The test was used to determine the significance of the differences between the mean gains of the two groups. The experimental groups made

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[15] Hugh Thompson, "Weight Training Vs. Isometric Training," Scholastic Coach, XXXII, n. 1. (September, 1962), p. 38.

[16] Charles P. Wolbers and Frank D. Sills, "Development of Strength in High School Boys by Static Muscle Contractions," Research Quarterly, XXXII, n. 4, (December, 1956), p. 446.

greater gains in the back lift, the leg lift and the combined hand grip test than did the control group. These gains were statistically significant.

It was concluded that for the muscle groups tested in this experiment, static muscle contractions of six seconds duration will cause significant gains in strength. The increase in leg strength made by the members of the experimental group were not proportionately great enough to produce a statistically significant gain in the Sargent Jump.

CHAPTER III

PROCEDURE

The subjects used in this study were all freshman students participating in the physical education service program at the University of North Dakota.

Two physical education classes were selected based on their results on the American Association of Health, Physical Education, and Recreation Youth Fitness Test. This test was administered to all freshman physical education service classes after a six week conditioning program. Two classes with mean scores of 390.8 and 391.2 were selected for the study. The mean score for all students in the freshman physical education service classes was 390.

The results of each individual's American Association of Health, Physical Education, and Recreation Youth Fitness Tests were placed on a T-scale allowing the scores to be totaled. The individual's total scores were used for equating the two groups by the matched pairs procedure as illustrated in Table 1 on page 13

Warm-up Exercise Program

Group I- The seventeen students that participated in the conventional exercise program shall, from here on, be referred to as Group I. The program for Group I consisted of thirteen exercises that could be executed with gravity serving as the only resistance to the performance of the exercise. The conventional

used were: (1) shoulder adduction, (2) shoulder abduction, (3) shoulder extension, (4) shoulder flexion, (5) bicep flexion, (6) triceps flexion, (7) leg adduction, (8) leg abduction, (9) leg extension, (10) leg flexion, (11) back hyper-extension, (12) static sit-up, and (13) static resistance rowing exercise.

Testing

Leg Strength - The leg lift was measured with the back and leg dynamometer, with the use of the belt. This test took the longest time to administer and was probably the most difficult to administer. The boy stood erect, with feet placed parallel and with the center of the foot opposite the anchoring chain. The bar was placed in the subject's hands, which were held close together with arms straight down. The bar was pressed lightly against the thighs. The looped end of the belt was slipped over one end of the bar. The free end of the belt was placed around the hips and wrapped around the remaining end of the bar. The subject then assumed partial squat position, with knees bent to an angle of about 130°. The nearest link of the chain attached to the dynamometer was then placed on the anchoring hook. The arms were straight with head held erect and chest up. The subject applied a maximum upward effort. When the belt was released, the score was read to the nearest pound as given on the dial.[17]

Back lift - The same dynamometer was used for the back lift. The subject stood erect on the platform with the feet in the same

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[17] H. Harrison, Clarke, Application of Measurement to Health and Physical Education, (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1959), p. 187.

exercises used were: (1) 20 jumping jacks, (2) running in place,
(3) 5 neck twisters each way, (4) wind mill for 30 seconds,
(5) 10 burpees, (6) 20 situps, (7) 5 spread eagles, (8) 20 push-ups,
(9) 10 modified pull-ups, (10) bicycle for 20 seconds, (11) sit
and bob 10 times, (12) 5 wing lifts, and (13) run one lap around
the gym. (For explanation and illustrations see Appendix A.)

TABLE I

PAIRED SCORES ON THE AMERICAN ASSOCIATION OF HEALTH,
PHYSICAL EDUCATION, AND RECREATION YOUTH FITNESS TEST

Group I	Test Scores	Group II	Test Scores
1. I. S.	424	1. M. M.	428
2. R. C.	395	2. B. M.	390
3. R. J.	405	3. F. B.	405
4. J. G.	361	4. R. W.	366
5. J. F.	405	5. T. A.	405
6. T. O.	428	6. J. L.	430
7. J. S.	346	7. W. B.	340
8. W. T.	384	8. J. C.	386
9. F. B.	410	9. G. G.	408
10. M. C.	399	10. M. L.	398
11. D. L.	408	11. T. J.	408
12. J. H.	354	12. M. G.	348
13. J. C.	357	13. B. E.	356
14. H. W.	422	14. G. G.	424
15. K. W.	370	15. R. W.	372
16. S. L.	386	16. L. F.	382
17. R. B.	407	17. R. N.	406
Mean	390.8	Mean	391.2

Group II - The seventeen students that participated in the
static resistance exercise program, from here on, shall be referred
to as Group II. The program for Group II consisted of thirteen
exercises that were executed for a maximum duration of six seconds
each. The exercises were performed through the use of the buddy
system as illustrated in Appendix B. The static resistance exercises

position as for the leg lift, hands on the front of the thigh, fingers extended downward. The chain was hooked so that the bar level was just below the finger tips. The handle was grasped at the ends of the bar, with one palm forward and one palm backward. The back was slightly bent at the hips and did not completely straighten when lifting. Care was taken to keep the knees straight. The lift was recorded to the nearest pound as given on the indicator.[18]

Bent arm hang - The subjects were helped to a position on the bar where they could place their hands shoulder width apart, palms outward, on a one-inch standard horizontal bar, with elbows flexed to permit the chin to be level with the bar. The support is removed and the subject holds his chin at the level of the bar as long as he can do so. The legs should remain extended throughout the exercise. The score is the number of seconds the student is able to maintain the bent arm position.

Bar dips - The bar dips or the push-up tests were administered on the regular gymnasium parallel bars. The bars were adjusted approximately to shoulder height and width. The subjects stood at one end of the parallel bars, grasping one bar in each hand. The subject jumped to the front support with arms straight (this counted one) and then lowered his body until the angle of the upper arm and forearm was less than a right angle, then pushed up to the straight-arm position (this counted two). This movement was repeated as many times as possible by each student. The subjects were not permitted to jerk or kick when executing push-ups.

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[18] Ibid., pp. 187-188.
[19] Ibid., p. 239

During the first dip for each subject, the tester gauged
the proper elbow angle. The tester then held his fist so that
the subject's shoulder touched on each repeated dip. If the
subject did not go down to the proper bent-arm angle or all the
way to a straight-arm position half-credit was given, up to four
half credits.[20]

Experimental Design and Procedure

The physical education service program for freshman students
at the University of North Dakota was divided into six weeks of
conditioning, one week to administer the American Association
of Health, Physical Education, and Recreation Youth Fitness Test,
and eight weeks of skilled activities. The activities were
divided into four class periods each of volleyball, basketball,
tumbling, and wrestling.

The experiment for this study started after the completion
of the conditioning and testing programs. It was felt that
testing at this time would find all subjects at a high level of
performance and this should aid in establishing more valid and
reliable results. The physical education service program classes
met twice a week for one hour periods. The pre-test was given the
first day that the skilled activities were to be taught. At this
time an explanation was given of the tests, testing equipment,
and the exercise program in which they were going to participate.

The bent arm hang was administered by the class instructor,
the bar dips by the student leader and the leg and back lifts were

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[20]Ibid., p. 193

administered by the author. The exercises used were under the
direction of the student leaders, (illustrations in Appendix A
and Appendix B). The warm-up exercises were performed before each
for eight weeks. The warm-up exercises were timed and recorded
as each group was expected to finish their warm-up exercises
within five minutes after the class period started. The times and
dates are given in Table 2

TABLE 2

DATE AND AMOUNT OF TIME SPENT
ON EACH EXERCISE PROGRAM

Dates Group I	Time	Dates Group II	Time	
Nov. 13	Test #1	Nov. 12	Test #1	
Nov. 18	10:07	Nov. 14	9:17	
Nov. 20	7:04	Nov. 19	6:02	
Nov. 25	No classes	Nov. 21	5:48	
Nov. 27	6:10	Nov. 26	5:27	
Dec. 2	5:35	Dec. 3	5:27	
Dec. 4	5:17	Dec. 5	5:23	Test #2
Dec. 9	5:24 Test #2	Dec. 10	5:17	
Dec. 11	5:24	Dec. 12	5:19	
Dec. 16	5:19	Dec. 17	5:16	
Dec. 18	5:21	Dec. 19	5:20	
Jan. 6	5:17	Jan. 7	5:17	
Jan. 8	5:15	Jan. 9	5:14	
Jan. 13	Test #3	Jan. 14	Test #3	

The second test was given during the class period closest to
the beginning of Christmas vacation. The same procedure and tester
were used as in the initial test. The author felt it necessary to
test at this time because of the two week vacation.

The third test was administered two weeks after the return of
the students from Christmas vacation. The same procedure and testers
were used as in the two previous testings.

CHAPTER IV

ANALYSIS AND INTERPRETATION OF DATA

The purpose of this experiment was to determine the relative effects of two warm-up methods upon arm, leg, and back strength. Performances on the three tests for each of the experimental warm-up procedures were analyzed and compared for each of the thirty-four subjects. It became necessary at this point in the study to choose a statistical instrument that would test the significance of the difference between the means of the groups utilizing the two warm-up procedures.

Statistical Procedure

The null hypothesis was assumed in analyzing the differences between the means of the two groups. This hypothesis declares that there is no true difference between the two mean scores, and the difference, if found, would be due to a chance occurrence of no significance.[21]

Of the several possible tests of the null hypothesis, the "t" technique for testing the significance of the difference between means derived from paired observations of small samples appeared best suited for this study. This test determines the ratio

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[21] Henry E. Garrett, Statistics in Psychology and Education, New York: Longmans, Green and Co., 1955, p. 213.

between the mean difference and the estimate of sampling error of the mean difference. This ratio was expressed as "t" and was verified for significance in a "t" table.[22] The value of "t" is proportional to the degrees of freedom (n - 1) allowed in determining the relationship between the mean differences and the estimate of sampling error of the mean difference.[23]

For this study, the null hypothesis was retained up to the .05 level of confidence.

Complete data and the mathematical procedures in the statistical analysis are presented in Appendix C.

Leg Strength

Conventional Warm-up vs. Static Resistance Warm-up

The conventional warm-up procedure for leg strength (used by Group I) resulted in mean scores of 88.58 pounds (test #1), 893.52 (test #2), 901.76 pounds (test #3) as compared to mean scores of 747.35 pounds (test #1), 861.17 pounds (test #2), 892.22 pounds (test #3) for the static resistance warm-up procedure used by Group II. The standard errors of the differences between means for the two groups were 54.51, 73.54, 64.88 pounds respectively. With 16 degrees of freedom, "t" value at the .05 level of confidence was 2.19, so the null hypothesis was rejected on test #1 and accepted on tests #2 and #3 as shown on Table 3 on page 26. Group I

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[22] Allen L. Edwards, _Statistical Methods for the Behavioral Sciences_, New York: Reinhart and Co. Inc., 1954, p. 255.

[23] Quinn McNemar, _Psychological Statistics_, New York: John Wiley and Sons, Inc., 1949, p. 221.

was significantly superior on leg strength to that of Group II on test #1. There was no significant difference in leg strength between the two groups on tests #2 and #3.

Test-Retest-Retest for Conventional Warm-up

The conventional warm-up procedure for leg strength resulted in mean scores as given on page 19. The standard error of the difference between two means for test #1 and test #2, test #1 and test #3, test #2 and test #3 were 26.97, 28.60, and 241.94 pounds respectively. With 16 degrees of freedom, "t" values of .294, .594, and .330 were obtained. The null hypothesis was accepted on the test-retest-retest for conventional warm-up on the amount of leg strength gained and lost as shown in Table 6 on page 29. The leg strength test indicated that Group I had no significant changes in leg strength between tests #1 and #2, #1 and #3, #2 and #3.

Test-Retest-Retest for Static Resistance Warm-up

The static resistance warm-up procedure for leg strength resulted in mean scores as given above. The standard error of the difference between two means for tests #1 and #2, #1 and #3, #2 and #3 were 25.79, 46.84, and 10.72 pounds respectively. With 16 degrees of freedom, "t" values of 2.64, 3.09, and 2.89 were obtained. From the "t" values obtained the null hypothesis was rejected on the test-retest-retest for exercises used for Group II as shown on Table 7 on page 30. The leg strength test indicated that Group II had significant improvement in leg strength between tests #1 and #2, #1 and #3, #2 and #3.

Back Strength

Conventional Warm-up vs. Static Resistance Warm-up

The conventional warm-up procedure for back strength resulted
in mean scores of 318.53, 312.64, and 322.94 pounds respectively
for the three tests as compared to mean scores of 247.41, 294.70,
and 308.23 pounds for the static resistance warm-up procedure.
The standard errors of the differences between means were 15.93,
12.45, and 17.03 pounds respectively. With 16 degrees of freedom,
"t" values of 4.46, .144, and .863 were obtained. The needed "t"
value at the .05 level of confidence was 2.19, so the null hypothesis
was rejected on test #1 and accepted on tests #2 and #3, as shown
on Table 4 on page 27. Group I was significantly superior on
back strength to that of Group II on test #1. There was no sig-
nificant difference in back strength between the two groups on
test #2 and #3.

Test-Retest-Retest for Conventional Warm-up

The conventional warm-up procedure for back strength resulted
in mean scores as given above. The standard errors of the difference
between means for tests #1 and #2, #1 and #3, #2 and #3 were 6.88,
8.48, 5.29 pounds respectively. With 16 degrees of freedom, "t"
values of .858, .520, and 1.94 were obtained. The null hypothesis
was accepted on the test-retest-retest for conventional warm-up
on the amount of back strength gained and lost as shown in Table 6,
page 29.

Test-Retest-Retest for Static Resistance Warm-up

The static resistance warm-up procedure for back strength
resulted in mean scores as given above. The standard errors
of the differences between means for tests #1 and #2, #1 and #3,
#2 and #3 were 5.22, 6.42, and 13.23 pounds respectively. With
16 degrees of freedom, "t" values of 9.05, 6.42, and 1.02 were
obtained. From the "t" values obtained, the null hypothesis was
rejected on Tests #1 and #2. The null hypothesis was accepted
on test #3 as shown on Table 7 on page 30. The back strength
test indicated that Group II made significant improvement in
back strength between tests #1 and #2, #1 and #3, but failed to
show significant improvement between tests #2 and #3.

Arm Strength (Bent Arm Hang)

Conventional Warm-up vs. Static Resistance Warm-up

The conventional warm-up procedure for arm strength using
the bent arm hang test resulted in mean scores of 45.64, 38.52,
and 50.47 seconds for tests #1, #2, and #3 as compared to mean
scores of 38.25, 45.88, 40.17 seconds for the static resistance
warm-up procedure group. The standard errors of the differences
between means were 4.98, 4.33, and 4.07 seconds respectively on
tests #1, #2, and #3. With 16 degrees of freedom, "t" values of
1.43, .1306 and 2.53 were obtained. The needed "t" value at the
.05 level of confidence was 2.19, so the null hypothesis was
accepted on tests #1 and #2 and was rejected on test #3 as shown
on Table 5, page 28. Group I had superior arm strength to that

of Group II when using the bent arm hang test on test #3. There was no significant difference in arm strength between the two groups on tests #1 and #2.

Test-Retest-Retest for Conventional Warm-up

The conventional warm-up procedure for arm strength using the bent arm hang test resulted in mean scores as given above. The standard errors of the differences between means for tests #1 and #2, #1 and #3, #2 and #3 were 1.68, 2.34, and 1.84 seconds respectively. With 16 degrees of freedom, "t" values of .208, 2.06, and 2.81 were obtained. The null hypothesis was accepted on tests #1 and #2 and was rejected on test #3 as shown in Table 6, page 29. The bent arm test indicated that Group I had a significant improvement in arm strength between tests #2 and #3. No significant difference in arm strength resulted between tests #1 and #2, #1 and #3.

Test-Retest-Retest for Static Resistance Warm-up

The static resistance warm-up procedure for arm strength using the bent arm hang test resulted in mean scores as given above. The standard errors of the differences between means for tests #1 and #2, #1 and #3, #2 and #3 were 2.51, 2.74, 1.71 seconds respectively. With 16 degrees of freedom, "t" values of 2.83, .600, 3.33 were obtained. Group II rejected the null hypothesis with a significant gain of arm strength developing between tests #1 and #2. No significant change in arm strength occurred between tests #1 and #3. The null hypothesis was again rejected on the differences

of arm strength between tests #2 and #3. Group II had a significant
loss of arm strength between Tests #2 and #3 using the bent arm
hang test.

Arm Strength (Bar Dips)

Conventional Warm-up vs. Static Resistance Warm-up

The conventional warm-up procedure for arm strength using the
bar dip test resulted in mean scores of 10.05, 10.00, 12.47 for the
three tests as compared to mean scores of 7.82, 10.76, and 11.58
dips for the static resistance warm-up procedure group. The
standard errors of the differences between means were 1.15, 1.39,
1.35 dips respectively on tests #1, #2, and #3. With 16 degrees
of freedom, "t" values of 1.85, .547, and 1.37 were obtained. The
needed "t" value at the .05 level of confidence was 2.19, so the
null hypothesis was accepted on tests #1, #2, and #3 as shown on
Table 8, page 31. The bar dip test indicated that no significant
changes were made in arm strength between the two warm-up programs.

Test-Retest-Retest for Conventional Warm-up

The conventional warm-up procedure for arm strength using
the bar dip test resulted in mean scores as given above. The
standard errors of the differences between means for tests #1 and
#2, #1 and #3, #2 and #3 were .578, 1.36, and 1.67 dips respect-
ively. With 16 degrees of freedom, "t" values of .096, 1.78
and 1.47 were obtained. The bar dip test indicated that Group I

had no significant improvement in arm strength, so the null
hypothesis was accepted on all three comparisons as shown on
Table 6 page 29.

Test-Retest-Retest for Static Resistance Warm-up

The static resistance warm-up procedure for arm strength
using the bar dip test resulted in mean scores as given above. The
standard errors of the differences between means for tests #1 and
#2, #1 and #3, #2 and #3 were 1.16, 1.30, and .97 dips respectively.
With 16 degrees of freedom, "t" values of 2.53, 2.88, and .845
were obtained. Group II rejected the null hypothesis with a
significant gain of arm strength developing between tests #1 and
#2, and tests #1 and #3. No significant change in occurred between
tests #2 and #3.

Accumulative Scores

Through the use of accumulative scores (combining scores from
all four tests for each group) it was found that the null hypothesis
was rejected on test #1 as the "t" value showed a significant
difference between mean scores. Tests #2 and #3 accepted the null
hypothesis. It was found that on test #1, Group I had a mean score
of greater significance than did Group II. Group I accepted the
null hypothesis on the test-retest-retest as illustrated on Table 9
page 32. Group II rejected the null hypothesis on comparisons be-
tween tests #1 and #2, but accepted the null hypothesis on compar-
isons between tests #1 and #3, and test #2 and #3.

T A B L E   I I I

Comparison of Mean Scores of 34
Subjects Tested for Leg Strength

	Mean Scores	Standard Deviation	Standard Error of the difference between two means	Critical Ratio ("t")
Group I (Test # 1)	885.58			
Group II (Test # 1)	747.35	224.772	54.51	2.53
Group I (Test # 2)	893.52			
Group II (Test # 2)	861.17	303.165	73.54	.439
Group I (Test # 3)	901.76			
Group II (Test # 3)	892.22	267.525	64.88	.147

"t" significance of difference at .05 level = 2.19

TABLE IV

Comparison of Mean Scores of 34
Subjects Tested for Back Strength

	Mean Scores	Standard Deviation	Standard Error of the difference between two means	Critical Ratio ("t")
Group I (Test # 1)	318.53			
Group II (Test # 1)	247.41	65.697	15.93	4.46
Group I (Test # 2)	312.64			
Group II (Test # 2)	294.70	51.327	12.45	1.44
Group I (Test # 3)	322.94			
Group II (Test # 3)	308.23	70.255	17.03	.863

"t" significance of difference at .05 level = 2.19

TABLE V
Comparison of Mean Scores of 34 Subjects
Tested on Arm Strength using the Bent Arm Hang

	Mean Scores	Standard Deviation	Standard Error of the difference between two means	Critical Ratio ("t")
Group I (Test # 1)	45.64			
Group II (Test # 1)	38.52	20.565	4.98	1.43
Group I (Test # 2)	45.29			
Group II (Test # 2)	45.88	17.867	4.33	.1306
Group I (Test # 3)	50.47			
Group II (Test # 3)	40.17	16.810	4.07	2.53

"t" significance of difference at .05 level = 2.19

T A B L E   V I
Conventional Warm-up Test-Retest-Retest Comparisons
Of Mean Scores on Leg Strength, Back Strength, Bent Arm Hang and Bar Dips

Mean Scores	Tests # 1 and # 2		Tests # 1 and # 3		Tests # 2 and # 3	
Leg Strength	885.58	893.52	885.58	901.76	893.52	901.76
Back Strength	318.53	312.64	318.53	322.94	312.64	322.94
Bent Arm Hang	45.64	45.29	45.64	50.47	45.29	50.47
Bar Dips	10.05	10.00	10.05	12.47	10.00	12.47
Standard Deviation						
Leg Strength	111.201		117.92		102.847	
Back Strength	28.296		34.999		21.812	
Bent Arm Hang	6.957		9.655		7.632	
Bar Dips	2.384		5.615		6.925	
Standard Error of the difference between two means						
Leg Strength	26.97		28.60		24.94	
Back Strength	6.86		8.48		5.29	
Bent Arm Hang	1.68		2.34		1.84	
Bar Dips	.578		1.36		1.67	
Critical Ratio ("t")						
Leg Strength	.294**		.564**		.330**	
Back Strength	.858**		.520**		1.94**	
Bent Arm Hang	.208**		2.06**		2.81	
Bar Dips	.096**		1.78**		1.47**	

"t"   significance of difference at .05 level = 2.19
** Not significant at the .05 level.

T A B L E V I I
Static Resistant Warm-up Test-Retest-Retest Comparisons
of Mean Scores on Leg Strength, Back Strength, Bent Arm Hang and Bar Dips

Mean Score	Tests # 1 and # 2		Tests # 1 and # 3		Tests # 2 and # 3	
Leg Strength	747.35	861.17	747.35	892.22	861.17	892.22
Back Strength	247.41	294.7	247.41	308.23	294.7	308.23
Bent Arm Hang	38.52	45.88	38.52	40.17	45.88	40.17
Bar Dips	7.82	10.76	7.82	11.58	10.76	11.58
Standard Deviation						
Leg Strength	106.365		193.123		44.20	
Back Strength	21.525		26.41		54.57	
Bent Arm Hang	10.358		11.302		7.042	
Bar Dips	4.554		5.369		4.014	
Standard Error of the difference between two means						
Leg Strength	25.79		46.84		10.72	
Back Strength	5.22		6.42		13.23	
Bent Arm Hang	2.51		2.74		1.71	
Bar Dips	1.16		1.30		.97	
Critical Ratio ("t")						
Leg Strength	2.64		3.09		2.89	
Back Strength	9.05		9.47		1.02**	
Bent Arm Hang	2.83		.600**		3.33	
Bar Dips	2.53		2.88		.845**	

"t" significance of difference at .05 level = 2.19
** Not significant at the .05 level

T A B L E V 1 1 1

Comparison of Mean Scores of 34 Subjects

Tested on Arm Strength using Bar Dips

	Mean Scores	Standard Deviation	Standard Error of the difference between two means	Critical Ratio ("5")
Group I (Test # 1)	10.05	4.776	1.15	1.85
Group II (Test # 1)	7.82			
Group I (Test # 2)	10.00	5.760	1.39	.547
Group II (Test # 2)	10.76			
Group I (Test # 3)	12.47	5.667	1.35	1.37
Group II (Test # 3)	11.58			

"t" significance of difference at .05 level = 2.19

T A B L E   I X

Comparison of Results using Accumulative Scores

Mean Scores	Tests # 1 and # 2		Tests # 1 and # 3		Tests # 2 and 3	
Group I	1268.36	1260.88	1268.36	1293.11	1260.88	1293.11
Group II	1087.52	1212.76	1087.52	1199.647	1212.76	1199.647
Standard Deviation						
Group I	135.65		165.38		98.51	
Group II	144.247		234.64		153.03	
Standard Error of the difference between two means						
Group I	32.90		40.11		27.28	
Group II	34.98		56.91		37.11	
Critical Ratio "t"						
Group I	.227**		.617**		1.181**	
Group II	3.580		1.968**		.353**	

"t" significance of difference at .05 level = 2.19
** Not significant at the .05 level

CHAPTER V

SUMMARY

Thirty-four young men were tested in an attempt to find out
whether there were any significant differences between two programs
of warming-up. One warm-up program consisted of thirteen static
resistance exercises, the other program consisted of thirteen
conventional exercises. The exercises were taken by the participants
for the purpose of warm-up before participation in regular class
activities.

Static contraction and conventional exercises were compared
for the following purposes: to determine which method retained
strength in the arms, legs, and back longer after the student had
been physically conditioned for six weeks; and to determine the
feasibility of static contraction as a new warm-up exercise program
for physical education classes.

Two classes were selected from the freshman physical education
service program. Both classes had participated in the six weeks
conditioning program established during the first semester 1963-
1964, at the University of North Dakota. The two classes selected
were equated on the basis of results on the American Association of
Health, Physical Education and Recreation Youth Fitness Test. The
selected classes took part of the PFI Test to determine arm, back,
and leg strength.

A statistical comparison was made between the two groups investigated in this paper. As this study was concerned with observations of paired groups for small samples, the "t" test was used to determine the retention or rejection of the null hypothesis. The .05 level of significance was established as the acceptable point of confidence on the Table of "t", for rejection of the null hypothesis.

CONCLUSIONS

The results of the investigation indicate the following:

1. The static resistance group revealed significant differences in arm, back, and leg strength between the initial testsand test two, and the initial test and test three. Performances on tests two and three were significantly superior to those on the initial test.

2. The static resistance group revealed no significant difference in back and leg strength between test two and test three.

3. Arm strength, as measured by the bent arm hang, for the static resistance group revealed a significant difference between test two and test three. Test three was significantly inferior to test two.

4. The conventional exercise group revealed no significant difference in their test-retest-retest.

RECOMMENDATIONS

1. A similar study should be made with larger samples of the two groups in this study.

2. A study should be made to attempt to determine the feasibility of static resistance exercise. This should be done where there is no more than one skilled activity being taught during the experiment.

3. A study should be made to determine the results on non-conditioned physical education students.

4. A similar study should be made with junior and senior high school students.

5. A similar study should be conducted without a vacation period.
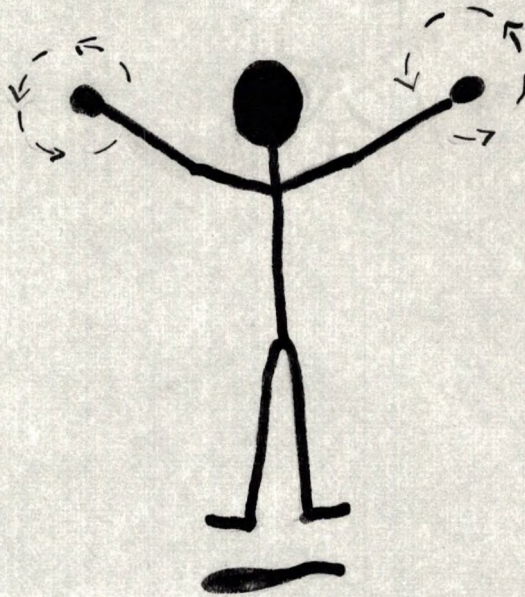
Arm Circling: Standing, feet parallel and shoulder distance apart, arms out from body at horizontal level, move arms in small, medium and large circles. Reverse and go in opposite direction.

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BICYCLE

Bicycle: Lie on floor with legs extended toward the ceiling, bracing the hips with your hands. Flex and extend the legs as in running.

SIT-AND-BOB

Sit-and-Bob: Sitting with legs straight out and feet at right angles to the legs. Extend arms toward toes by bending at hip joints and tilting pelvis forward. Bob forward, (count one) reaching for toes and forehead to knee. Back to sitting position on count two.
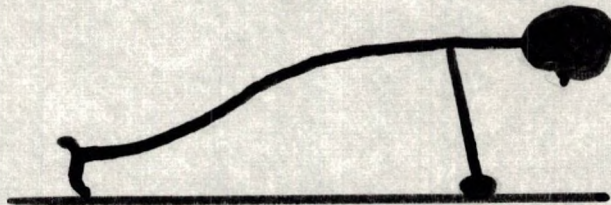
Burpee: Start in normal standing position. On count one bend at the knees and place hands on the floor. Count two extend legs behind you with hands in position from count one. Count three return to position in count number two. Count four return to starting position.
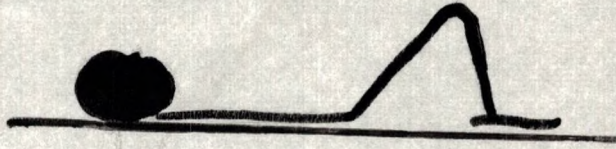
Sit-ups: Lie on your back. Tilt pelvis to flatten lower back to floor. With hands clasped behind the head, curl head, shoulders back and come to sitting position. Keep knees slightly bent, with a partner or some support on them.
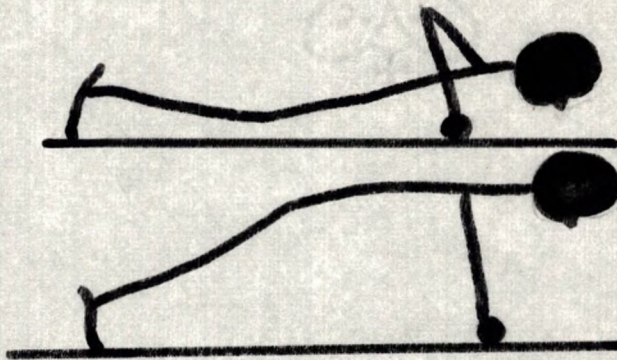
Push-ups: Lie face down on floor. Place hands directly under shoulder joint with fingers parallel and turned inward slightly. Etend arms and lift body in straight line. Lower body slowly until chin touches the floor and then push up again. Movement in arms and shoulders, not in any other part of the body. Chin touches before thighs. Keep body line straight from head to toes.

SPREAD EAGLE
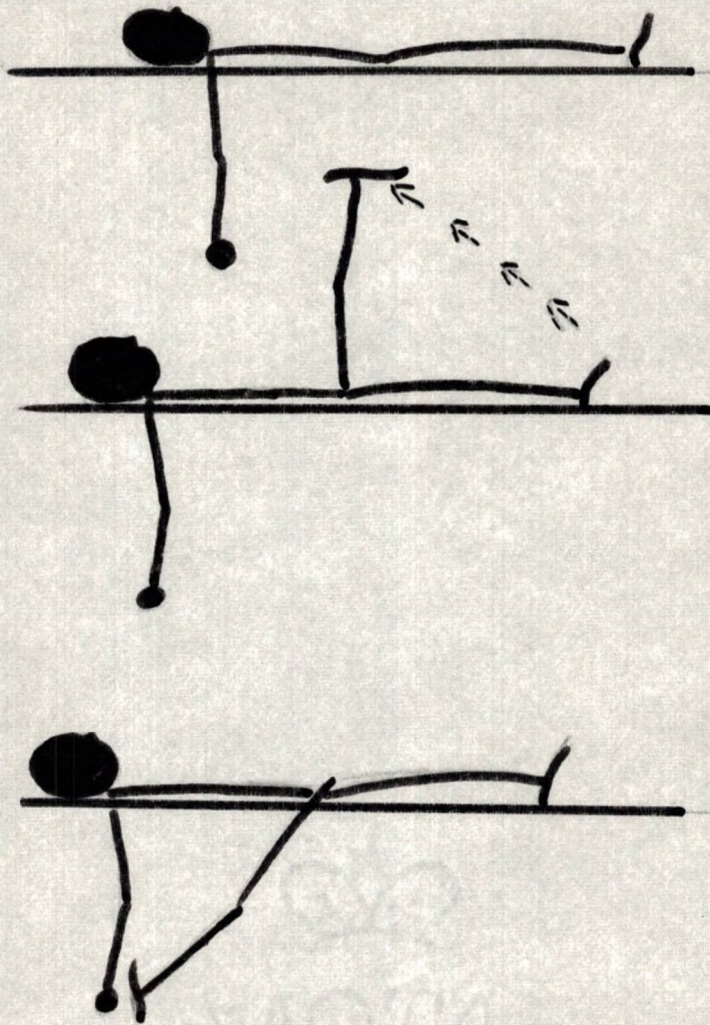
Spread Eagle: Lie on back with arms out from body at horizontal level.

Raise left leg vertical to the floor, then rotate hips so leg touches

hand. Try not to move the arms from the floor. Alternate using both

legs.
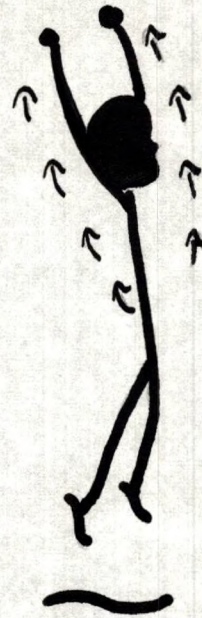
Jumping Jack: Start in a normal standing position and on count one flex and abduct the arms above the head, and abduct the legs to the side. Count two return to the starting position.

RUNNING IN PLACE
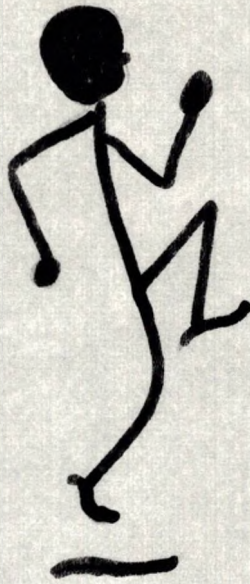
Running in Place: In a standing position bring knees one at a time as close to the chest as possible. Use same procedure as if running but stay in a stationary place on the floor.

NECK TWISTER

Neck Twister: Standing in a normal position, on count one, bend neck forward so the chin touches the chest. On count two, rotate the head to the right so the ear touches the right shoulder. On count three rotate the head to the back. On count four, rotate the head so the left ear touches the left shoulder.

MODIFIED PULL-UP
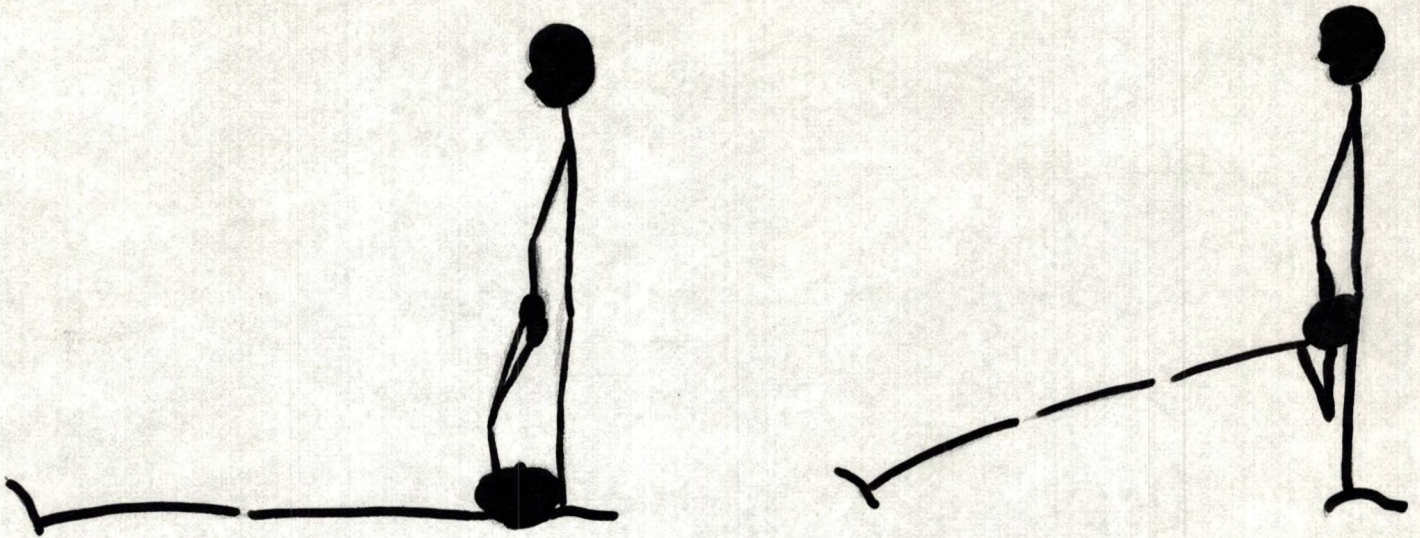
Modified Pull-up: Partner lying on the floor reach up and clasp hands
with partner in standing position. On count one raise the body from
the floor using only the arms. Keep the body straight and heels on the
floor.

WING LIFT
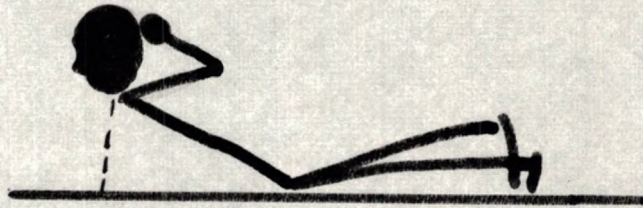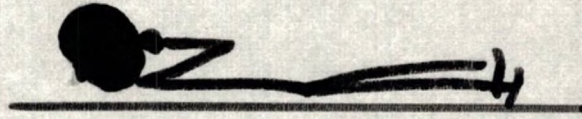
Wing Lifts: Lie face down on the floor, arms clasped at the back of neck and eyes directed straight down, legs straight, and toes touching floor. Lift head, upper back, and arms off floor about 12 inches. Chin in. Return to starting position. Do not allow elbows to touch floor or toes to leave floor. Repeat.

50
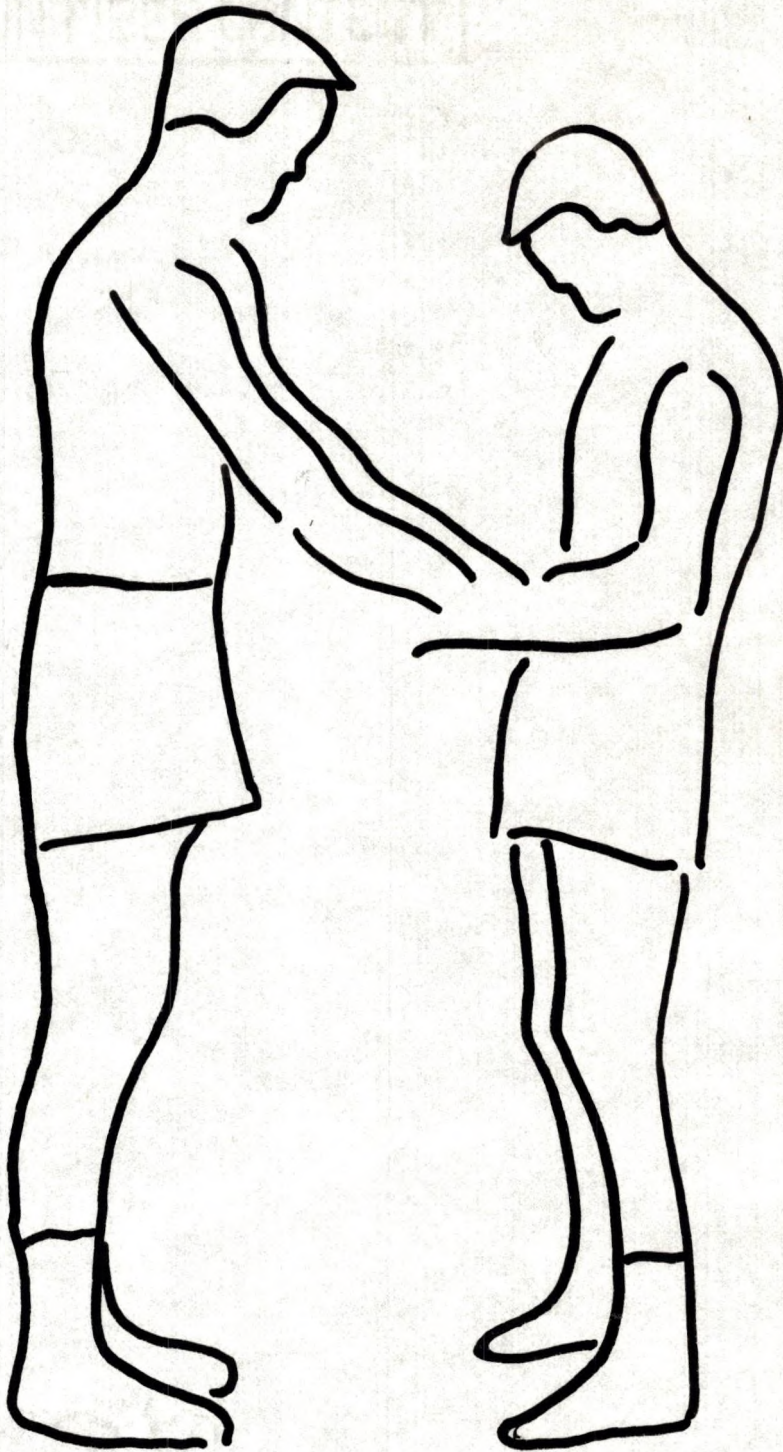
Bicep Flexion - Partner clasp wrist then try to curl arm upward
while partner applies pressure downward.
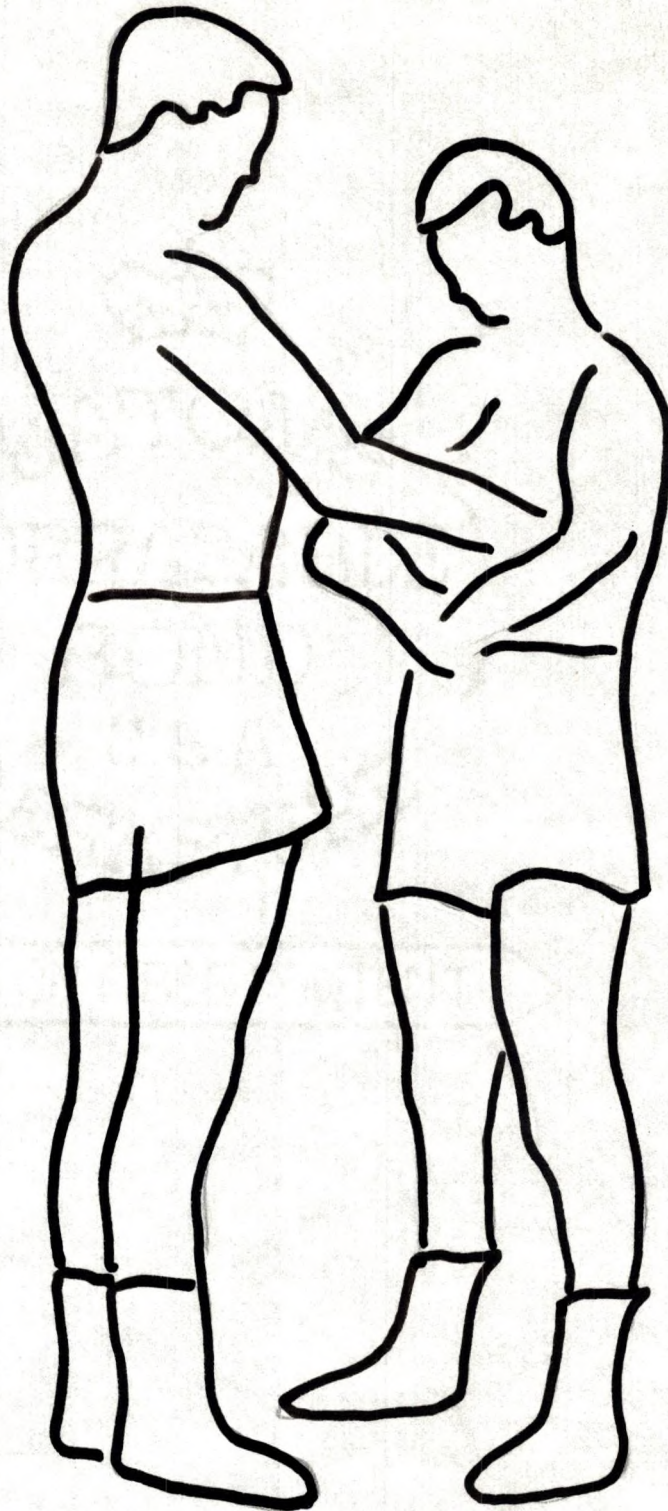
Shoulder Abduction - Place arms inside of partners arms and
exert pressure outward while partner exerts
pressure inward.
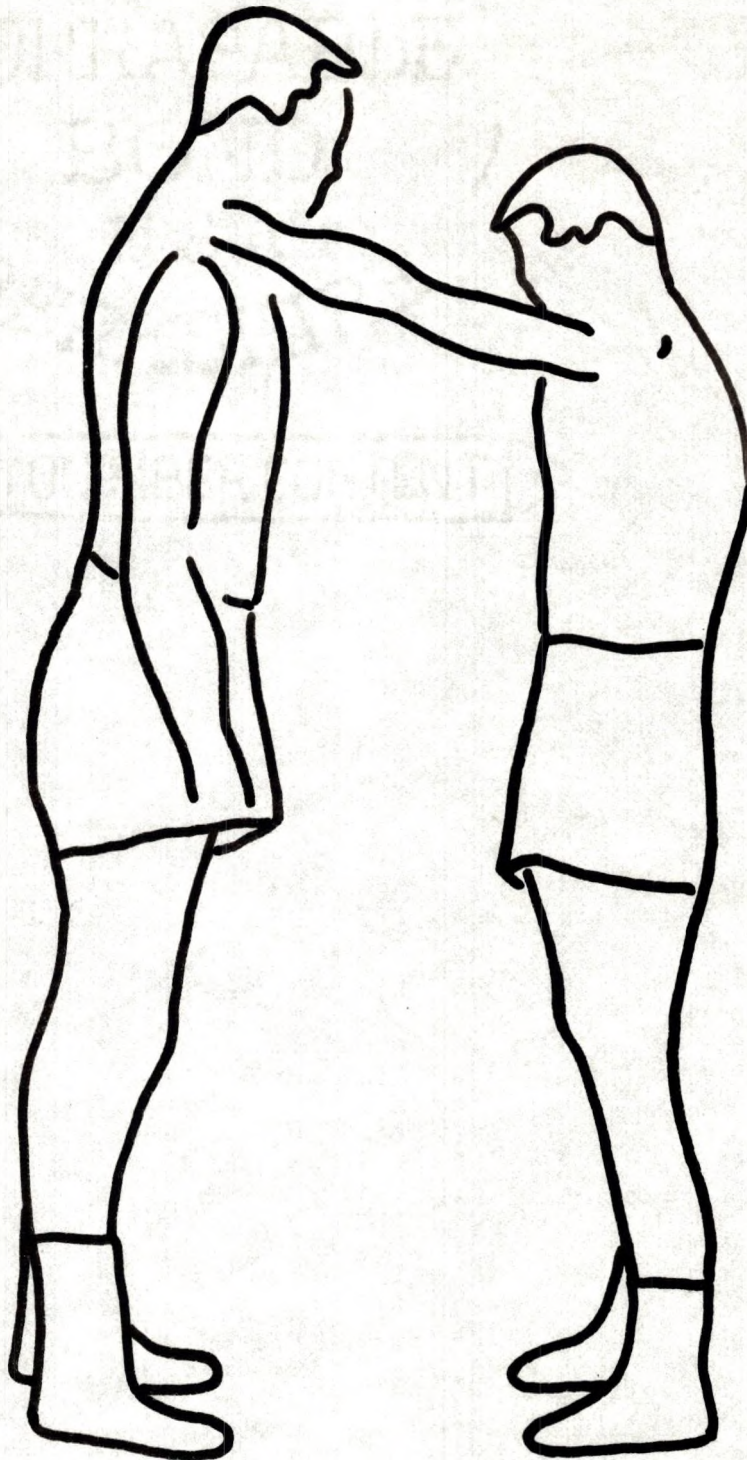
Shoulder Extension - Place hands on top of partners shoulders and exert pressure downward.
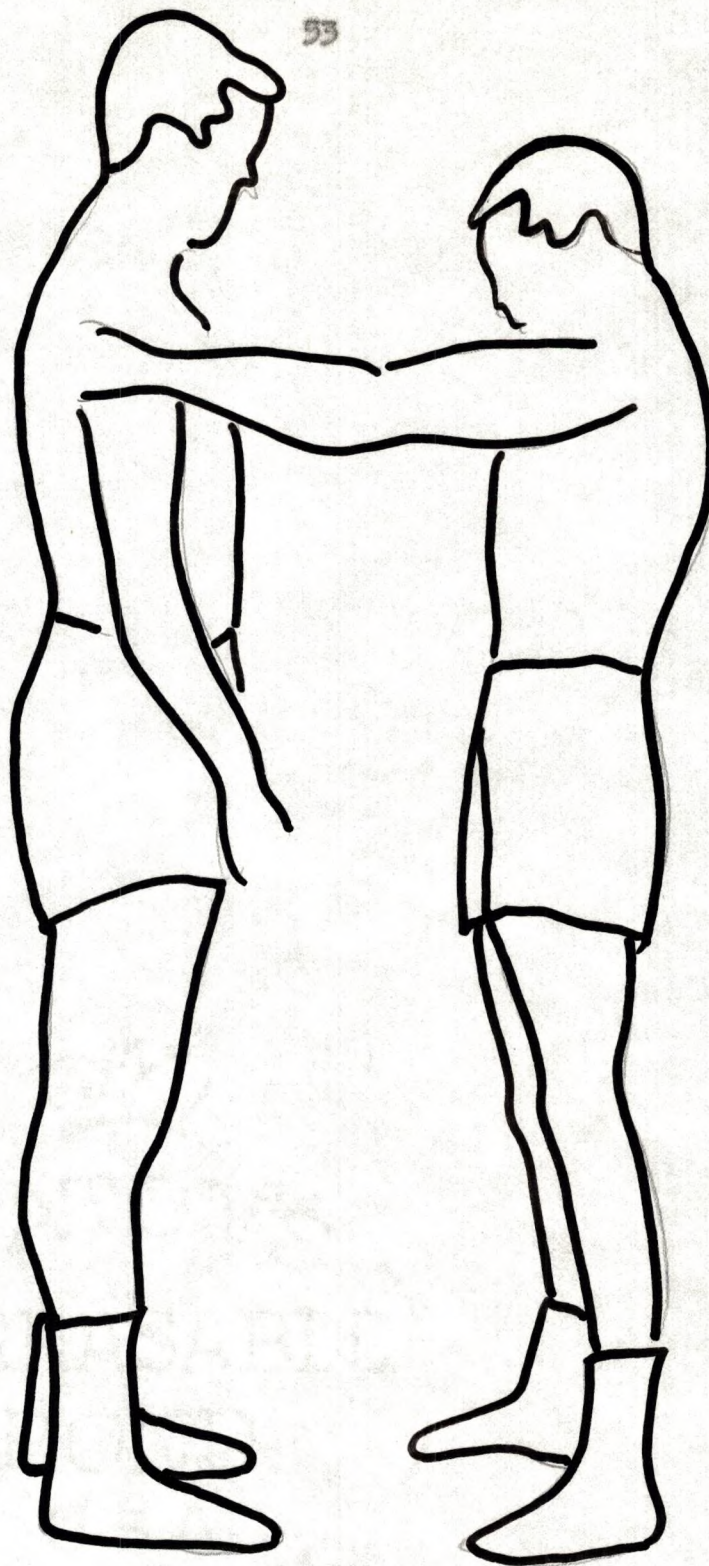
Arm Adduction - Place your hands on partners shoulders, force arms
       inward while using partners shoulders as resistance.
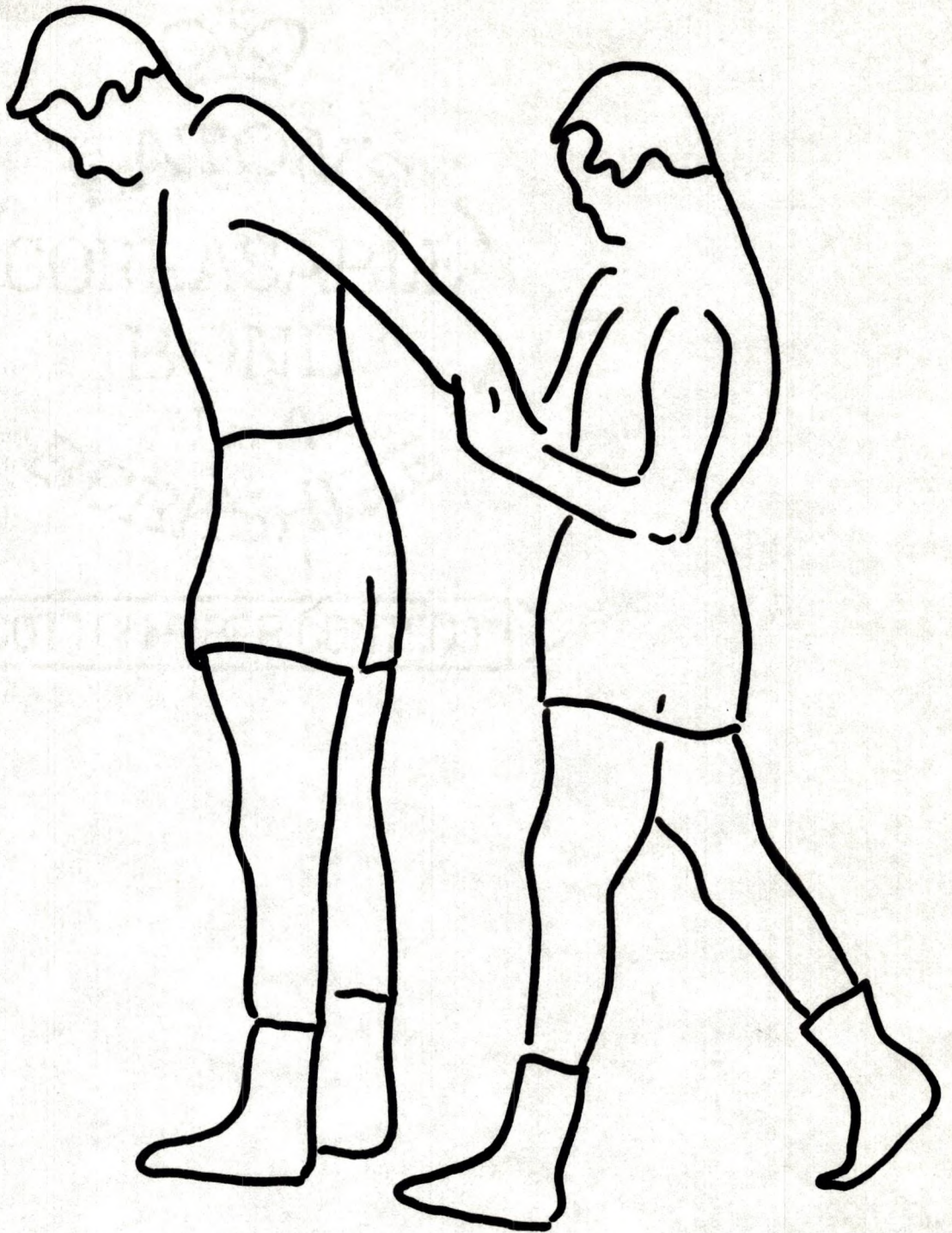
Tricep Flexion - Place arms behind you and raise in an upward motion while partner applies downward pressure.

Back Hyper-extension - Raise shoulders from floor while partner
applies pressure to shoulders and legs.
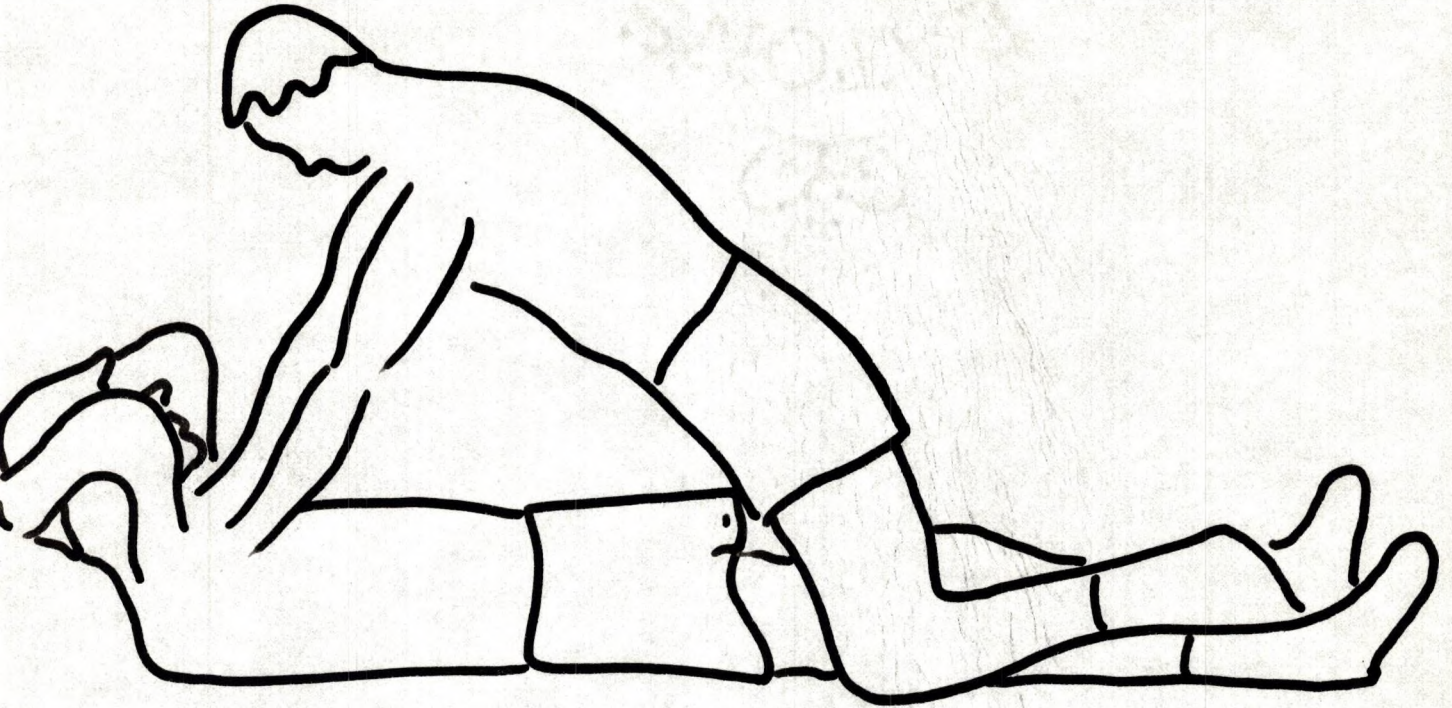
Static Sit-up - Raise shoulders from floor while pressure is being
applied to shoulders and legs by partner.
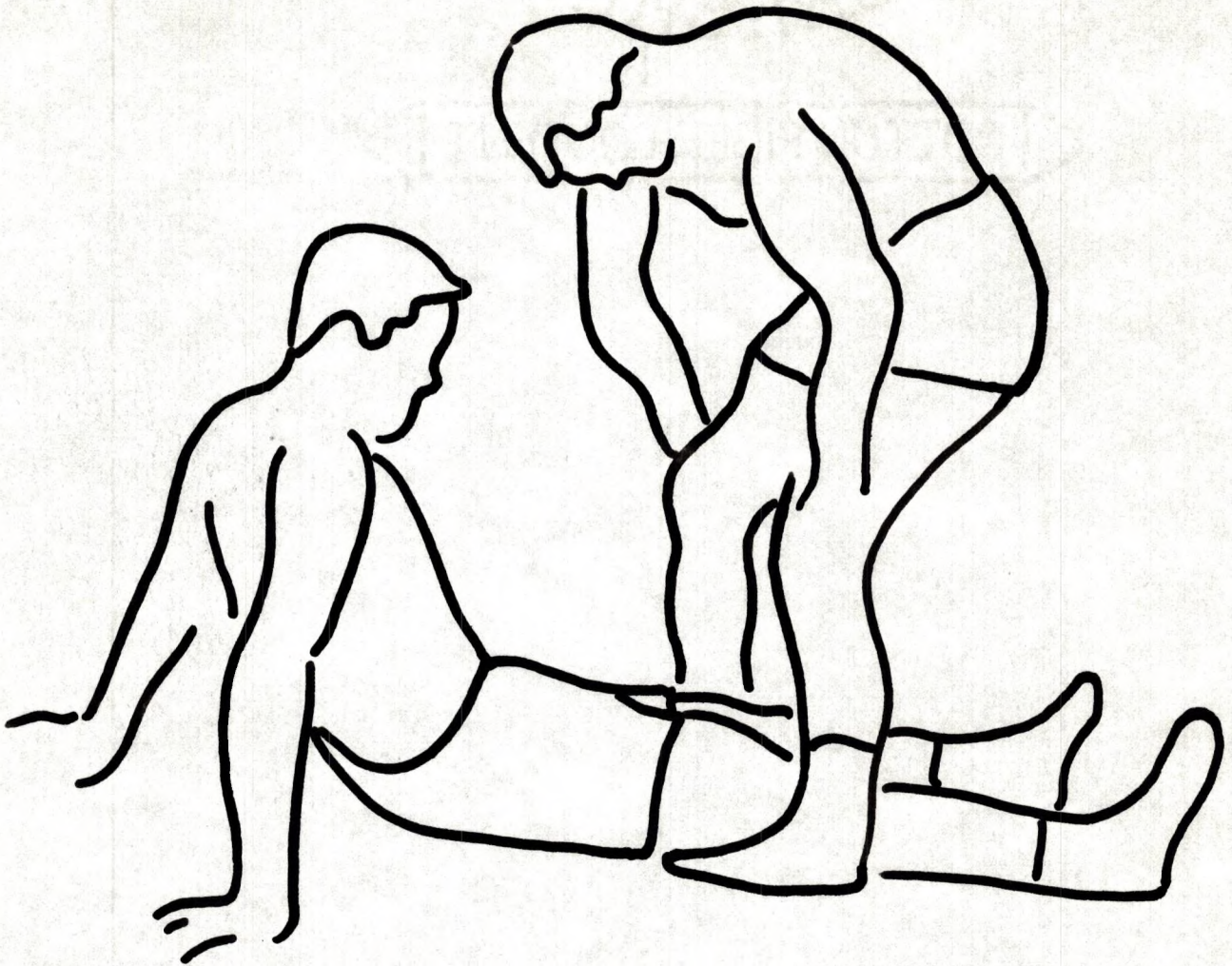
Leg Abduction - Partner places his legs outside of knees, try to spread legs apart.
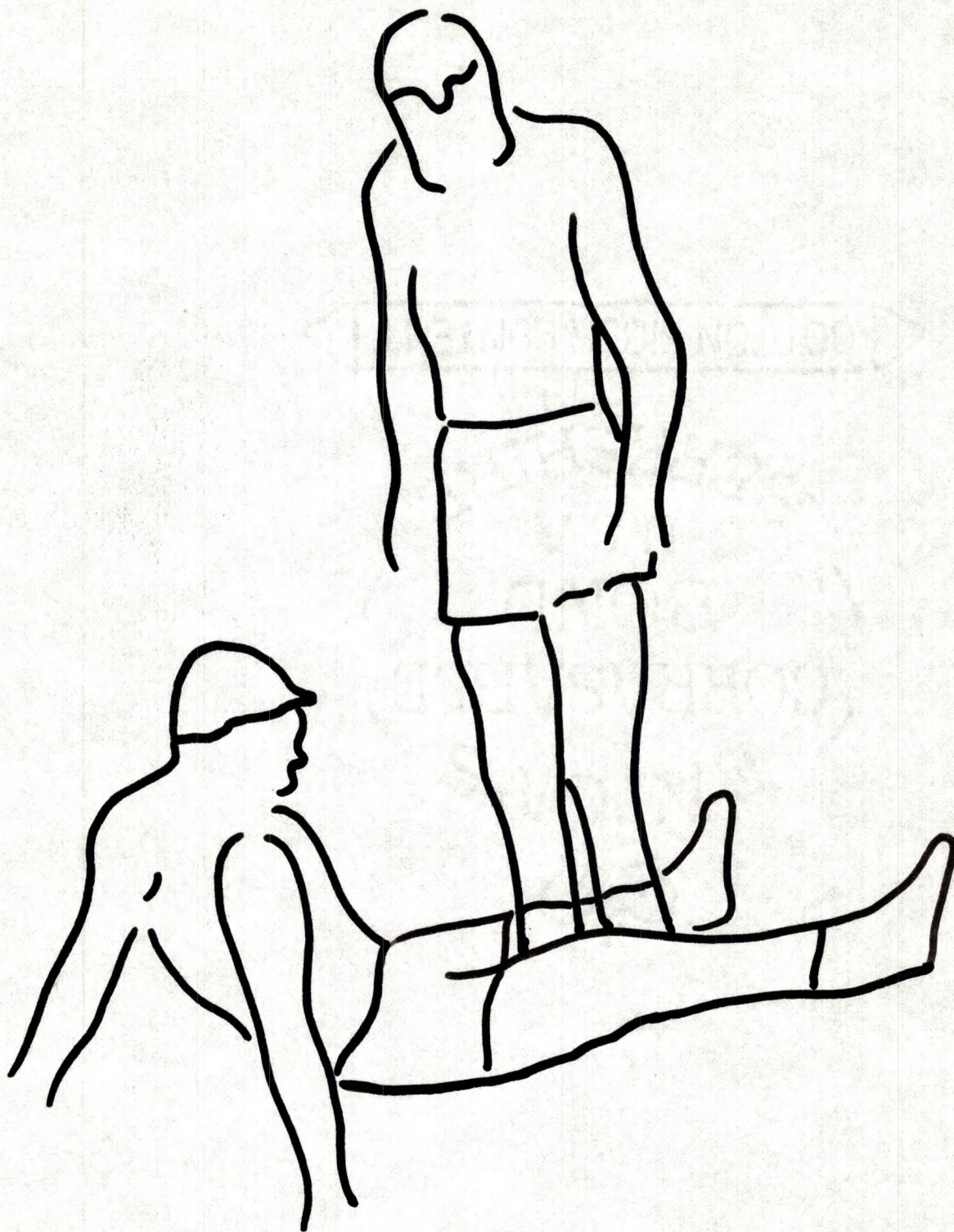
Leg Avduction - Partner places his legs inside of knees, try to
bring legs together.

Knee Extension - Try to straighten leg while partner applies pressure at buttock and ankle.

Knee Flexion - Try to bend leg at knee while partner applies
pressure at buttock and ankle.
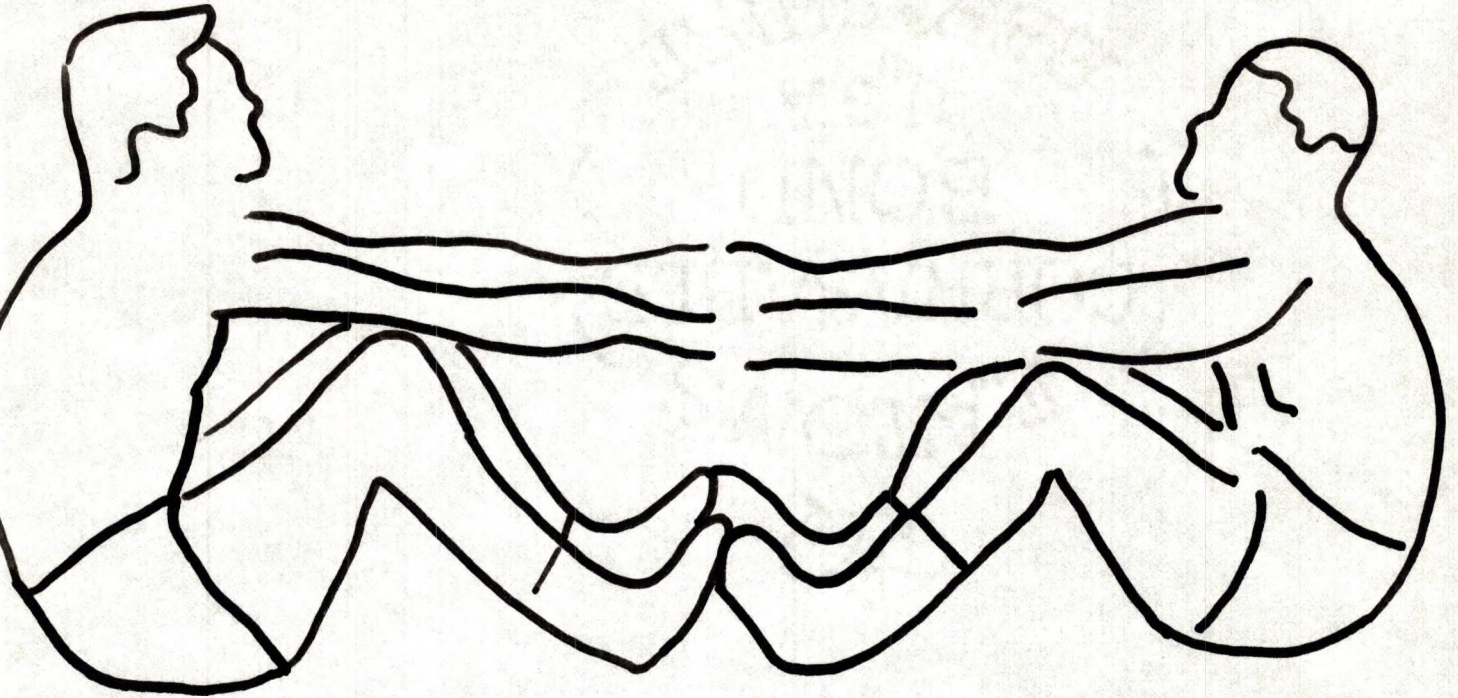
Static Rowing - Both men in a sitting position place feet
together, clasp hands together and pull,
try to have as little movement as possible.

Area of Comparison: __Accumulative Scores__

__Group I and Group II   (Test #1)__

Subjects	Group I	Group II	D	D^2
1	1297	1163	134	17956
2	1104	942	162	26244
3	1201	1248	-47	2209
4	1509	951	558	311364
5	1274	1666	-392	153644
6	1452	1437	15	225
7	733	733	0	0
8	1121	1294	-173	29929
9	1580	1024	556	309136
10	1211	1165	-54	2916
11	1142	951	191	36481
12	1221	787	434	188356
13	1004	767	237	56169
14	1173	1160	13	169
15	1693	1090	594	352836
16	1294	890	404	163216
17	1553	1211	342	116964

$\Sigma X = 21562$ $\qquad$ $\Sigma X = 18488$ $\qquad$ $\Sigma D = 2974$ $\qquad$ $\Sigma D^2 = 1767834$

$\bar{X} = 1268.36$ $\qquad\qquad\qquad$ $\bar{X} = 1087.52$

The Significance of the Difference
between Means from Paired Observations

Test: Accumulative Scores (Test # 1)

$n =$ ___17___ $\Sigma D =$ _2,074_ $\Sigma D^2 =$ _1,767,834_

$\Sigma d^2 = \Sigma D^2 - \dfrac{(\Sigma D)^2}{n}$ $\Sigma d^2 =$ _1,247,559_

$S_d = \sqrt{\dfrac{\Sigma d^2}{n-1}}$ $S_d = \sqrt{\dfrac{1,247,559}{16}}$ $S_d =$ _279.235_

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{279.235}{\sqrt{17}}$

$S\bar{x} - \bar{x} =$ $\dfrac{279.235}{4.123}$ $S\bar{x} - \bar{x} =$ _67.72_

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{1,268.36 - 1,087.52}{67.72}$

$t =$ ___2.67___

t at .05 level $=$ 2.19

$df = n-1$

$df =$ 16

Significance of Difference: _Beyond .05 level_

Area of Comparison: __Accumulative Scores__

__Group I and Group II (Test #2)__

Subjects	Group I	Group II	D	D^2
1	1356	1417	-61	3721
2	1297	1058	239	57121
3	1214	1613	-299	89401
4	1513	904	627	393129
5	1063	1776	-713	508369
6	1511	1426	85	7225
7	941	940	1	1
8	1170	1122	48	2304
9	1640	1127	531	263169
10	1157	1651	-494	244036
11	1173	1134	39	1521
12	1197	889	308	94864
13	987	809	178	31684
14	986	1262	-276	76176
15	1634	1306	328	107584
16	1235	963	272	73984
17	1342	1320	23	529

$\Sigma X = 21435$ $\Sigma X = 20617$ $\Sigma D = 818$ $\Sigma D^2 = 1954818$

$\bar{X} = 1260.88$ $\bar{X} = 1212.76$

The Significance of the Difference
between Means from Paired Observations

Test: Accumulative Scores (Test # 2)

n = _____17_____ Σ D = _____618_____ Σ D^2 = _____1,954,818_____

Σ d^2 = Σ D^2 - $\dfrac{(\Sigma D)^2}{n}$ Σ d^2 = _____1,915,458_____

$S_d = \sqrt{\dfrac{\Sigma d^2}{n-1}}$ $S_d = \sqrt{\dfrac{1,915,458}{16}}$ $S_d = $ _____346_____

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{346}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{346}{4.123}$ $S\bar{x} - \bar{x} = $ _____83.92_____

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{1260.88 - 1212.76}{83.92}$

t = _____.549_____

t at .05 level = 2.13

df = n-1

df = 16

Significance of Difference: _____Not Significant_____

Area of Comparison: <u>Accumulative Scores</u>

<u>Group I and Group II (Test #3)</u>

Subjects	Group I	Group II	D	D^2
1	1283	1365	-82	6724
2	1277	1034	243	59049
3	1462	1448	14	196
4	1516	1048	468	219024
5	1306	1604	298	158404
6	1455	1599	-144	20736
7	924	863	61	3721
8	1237	1283	-46	2116
9	1653	1226	427	182329
10	1159	1930	-771	594441
11	1177	1039	138	19044
12	1283	870	413	170569
13	1155	910	245	60025
14	1027	1295	-268	71824
15	1414	1630	-216	46656
16	1410	1250	160	25600
17	1352	1196	165	24336

$\Sigma X = $ 21995 $\Sigma X = $ 20394 $\Sigma D = $ 400 $\Sigma D^2 = $ 1664794

$\bar{X} = $ 1293.11 $\bar{X} = $ 1199.647

The Significance of the Difference
between Means from Paired Observations

Test: Accumulative Scores (Test # 3)

$n = $ _____17_____ $\sum D = $ _____400_____ $\sum D^2 = $ _____1,664,794_____

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2 = $ _____1,655,382_____

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{1,655,382}{17-1}}$ $S_d = $ _____321.5075_____

$S_{\bar{x} - \bar{x}} = \dfrac{S_d}{\sqrt{n}}$ $s_{\bar{x} - \bar{x}} = \dfrac{321.5075}{\sqrt{17}}$

$S_{\bar{x} - \bar{x}} = \dfrac{321.5075}{4.123}$ $S_{\bar{x} - \bar{x}} = $ _____77.97_____

$t = \dfrac{\bar{X} - \bar{X}}{S_{x-x}}$ $t = \dfrac{1293.11 - 1199.65}{77.97}$

$t = $ _____1.198_____

t at .05 level =   2.19

df = n-1

df =   16

Significance of Difference: _____Not Significant_____

Area of Comparison: ___Accumulative Scores___

___Test #1 and Test #2 (Group 1)___

Subjects	Test #1	Test #2	D	D^2
1	1297	1356	-59	3481
2	1104	1297	-193	37249
3	1201	1214	-13	169
4	1509	1531	-22	484
5	1274	1063	211	44521
6	1452	1511	-59	3481
7	733	941	-208	43264
8	1121	1170	-49	2401
9	1580	1640	-60	3600
10	1211	1157	-54	2916
11	1442	1173	269	72361
12	1221	1197	24	576
13	1004	987	17	289
14	1173	986	187	34969
15	1693	1634	59	3481
16	1294	1235	59	3481
17	1553	1343	210	44100

$\Sigma X = 21562$　　$\Sigma X = 21435$　　$\Sigma D = 129$　　$\Sigma D^2 = 300823$

$\bar{X} = 1268.36$　　　　　　$\bar{X} = 1260.88$

The Significance of the Difference
between Means from Paired Observations

Test:
$\#$ 1 and $\#$ 2 (Group I)

n = _____17_____ $\sum D$ = __322__ $\sum D^2$ = __300,823__

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2$ = __294,417.12__

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{294,417.12}{16}}$ S_d = __135.65__

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{135.65}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{135.65}{4.123}$ $S\bar{x} - \bar{x}$ = __32.90__

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{1,263.35 - 1,260.86}{32.90}$

t = _____.227_____

t at .05 level = 2.19

df = n-1

df = 16

Significance of Difference: __Not Significant__

Area of Comparison: ___Accumulative Scores___
Test #1 and Test #3 (Group I)

Subjects	Test #1	Test #3	D	D^2
1	1297	1283	14	196
2	1104	1277	-173	29929
3	1201	1468	-261	68121
4	1509	1516	-7	49
5	1274	1206	68	4624
6	1452	1455	-3	9
7	733	924	-191	36481
8	1121	1237	-116	13456
9	1580	1653	-73	5329
10	1211	1159	52	2704
11	1442	1177	256	70225
12	1221	1283	-62	3844
13	1004	1155	-151	22801
14	1173	1027	146	21316
15	1693	1414	279	77841
16	1294	1410	-216	46656
17	1553	1352	201	40401

$\Sigma X = 21562$ $\Sigma X = 21995$ $\Sigma D = -328$ $\Sigma D^2 = 443982$

$\bar{X} = 1268.36$ $\bar{X} = 1293.11$

The Significance of the Difference
between Means from Paired Observations

Test: # 1 and # 3 (Group I)

$n =$ _____17_____ $\sum D =$ _____-325_____ $\sum D^2 =$ _____443,982_____

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2 =$ _____437,653.53_____

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{437,653.53}{16}}$ $S_d =$ _____165.39_____

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{165.39}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{165.39}{4.123}$ $S\bar{x} - \bar{x} =$ _____40.11_____

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{1268.36 - 1891.11}{40.11}$

$t =$ _____-.617_____

t at .05 level =   2.19

df = n-1

df =   16

Significance of Difference: _____Not Significant_____

Area of Comparison: __Accumulative Scores__

__Test #2 and Test #3   (Group 1)__

Subjects	Test #2	Test #3	D	D^2
1	1356	1283	73	5329
2	1297	1277	20	400
3	1214	1462	-158	24964
4	1513	1516	16	225
5	1063	1206	-133	17689
6	1511	1455	56	3136
7	941	924	17	289
8	1170	1237	-67	4489
9	1640	1653	-13	169
10	1157	1159	-2	4
11	1173	1177	-4	16
12	1197	1283	-86	7396
13	987	1027	-41	1681
14	986	1155	-168	28224
15	1634	1414	220	48400
16	1235	1400	-175	30625
17	1343	1352	-9	81

$\Sigma X = 21435$ $\Sigma X = 21995$ $\Sigma D = -539$ $\Sigma D^2 = 173117$

$\bar{X} = 1260.88$ $\bar{X} = 1293.11$

The Significance of the Difference
between Means from Paired Observations

Test: # 2 and # 3 (Group I)

$n = \underline{\quad 17 \quad}$ $\qquad$ $\sum D = \underline{\quad -539 \quad}$ $\qquad$ $\sum D^2 = \underline{\quad 173,117 \quad}$

$$\sum d^2 = \sum D^2 - \frac{(\sum D)^2}{n} \qquad\qquad \sum d^2 = \underline{\quad 156,027.53 \quad}$$

$$S_d = \sqrt{\frac{\sum d^2}{n-1}} \qquad\qquad S_d = \sqrt{\frac{156,027.53}{16}} \qquad S_d = \underline{\quad 98.51 \quad}$$

$$S\bar{x} - \bar{x} = \frac{S_d}{\sqrt{n}} \qquad\qquad s\bar{x} - \bar{x} = \frac{98.51}{\sqrt{17}}$$

$$S\bar{x} - \bar{x} = \frac{98.51}{4.123} \qquad\qquad S\bar{x} - \bar{x} = \underline{\quad 27.28 \quad}$$

$$t = \frac{\bar{X} - \bar{X}}{Sx - x} \qquad\qquad t = \frac{1260.88 - 1293.11}{27.28}$$

$t = \underline{\quad -1.181 \quad}$

t at .05 level = 2.19

df = n-1

df = 16

Significance of Difference: $\underline{\text{Not Significant} \qquad\qquad\qquad\qquad}$

Accumulative Scores

Area of Comparison: Test #1 and Test #2 (Group II)

Subjects	Test #1	Test #2	D	D^2
1	1163	1417	-254	64516
2	942	1058	-116	13456
3	1248	1513	-256	70225
4	951	904	47	2209
5	1666	1776	-110	12100
6	1437	1426	11	121
7	733	940	-207	42849
8	1294	1122	172	29584
9	1024	1127	-103	10609
10	1165	1651	-486	236196
11	951	1134	-183	33489
12	787	889	-102	10404
13	767	809	-42	1764
14	1160	1262	-102	10404
15	1090	1306	-216	46656
16	890	963	-73	5329
17	1211	1320	-109	11881
	18488	20617	-2138	601792

$\Sigma X =$

$\Sigma X =$

$\Sigma D =$

$\Sigma D^2 =$

1087.52

1212.76

$\bar{X} =$

$\bar{X} =$

The Significance of the Difference
between Means from Paired Observations

Test:

 # 1 and # 2 (Group II)

$n =$ _____17_____ $\sum D =$ ____-2138____ $\sum D^2 =$ ____601,792____

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2 =$ ____332,907.06____

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{332,907.06}{16}}$ $S_d =$ ___144.247___

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{144.247}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{144.247}{4.123}$ $S\bar{x} - \bar{x} =$ ___34.98___

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{1087.52 - 1212.76}{34.98}$

$t =$ ___-3.5803___

t at .05 level = 2.19

df = n-1

df = 16

Significance of Difference: __Significant beyond .05 level__

Area of Comparison: ___Accumulative Scores___

___Test #1 and Test #3 (Group II)___

Subjects	Test #1	Test #3	D	D^2
1	1163	1365	-202	40804
2	942	1034	-92	8464
3	1246	1446	-200	40000
4	951	1048	-97	9409
5	1666	1604	62	3844
6	1437	1599	-162	26244
7	733	863	-130	16900
8	1294	1283	11	121
9	1024	1226	-202	40804
10	1165	1930	-765	585225
11	951	1039	-88	7744
12	787	870	-83	6889
13	767	910	-143	20449
14	1160	1295	-135	18225
15	1090	1630	-54 0	291000
16	890	1250	-360	129000
17	1211	1196	115	13225

ΣX = 18488 ΣX = 20394 ΣD = -2911 ΣD^2 = 1258544

$\bar{X}$ = 1087.52 $\bar{X}$ = 1199.647

The Significance of the Difference
between Means from Paired Observations

Test: # 1 and # 3 (Group II)

n = ___17___ $\sum D$ = ___-2911___ $\sum D^2$ = ___1,258,844___

$$\sum d^2 = \sum D^2 - \frac{(\sum D)^2}{n}$$ $\sum d^2$ = ___877,725.12___

$$S_d = \sqrt{\frac{\sum d^2}{n-1}}$$ $$S_d = \sqrt{\frac{877,725.12}{16}}$$ S_d = ___234.64___

$$S\bar{x} - \bar{x} = \frac{S_d}{\sqrt{n}}$$ $$s\bar{x} - \bar{x} = \frac{234.64}{\sqrt{17}}$$

$$S\bar{x} - \bar{x} = \frac{234.64}{4.123}$$ $S\bar{x} - \bar{x}$ = ___56.91___

$$t = \frac{\bar{X} - \bar{X}}{Sx - x}$$ t = ___1087.52 - 1199.647___

t = ___-1.968___

t at .05 level = 2.19

df = n-1

df =   16

Significance of Difference: ___Not Significant___

Area of Comparison: __Accumulative Scores__

__Test #2 and Test #3 (Group II)__

Subjects	Test #2	Test #3	D	D^2
1	1417	1365	52	2704
2	1058	1034	24	576
3	1513	1448	65	4225
4	904	1048	-144	20736
5	1776	1604	172	29584
6	1426	1599	-172	29584
7	940	863	77	5929
8	1122	1283	-161	25921
9	1127	1226	-99	9801
10	1651	1930	-279	77841
11	1134	1039	95	9025
12	889	870	19	361
13	809	910	-101	10201
14	1262	1295	-33	1089
15	1306	1630	-324	104976
16	963	1250	-287	82369
17	1320	1196	124	15376

$\Sigma X = 20617$ $\Sigma X = 20394$ $\Sigma D = -972$ $\Sigma D^2 = 430298$

$\bar{X} = 1212.76$ $\bar{X} = 1199.647$

The Significance of the Difference
between Means from Paired Observations

Test: #2 and #3 (Group II)

n = _____17_____ $\sum D$ = ____-272____ $\sum D^2$ = ____430,290____

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2$ = ____374,722.40____

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{374,722.40}{16}}$ S_d = ____153.03____

$S_{\bar{x}-\bar{x}} = \dfrac{S_d}{\sqrt{n}}$ $s_{\bar{x}-\bar{x}} = \dfrac{153.03}{\sqrt{17}}$

$S_{\bar{x}-\bar{x}} = \dfrac{153.03}{4.123}$ $S_{\bar{x}-\bar{x}}$ = ____37.11____

$t = \dfrac{\bar{X}-\bar{X}}{S_{x-x}}$ $t = \dfrac{1212.76 - 1199.647}{37.11}$

t = ____.353____

t at .05 level = 2.19

df = n-1

df = 16

Significance of Difference: ____Not Significant____

Area of Comparison: __Leg Strength_____

Test #1 and Test #2 (Group I)

Subjects	Test #1	Test #2	D	D^2
1	900	960	-40	1600
2	800	960	-160	25600
3	940	910	30	900
4	1135	1140	-5	25
5	930	720	210	44100
6	990	1040	-50	2500
7	490	680	-190	36100
8	700	760	-60	3600
9	1190	1230	-40	1600
10	760	790	-30	900
11	640	790	-150	22500
12	840	860	-20	400
13	680	680	0	0
14	830	680	150	22500
15	1190	1180	10	100
16	860	840	20	400
17	1160	970	90	36100

$\Sigma X = 15055$ $\Sigma X = 15190$ $\Sigma D = -135$ $\Sigma D^2 = 198925$

$\bar{X} = 885.58$ $\bar{X} = 893.52$

The Significance of the Difference
between Means from Paired Observations

Test: Leg Strength

$n = \underline{\quad 17 \quad}$ $\Sigma D = \underline{\quad -135 \quad}$ $\Sigma D^2 = \underline{\quad 198925 \quad}$

$\Sigma d^2 = \Sigma D^2 - \dfrac{(\Sigma D)^2}{n}$ $\Sigma d^2 = \underline{\quad 197852.95 \quad}$

$S_d = \sqrt{\dfrac{\Sigma d^2}{n-1}}$ $S_d = \sqrt{\dfrac{197852.95}{16}}$ $S_d = \dfrac{111.201}{4}$

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{111.201}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{111.201}{4.123}$ $S\bar{x} - \bar{x} = \underline{\quad 26.97 \quad}$

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{985.58 - 993.52}{26.97}$

$t = \underline{\quad .294 \quad}$

t at .05 level = 2.19

df = n-1

df = 16

Significance of Difference: $\underline{\quad \text{Not Significant} \quad}$

Area of Comparison: __Leg Strength__

__Test #1 and Test #3__

Subjects	Test #1	Test #3	D	D^2
1	900	860	40	1600
2	800	920	-120	14400
3	940	1120	-180	32400
4	1135	1080	55	3025
5	930	880	-50	2500
6	990	990	0	0
7	490	680	-190	36100
8	700	810	-110	12100
9	1190	1220	-30	900
10	760	700	60	3600
11	640	760	-120	14400
12	840	910	-70	4900
13	680	810	-130	16900
14	830	720	110	12100
15	1190	980	210	44100
16	860	940	80	6400
17	1160	950	210	44100

$\Sigma X = 15055$ $\Sigma X = 15330$ $\Sigma D = 95$ $\Sigma D^2 = 231525$

$\bar{X} = 885.58$ $\bar{X} = 901.76$

The Significance of the Difference
between Means from Paired Observations

Test: Leg Strength

n = _____17_____ $\sum D$ = _____95_____ $\sum D^2$ = _____231525_____

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2$ = _____222500_____

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{222500}{16}}$ S_d = _____117.92_____

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{117.92}{\sqrt{17}}$

$S\bar{x} - \bar{x}$ = _____$\dfrac{117.92}{4.123}$_____ $S\bar{x} - \bar{x}$ = _____28.60_____

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ t = _____885.58 - 901.76_____

t = _____.564_____

t at .05 level =   2.13

df = n-1

df =   16

Significance of Difference: Not Significant _____

Area of Comparison: Leg Strength

Test # 2 and Test # 3 : (Group I)

Subjects	Test # 2	Test # 3	D	D²
1	960	860	100	10000
2	960	920	40	1600
3	910	1120	-210	44100
4	1140	1080	60	3600
5	720	880	-160	25600
6	1040	990	50	2500
7	680	680	0	0
8	760	810	-50	2500
9	1230	1220	10	100
10	790	700	90	8100
11	790	760	30	900
12	860	910	-50	2500
13	680	810	-130	16900
14	680	720	-40	1600
15	1180	980	200	400000
16	840	940	-100	10000
17	970	950	20	400

$\Sigma X = 15190$ $\Sigma X = 15330$ $\Sigma D = -140$ $\Sigma D^2 = 170400$

$\bar{X} = 893.52$ $\bar{\bar{X}} = 901.76$

The Significance of the Difference
between Means from Paired Observations

Test: Leg Strength

n = 17 $\sum D$ = -140 $\sum D^2$ = 170,000

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2$ = 169247.06

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{169247.06}{16}}$ S_d = 102.347

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{102.847}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{102.847}{4.123}$ $S\bar{x} - \bar{x}$ = 24.94

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{893.52 - 901.76}{24.94}$

t = .330

t at .05 level = 219

df = n-1

df = 16

Significance of Difference: Not Significant

Area of Comparison: <u>Leg Strength</u>

<u>Test # 1 and Test # 2 : (Group II)</u>

Subjects	Test # 1	Test # 2	D	D^2
1	800	1000	-200	40000
2	670	760	-110	12100
3	920	1150	-230	52900
4	690	610	80	6400
5	1200	1290	-90	8100
6	1010	990	20	400
7	480	670	-190	36100
8	640	830	-190	36100
9	680	750	-70	4900
10	900	1280	-380	144400
11	690	810	-120	14400
12	520	625	-105	11025
13	440	460	-20	400
14	840	925	-85	7225
15	695	850	-155	24025
16	630	660	-30	900
17	900	980	-80	6400

$$\Sigma X = 12705 \qquad \Sigma X = 14640 \qquad \Sigma D = -1955 \qquad \Sigma D^2 = 405775$$

$$\bar{X} = 747.35 \qquad \qquad \bar{X} = 861.17$$

The Significance of the Difference
between Means from Paired Observations

Test: Leg Strength

$n =$ ___17___ $\sum D =$ ___-1955___ $\sum D^2 =$ ___405,775___

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2 =$ ___181003.83___

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{181003.83}{16}}$ $S_d =$ ___106.365___

$S_{\bar{x} - \bar{x}} = \dfrac{S_d}{\sqrt{n}}$ $s_{\bar{x} - \bar{x}} = \dfrac{106.365}{\sqrt{17}}$

$S_{\bar{x} - \bar{x}} = \dfrac{106.365}{4.123}$ $S_{\bar{x} - \bar{x}} =$ ___25.79___

$t = \dfrac{\bar{X} - \bar{X}}{S_{x} - x}$ $t = \dfrac{747.35 - 816.17}{25.79}$

$t =$ ___2.64___

t at .05 level = ___2.19___

$df = n-1$

$df =$ ___16___

Significance of Difference: ___Significant beyond .05 level of confidence___

Area of Comparison: Eye Strength

Test # 1 and Test # 3 : (Group II)

Subjects	Test # 1	Test # 3	D	D²
1	800	940	-140	19600
2	670	740	-70	4900
3	920	1080	-160	25600
4	690	660	30	900
5	1220	1120	80	6400
6	1010	1190	-180	32400
7	480	570	-90	8100
8	640	950	-310	96100
9	620	840	-160	25600
10	900	1540	-640	409600
11	690	620	70	4900
12	520	570	-50	2500
13	440	560	-120	14400
14	940	920	-20	400
15	695	1190	-495	245025
16	630	910	-280	78400
17	900	800	30	900

$\Sigma X = 12705 \qquad \Sigma X = 15270 \qquad \Sigma D = 2565 \qquad \Sigma D^2 = 761225$

$\bar{X} = 747.35 \qquad \bar{X} = 892.22$

The Significance of the Difference
between Means from Paired Observations

Test: Leg Strength

$n = \underline{17}$ $\qquad \sum D = \underline{2565} \qquad \sum D^2 = \underline{761,225}$

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\qquad \sum d^2 = \underline{596744.75}$

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $\qquad S_d = \sqrt{\dfrac{596744.75}{16}} \qquad S_d = \underline{193.123}$

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $\qquad s\bar{x} - \bar{x} = \dfrac{193.123}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{193.123}{4.123}$ $\qquad S\bar{x} - \bar{x} = \underline{46.34}$

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $\qquad t = \dfrac{747.35 - 892.22}{46.34}$

$t = \underline{3.09}$

t at .05 level = 219

df = n-1

df = 16

Significance of Difference: __Significant beyond the .05 level of confidence__

Area of Comparison: Leg Strength

Test # 2 and Test # 3 :   (Group II)

Subjects	Test # 2	Test # 3	D	D^2
1	1000	940	60	3600
2	760	740	20	400
3	1150	1080	70	4900
4	610	660	-50	2500
5	1290	1120	70	4900
6	990	1190	-200	40000
7	670	570	100	10000
8	830	950	-120	14400
9	750	840	-90	8100
10	1280	1540	-260	67600
11	810	620	190	36100
12	625	570	55	3025
13	460	560	-100	10000
14	925	920	5	25
15	850	1190	-340	115600
16	660	910	-250	62500
17	980	870	110	12100

$\Sigma X = $ 14640 $\Sigma X = $ 15270 $\Sigma D = $ -730 $\Sigma D^2 = $ 395750

$\bar{X} = $ 861.17 $\bar{X} = $ 892.22

The Significance of the Difference
between Means from Paired Observations

Test: Leg Strength

$n = \underline{\hspace{1em} 17 \hspace{1em}}$ $\Sigma D = \underline{\hspace{1em} -730 \hspace{1em}}$ $\Sigma D^2 = \underline{\hspace{1em} 365,730 \hspace{1em}}$

$\Sigma d^2 = \Sigma D^2 - \dfrac{(\Sigma D)^2}{n}$ $\Sigma d^2 = \underline{\hspace{1em} 31,347.05 \hspace{1em}}$

$S_d = \sqrt{\dfrac{\Sigma d^2}{n-1}}$ $S_d = \sqrt{\dfrac{31,347.05}{16}}$ $S_d = \underline{\hspace{1em} 44.20 \hspace{1em}}$

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{44.20}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{44.30}{4.123}$ $S\bar{x} - \bar{x} = \underline{\hspace{1em} 10.72 \hspace{1em}}$

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{441.17 - 492.22}{10.72}$

$t = \underline{\hspace{1em} 2.80 \hspace{1em}}$

t at .05 level $= \underline{\hspace{1em} 2.12 \hspace{1em}}$

$df = n-1$

$df = \underline{\hspace{1em} 16 \hspace{1em}}$

Significance of Difference: <u>Significant beyond .05 level of confidence</u>

Area of Comparison: <u>Back Strength</u>

<u>Test # 1 and Test # 2 :(Group I)</u>

Subjects	Test # 1	Test # 2	D	D^2
1	310	330	-20	400
2	270	290	-20	400
3	230	275	-45	2025
4	320	340	-20	400
5	310	310	0	0
6	375	375	0	0
7	210	225	-15	225
8	360	355	5	25
9	320	355	-35	1225
10	340	300	40	1600
11	330	310	20	400
12	340	300	40	1600
13	290	260	30	900
14	280	260	20	400
15	440	390	50	2500
16	350	320	30	900
17	340	320	20	400
	$\Sigma X = 5415$	$\Sigma X = 5315$	$\Sigma D = 100$	$\Sigma D^2 = 13400$
	$\bar{X} = 318.53$	$\bar{X} = 312.64$		

The Significance of the Difference
between Means from Paired Observations

Test: Back Strength

$n = $ _____ 17 _____ $\sum D = $ _____ 100 _____ $\sum D^2 = $ _____ 13,400 _____

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2 = $ _____ 12,811.77 _____

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{12,811.77}{16}}$ $S_d = $ _____ 28.296 _____

$S_{\bar{x} - \bar{x}} = \dfrac{S_d}{\sqrt{n}}$ $s_{\bar{x} - \bar{x}} = \dfrac{}{\sqrt{17}}$

$S_{\bar{x} - \bar{x}} = $ _____ $\dfrac{28.296}{4.123}$ _____ $S_{\bar{x} - \bar{x}} = $ _____ 6.86 _____

$t = \dfrac{\bar{X} - \bar{X}}{S_{x - x}}$ $t = \dfrac{318.53 - 312.64}{6.86}$

$t = $ _____ .858 _____

t at .05 level $= $ 2.19

df $= n-1$

df $= $ 16

Significance of Difference: _____ Not Significant _____

Area of Comparison: ___Back Strength___

Test # 1 and Test # 3: (Group I)

Subjects	Test # 1	Test # 3	D	D^2
1	310	340	-30	900
2	270	300	-30	900
3	230	295	-65	4225
4	320	380	-60	3600
5	310	290	20	400
6	375	380	-5	25
7	210	210	0	0
8	360	370	-10	100
9	320	360	-40	1600
10	340	290	50	2500
11	330	330	0	0
12	340	320	20	400
13	290	290	0	0
14	280	250	30	900
15	440	370	70	4900
16	350	375	-25	625
17	340	340	0	0

$\Sigma X = 5415$ $\Sigma X = 5490$ $\Sigma D = -75$ $\Sigma D^2 = 21075$

$\bar{X} = 318.53$ $\bar{X} = 322.94$

The Significance of the Difference
between Means from Paired Observations

Test: Back Strength

$n = \underline{\quad 17 \quad}$ $\qquad \sum D = \underline{\quad -75 \quad}$ $\qquad \sum D^2 = \underline{\quad 21,075 \quad}$

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\qquad \sum d^2 = \underline{\quad 20,744.12 \quad}$

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $\qquad S_d = \sqrt{\dfrac{20,744.12}{16}}$ $\qquad S_d = \underline{\quad 34.999 \quad}$

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $\qquad s\bar{x} - \bar{x} = \dfrac{34.999}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{34.999}{4.123}$ $\qquad S\bar{x} - \bar{x} = \underline{\quad 8.48 \quad}$

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $\qquad t = \dfrac{318.53 - 322.94}{8.48}$

$t = \underline{\quad .520 \quad}$

t at .05 level = 2.19

df = n-1

df = 16

Significance of Difference: $\underline{\text{Not Significant} \qquad\qquad\qquad}$

Area of Comparison: Back Strength

Test # 2 and Test # 3 : (Group I)

Subjects	Test #2	Test # 3	D	D^2
1	330	340	-10	100
2	290	300	-10	100
3	275	295	-20	400
4	340	380	-40	1600
5	310	290	20	400
6	375	380	-5	25
7	225	210	15	225
8	355	370	-15	225
9	355	360	15	225
10	300	290	10	100
11	310	330	-20	400
12	300	320	-20	400
13	260	290	-30	900
14	260	250	10	100
15	390	370	20	400
16	320	375	-55	3025
17	320	340	-20	400

$\Sigma X =$ 5315 $\Sigma X =$ 5490 $\Sigma D =$ 155 $\Sigma D^2 =$ 9025

$\bar{X} =$ 312.64 $\bar{X} =$ 322.94

The Significance of the Difference
between Means from Paired Observations

Test: Back Strength

n = ___17___ $\sum D$ = ___155___ $\sum D^2$ = ___9,025___

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2$ = ___7,611.77___

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{7,611.77}{16}}$ S_d = ___21.812___

$S_{\bar{x} - \bar{x}} = \dfrac{S_d}{\sqrt{n}}$ $s_{\bar{x} - \bar{x}} = \dfrac{21.812}{\sqrt{17}}$

$S_{\bar{x} - \bar{x}} = \dfrac{21.812}{4.123}$ $S_{\bar{x} - \bar{x}}$ = ___5.29___

$t = \dfrac{\bar{X} - \bar{X}}{S_{x - x}}$ $t = \dfrac{312.64 - 322.94}{5.29}$

t = ___1.94___

t at .05 level = 2.19

df = n-1

df = 16

Significance of Difference: Not Significant

Area of Comparison: Back Strength

Test # 1 and Test # 2 : (Group II)

Subjects	Test # 1	Test # 2	D	D^2
1	305	350	-45	2025
2	210	235	-25	625
3	290	310	-20	400
4	200	230	-30	900
5	420	420	0	0
6	380	370	10	100
7	210	210	0	0
8	230	240	-10	100
9	290	300	-10	100
10	270	315	-45	2025
11	230	275	-45	2025
12	250	245	5	25
13	270	280	-10	100
14	250	280	-30	900
15	360	420	-60	3600
16	230	260	-30	900
17	270	270	0	0
	$\Sigma X = 4665$	$\Sigma X = 5010$	$\Sigma D = 355$	$\Sigma D^2 = 13825$

$\bar{X} = $ 247.41 $\bar{X} = $ 294.7

The Significance of the Difference
between Means from Paired Observations

Test: Back Strength

$n =$ ___17___ $\sum D =$ ___355___ $\sum D^2 =$ ___13,825___

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2 =$ ___7,413.23___

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{7,413.23}{16}}$ $S_d =$ ___21.525___

$S_{\bar{x} - \bar{x}} = \dfrac{S_d}{\sqrt{n}}$ $s_{\bar{x} - \bar{x}} = \dfrac{21.525}{\sqrt{17}}$

$S_{\bar{x} - \bar{x}} = \dfrac{21.525}{4.123}$ $S_{\bar{x} - \bar{x}} =$ ___5.22___

$t = \dfrac{\bar{X} - \bar{X}}{S_{x-x}}$ $t = \dfrac{247.41 - 294.7}{5.22}$

$t =$ ___9.05___

t at .05 level $=$ 2.19

df $=$ n-1

df $=$ 16

Significance of Difference: ___Significant beyond .05 level___

Area of Comparison: _____Back Strength_____

Test # 1 and Test # 3 : (Group I)

Subjects	Test # 1	Test # 3	D	D²
1	305	360	-55	3025
2	210	230	-20	400
3	290	310	-20	400
4	200	230	-30	900
5	420	420	0	0
6	380	360	20	400
7	210	240	-30	900
8	230	280	-50	2500
9	290	320	-30	900
10	270	340	-70	4900
11	230	280	-50	2500
12	250	280	-30	900
13	270	290	-20	400
14	250	330	-80	6400
15	360	410	-50	2500
16	230	290	-60	3600
17	270	270	0	0
	$\Sigma X = 4665$	$\Sigma X = 5240$	$\Sigma D = 575$	$\Sigma D^2 = 30625$

$$\bar{X} = 247.41 \qquad\qquad \vec{X} = 308.23$$

The Significance of the Difference
between Means from Paired Observations

Test: Back Strength

$n =$ ___17___ $\sum D =$ ___575___ $\sum D^2 =$ ___30,625___

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2 =$ ___11,176.43___

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{11,176.43}{16}}$ $S_d =$ ___26.41___

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{26.41}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{26.41}{4.123}$ $S\bar{x} - \bar{x} =$ ___6.42___

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{247.41 - 309.23}{6.42}$

$t =$ ___9.47___

t at .05 level = 2.19

df = n-1

df = 16

Significance of Difference: ___Significant beyond .05 level___

Area of Comparison: <u>Back Strength</u>

<u>Test # 2 and Test # 3 : (Group I)</u>

Subjects	Test # 2	Test # 3	D	D^2
1	350	360	-5	25
2	235	230	5	25
3	310	310	0	0
4	230	230	0	0
5	420	420	0	0
6	370	360	10	100
7	210	240	-30	900
8	240	280	-40	1600
9	300	320	-20	400
10	315	340	-25	625
11	275	280	-5	25
12	245	280	-35	1225
13	280	290	-10	100
14	280	330	-50	2500
15	420	410	10	100
16	260	290	-30	900
17	270	270	0	0

$\Sigma X = 5010$ $\Sigma X = 5240$ $\Sigma D = -225$ $\Sigma D^2 = 8525$

$\bar{X} = 294.7$ $\bar{X} = 308.23$

The Significance of the Difference
between Means from Paired Observations

Test: Back Strength

$n =$ ___17___ $\sum D =$ ___-225___ $\sum D^2 =$ ___8,525___

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2 =$ ___2,977.94___

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{2,977.94}{16}}$ $S_d =$ ___54.57___

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{54.57}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{54.57}{4.123}$ $S\bar{x} - \bar{x} =$ ___13.23___

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{294.7 - 308.23}{13.23}$

$t =$ ___1.02___

t at .05 level = 2.19

df = n-1

df = 16

Significance of Difference: ___Not Significant at .05 level___

Area of Comparison: ___Arm Strength (Bent Arm Hang)___

Test # 1 and Test # 2 : (Group I)

Subjects	Test # 1	Test # 2	D	D^2
1	57	53	4	16
2	24	40	-16	256
3	27	25	2	4
4	43	41	-2	4
5	33	32	1	1
6	65	69	-4	16
7	25	27	-2	4
8	51	43	8	64
9	61	59	2	4
10	56	58	-2	4
11	57	58	-1	1
12	34	31	3	9
13	27	39	-12	144
14	49	37	12	144
15	53	53	0	0
16	71	61	10	100
17	42	44	-2	4

$\Sigma X = 776$ $\Sigma X = 770$ $\Sigma D = 1$ $\Sigma D^2 = 775$

$\bar{X} = 45.64$ $\bar{X} = 45.29$

The Significance of the Difference
between Means from Paired Observations

Test: Bent Arm Hang

$n =$ ___17___ $\Sigma D =$ ___1___ $\Sigma D^2 =$ ___775___

$\Sigma d^2 = \Sigma D^2 - \dfrac{(\Sigma D)^2}{n}$ $\Sigma d^2 =$ ___774___

$S_d = \sqrt{\dfrac{\Sigma d^2}{n-1}}$ $S_d = \sqrt{\dfrac{774}{16}}$ $S_d =$ ___6.957___

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{6.957}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{6.957}{4.123}$ $S\bar{x} - \bar{x} =$ ___1.68___

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{45.44 - 45.29}{1.68}$

$t =$ ___.208___

t at .05 level =   2.10

df = n-1

df =   16

Significance of Difference: ___Not Significant at .05 level___

Area of Comparison: <u>Arm Strength (Bent Arm Hang)</u>

<u>Test #1 and Test #3 (Group I)</u>

Subjects	Test #1	Test #3	D	D²
1	57	70	-13	169
2	24	45	-21	441
3	27	42	-15	225
4	43	43	0	0
5	33	34	-1	1
6	65	60	5	25
7	25	26	-1	1
8	51	41	10	100
9	61	62	-1	1
10	56	55	1	1
11	57	65	-8	64
12	34	48	-14	196
13	27	50	-23	529
14	49	40	9	81
15	53	53	0	0
16	71	74	-3	9
17	42	50	-8	64

$\Sigma X = 776$ $\qquad$ $\Sigma X = 858$ $\qquad$ $\Sigma D = -84$ $\qquad$ $\Sigma D^2 = 1907$

$\bar{X} = 45.64$ $\qquad\qquad\qquad$ $\bar{X} = 50.47$

The Significance of the Difference
between Means from Paired Observations

Test: Bent arm Hang

$n = 17$ _____ $\sum D = -84$ _____ $\sum D^2 = 1,907$ _____

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2 = 1491.95$ _____

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{1491.95}{16}}$ $S_d = 9.655$ _____

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{9.655}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{9.655}{4.123}$ _____ $S\bar{x} - \bar{x} = 2.34$ _____

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{45.64 - 50.47}{2.34}$

$t = \underline{\quad 2.06 \quad}$

t at .05 level $=$ 2.19

$df = n-1$

$df = 16$

Significance of Difference: Not Significant _____

Area of Comparison: ___Arm Strength (Bent Arm Hang)___

___Test # 2 and Test # 3 : (Group I)___

Subjects	Test # 2	Test # 3	D	D^2
1	53	70	-17	289
2	40	45	-5	25
3	25	42	-17	289
4	41	43	-2	4
5	32	34	-2	4
6	69	60	9	81
7	27	26	1	1
8	43	41	2	4
9	59	62	-3	9
10	58	55	3	9
11	58	65	-7	49
12	31	48	-17	289
13	39	50	-11	121
14	37	40	-3	9
15	53	53	0	0
16	61	74	-13	169
17	44	50	-6	36
	$\Sigma X = 770$	$\Sigma X = 858$	$\Sigma D = -88$	$\Sigma D^2 = 1388$

$\bar{X} = 45.29$　　　　　$\bar{X} = 5047$

The Significance of the Difference
between Means from Paired Observations

Test: Bent Arm Hang

$n = \underline{\quad 17 \quad}$ $\sum D = \underline{\quad -88 \quad}$ $\sum D^2 = \underline{\quad 1388 \quad}$

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2 = \underline{\quad 932.48 \quad}$

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{932.48}{16}}$ $S_d = \underline{\quad 7.632 \quad}$

$S_{\bar{x} - \bar{x}} = \dfrac{S_d}{\sqrt{n}}$ $s_{\bar{x} - \bar{x}} = \dfrac{7.632}{\sqrt{17}}$

$S_{\bar{x} - \bar{x}} = \underline{\dfrac{7.632}{4.123}}$ $S_{\bar{x} - \bar{x}} = \underline{\quad 1.84 \quad}$

$t = \dfrac{\bar{X} - \bar{X}}{S_{x - x}}$ $t = \dfrac{45.29 - 50.47}{1.84}$

$t = \underline{\quad 2.81 \quad}$

t at .05 level = $\quad 2.19$

df = n-1

df = $\quad 16$

Significance of Difference: $\underline{\quad \text{Significant beyond the .05 level} \quad}$

Area of Comparison: ___Arm Strength (Bent Arm Hang)___

Test # 1 and Test # 2 : (Group II)

Subjects	Test # 1	Test # 2	D	D^2
1	48	55	-7	49
2	52	49	3	9
3	30	45	-15	225
4	48	49	-1	1
5	40	54	-14	196
6	36	54	-18	324
7	41	53	-12	144
8	41	45	-4	8
9	44	66	-12	144
10	26	46	-20	400
11	24	36	-12	144
12	16	18	-2	4
13	50	59	-8	81
14	60	44	16	256
15	37	23	14	196
16	26	31	-5	25
17	36	53	-17	289

$\Sigma X = 655$ $\Sigma X = 780$ $\Sigma D = -115$ $\Sigma D^2 = 2495$

$\bar{X} = 38.52$ $\bar{X} = 45.88$

The Significance of the Difference
between Means from Paired Observations

Test: Bent Arm Hang

$n = \underline{17}$ $\qquad$ $\sum D = \underline{-115}$ $\qquad$ $\sum D^2 = \underline{2,495}$

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\qquad$ $\sum d^2 = \underline{1717.06}$

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $\qquad$ $S_d = \sqrt{\dfrac{1717.06}{16}}$ $\qquad$ $S_d = \underline{10,358}$

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $\qquad$ $s\bar{x} - \bar{x} = \dfrac{10.358}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{10.358}{4.123}$ $\qquad$ $S\bar{x} - \bar{x} = \underline{2.51}$

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $\qquad$ $t = \underline{38.52 - 45.88}$

$t = \underline{2.83}$

t at .05 level $= 2.19$

df $= n-1$

df $= 16$

Significance of Difference: Significant beyond the .05 level

Area of Comparison: ___Arm Strength (Bent Arm Hang)___

Test # 1 and Test # 3 : (Group II)

Subjects	Test # 1	Test # 3	D	D^2
1	48	51	-3	9
2	52	47	5	25
3	30	49	-19	361
4	48	39	9	81
5	40	56	-16	256
6	36	36	0	0
7	41	44	-3	9
8	41	44	-3	9
9	44	54	-10	100
10	26	39	-13	169
11	24	26	-2	4
12	16	17	-1	1
13	50	51	-1	1
14	60	33	27	729
15	37	22	15	225
16	26	36	-10	100
17	36	39	-3	9
	$\Sigma X = 655$	$\Sigma X = 683$	$\Sigma D = 28$	$\Sigma D^2 = 2088$
	$\bar{X} = 38.52$	$\bar{X} = 40.17$		

The Significance of the Difference
between Means from Paired Observations

Test: Bent Arm Hang

n = __17__ $\sum D$ = __20__ $\sum D^2$ = __2,091__

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2$ = __2044.24__

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{2044.24}{16}}$ S_d = __11.302__

$S_{\bar{x}-\bar{x}} = \dfrac{S_d}{\sqrt{n}}$ $s_{\bar{x}-\bar{x}} = \dfrac{11.302}{\sqrt{17}}$

$S_{\bar{x}-\bar{x}}$ = __11.302 / 4.123__ $S_{\bar{x}-\bar{x}}$ = __2.74__

$t = \dfrac{\bar{X}-\bar{X}}{S_{x-x}}$ $t = \dfrac{38.32 - 40.17}{}$

t = __.600__

t at .05 level = __2.19__

df = n-1

df = __16__

Significance of Difference: __Not significant at .05 level__

Area of Comparison: <u>Arm Strength (Bent Arm Hang)</u>

<u>Test # 2 and Test # 3 : (Group II)</u>

Subjects	Test # 2	Test # 3	D	D^2
1	55	51	4	16
2	49	47	2	4
3	45	49	-4	16
4	49	39	10	100
5	54	56	-2	4
6	54	36	18	324
7	53	44	9	81
8	45	44	1	1
9	66	54	12	144
10	46	39	7	49
11	36	26	10	100
12	18	17	1	1
13	59	51	8	64
14	44	33	11	121
15	23	22	1	1
16	31	36	-5	25
17	53	39	14	196

$\Sigma X = 780$ $\Sigma X = 683$ $\Sigma D = 97$ $\Sigma D^2 = 1247$

$\bar{X} = 45.88$ $\bar{X} = 40.17$

The Significance of the Difference
between Means from Paired Observations

Test: Bent Arm Hang

$n =$ _____17_____ $\qquad$ $\sum D =$ _____97_____ $\qquad$ $\sum D^2 =$ _____1,247_____

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\qquad\qquad$ $\sum d^2 =$ _____793.53_____

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $\qquad\qquad$ $S_d = \sqrt{\dfrac{793.53}{16}}$ $\qquad$ $S_d =$ _____7.042_____

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $\qquad\qquad$ $s\bar{x} - \bar{x} = \dfrac{7.042}{\sqrt{17}}$

$S\bar{x} - \bar{x} =$ $\dfrac{7.042}{4.123}$ $\qquad\qquad$ $S\bar{x} - \bar{x} =$ _____1.71_____

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $\qquad\qquad$ $t = \dfrac{45.88 - 40.17}{1.71}$

$t =$ _____3.33_____

t at .05 level $=$ 2.19

$df = n-1$

$df =$ 16

Significance of Difference: _____Significant at the .05 level_____

Area of Comparison: _____ Arm Strength (Bar Dips) _____

Test # 1 and Test # 2 : (Group I)

Subjects	Test # 1	Test # 2	D	D^2
1	10	13	-3	9
2	10	7	3	9
3	4	4	0	0
4	11	10	1	1
5	1	1	0	0
6	22	27	-5	25
7	8	9	-1	1
8	10	12	-2	4
9	9	6	3	9
10	9	9	0	0
11	15	15	0	0
12	7	6	1	1
13	7	8	-1	1
14	14	9	5	25
15	10	11	-1	1
16	13	14	-1	1
17	11	9	2	4
	$\Sigma X = 171$	$\Sigma X = 170$	$\Sigma D = 1$	$\Sigma D^2 = 91$
	$\bar{X} = 10.05$		$\bar{X} = 10$	

The Significance of the Difference
between Means from Paired Observations

Test: Bar Dips

$n = $ __17__ $\sum D = $ __1__ $\sum D^2 = $ __91__

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2 = $ __90.95__

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{90.95}{16}}$ $S_d = $ __2.384__

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{2.384}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{2.384}{4.123}$ $S\bar{x} - \bar{x} = $ __.578__

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{10.05 - 10}{.578}$

$t = $ __.096__

t at .05 level = 2.19

df = n-1

df = 16

Significance of Difference: __Not Significant__

Area of Comparison: __Arm Strength (Bar Dips)__

__Test # 1 and Test # 3 : (Group I)__

Subjects	Test # 1	Test # 3	D	D^2
1	10	13	-3	9
2	10	12	-2	4
3	4	5	-1	1
4	11	13	-2	4
5	1	2	-1	1
6	22	25	-3	9
7	8	8	0	0
8	10	16	-6	36
9	9	11	-2	4
10	9	14	-5	25
11	15	22	-7	49
12	7	5	2	4
13	7	5	2	4
14	14	17	-3	9
15	14	11	-1	1
16	13	21	-8	64
17	11	12	-1	1

$\Sigma X = 171$ $\qquad$ $\Sigma X = 212$ $\qquad$ $\Sigma D = -41$ $\qquad$ $\Sigma D^2 = 225$

$\bar{X} = 10.05$ $\qquad\qquad\qquad$ $\bar{X} = 12.47$

The Significance of the Difference
between Means from Paired Observations

Test: Bar Dips

$n =$ ___17___ $\Sigma D =$ ___41___ $\Sigma D^2 =$ ___225___

$\Sigma d^2 = \Sigma D^2 - \dfrac{(\Sigma D)^2}{n}$ $\Sigma d^2 =$ ___126.12___

$S_d = \sqrt{\dfrac{\Sigma d^2}{n-1}}$ $S_d = \sqrt{\dfrac{126.12}{16}}$ $S_d =$ ___5.615___

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{5.615}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{5.615}{4.123}$ $S\bar{x} - \bar{x} = \dfrac{}{1.36}$

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{10.03 - 12.47}{1.36}$

$t =$ ___1.78___

t at .05 level = 2.19

df = n-1

df = 16

Significance of Difference: ___Not Significant at .05 level___

Area of Comparison: ___Arm Strength (Bar Dips)___

___Test # 2 and Test # 3 : (Group I)___

Subjects	Test # 2	Test # 3	D	D^2
1	13	13	0	0
2	7	12	-5	25
3	4	5	-1	1
4	10	13	-3	9
5	1	2	-1	1
6	27	25	2	4
7	9	8	1	1
8	12	16	-4	16
9	6	11	-5	25
10	9	14	-5	25
11	15	22	-7	49
12	6	5	1	1
13	8	5	3	9
14	9	17	-8	64
15	11	11	0	0
16	14	21	-7	49
17	9	12	-3	9

$\Sigma X = 170$ $\Sigma X = 212$ $\Sigma D = 42$ $\Sigma D^2 = 288$

$\bar{X} = 10$ $\bar{X} = 12.47$

The Significance of the Difference
between Means from Paired Observations

Test: Bar Dips

$n =$ _____17_____ $\Sigma D =$ _____42_____ $\Sigma D^2 =$ _____288_____

$\Sigma d^2 = \Sigma D^2 - \dfrac{(\Sigma D)^2}{n}$ $\Sigma d^2 =$ _____184.24_____

$S_d = \sqrt{\dfrac{\Sigma d^2}{n-1}}$ $S_d = \sqrt{\dfrac{184.24}{16}}$ $S_d = 6.925$

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{6.925}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{6.925}{4.123}$ $S\bar{x} - \bar{x} =$ _____1.67_____

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{10 - 12.47}{1.67}$

$t =$ _____1.47_____

t at .05 level $=$ 2.19

$df = n-1$

$df =$ 16

Significance of Difference: _____Not significant at .05 level_____

Area of Comparison: ___Arm Strength (Bar Dips)___

Test # 1 and Test # 2 : (Group II)

Subjects	Test # 1	Test # 2	D	D^2
1	10	12	-2	4
2	10	14	-4	8
3	8	8	0	0
4	13	15	-2	4
5	6	8	-2	4
6	11	12	-1	1
7	2	7	-5	25
8	7	7	0	0
9	10	11	-1	1
10	5	10	-5	25
11	7	13	-6	36
12	1	1	0	0
13	7	10	-3	9
14	10	13	-3	9
15	7	13	-6	36
16	4	12	-8	64
17	15	17	-2	4

$\Sigma X = 133$ $\quad$ $\Sigma X = 183$ $\quad$ $\Sigma D = -50$ $\quad$ $\Sigma D^2 = 230$

$\bar{X} = 7.82$ $\quad\quad\quad\quad\quad\quad\quad$ $\bar{X} = 10.76$

The Significance of the Difference
between Means from Paired Observations

Test:

Bar Dips

$n =$ ___17___ $\sum D =$ ___-50___ $\sum D^2 =$ ___230___

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2 =$ ___82.99___

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{82.99}{16}}$ $S_d =$ ___4.554___

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{4.554}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{4.554}{4.123}$ $S\bar{x} - \bar{x} =$ ___1.16___

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{7.82 - 10.76}{1.16}$

$t =$ ___2.53___

t at .05 level $=$ 2.19

$df = n-1$

$df =$ 16

Significance of Difference: ___Significant at the .05 level___

Area of Comparison: _____Arm Strength (Bar Dips)_____

Test # 1 and Test # 3 : (Group II)

Subjects	Test # 1	Test # 3	D	D^2
1	10	16	-6	16
2	10	17	-7	49
3	8	9	-1	1
4	13	19	-6	36
5	6	8	-2	4
6	11	13	-2	4
7	2	9	-7	49
8	7	9	-2	4
9	10	12	-2	4
10	5	11	-6	36
11	7	13	-6	36
12	1	3	-2	4
13	7	9	-2	4
14	10	12	-2	4
15	7	8	-1	1
16	4	14	-10	100
17	15	17	-2	4
	$\Sigma X = 133$	$\Sigma X = 197$	$\Sigma D = -64$	$\Sigma D^2 = 356$

$\bar{X} = 7.82$ $\qquad$ $\bar{X} = 11.58$

The Significance of the Difference
between Means from Paired Observations

Test: Bar Dips

$n =$ _____17_____ $\sum D =$ ___-64___ $\sum D^2 =$ ___256___

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2 =$ ___115.06___

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{115.06}{16}}$ $S_d =$ ___5.369___

$S_{\bar{x} - \bar{x}} = \dfrac{S_d}{\sqrt{n}}$ $S_{\bar{x} - \bar{x}} = \dfrac{5.369}{\sqrt{17}}$

$S_{\bar{x} - \bar{x}} = \dfrac{5.369}{4.123}$ $S_{\bar{x} - \bar{x}} =$ ___1.30___

$t = \dfrac{\bar{X} - \bar{X}}{S_{x - x}}$ $t = \dfrac{7.82 - 11.58}{1.30}$

$t =$ ___2.88___

t at .05 level $=$ 2.18

$df = n-1$

$df =$ 16

Significance of Difference: ___Significant beyond the .05 level___

Area of Comparison: __Arm Strength (Bar Dips)__

Test # 2 and Test # 3 : (Group II)

Subjects	Test # 2	Test # 3	D	D^2
1	12	14	-2	4
2	14	17	-3	9
3	8	9	-1	1
4	15	19	-4	16
5	8	8	0	0
6	12	13	-1	1
7	7	9	-2	4
8	7	9	-2	4
9	11	12	-1	1
10	10	11	-1	1
11	13	13	0	0
12	1	3	-2	4
13	10	9	1	1
14	13	12	1	1
15	13	8	5	25
16	12	14	-2	4
17	17	17	0	0

$\Sigma X =$ 183 $\qquad$ $\Sigma X =$ 197 $\qquad$ $\Sigma D = 14$ $\qquad$ $\Sigma D^2 =$ 76

$\bar{X} =$ 10.76 $\qquad\qquad$ $\bar{X} =$ 11.58

The Significance of the Difference
between Means from Paired Observations

Test: Bar Dips

n = _____17_____ $\sum D$ = _____14_____ $\sum D^2$ = _____76_____

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2$ = _____64.48_____

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{64.48}{16}}$ S_d = ___4.014___

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x}$ = _____$\dfrac{4.014}{\sqrt{17}}$_____

$S\bar{x} - \bar{x}$ = _____$\dfrac{4.014}{4.123}$_____ $S\bar{x} - \bar{x}$ = ___.97___

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ t = ___10.76 - 11.58___

t = ___.845___

t at .05 level = 2.19

df = n-1

df = 16

Significance of Difference: Not significant _____

Area of Comparison: Leg Strength

Test # 1

Subjects	Group I	Group II	D	D²
1	900	800	100	10000
2	800	670	130	16900
3	960	920	20	400
4	1135	690	445	220025
5	950	1200	-270	72900
6	990	1010	-20	400
7	490	480	10	100
8	700	640	60	3600
9	1190	680	510	260100
10	740	900	-140	19600
11	840	690	-50	2500
12	840	520	320	102400
13	680	440	240	57600
14	690	840	-10	100
15	1190	695	495	245125
16	860	630	30	900
17	1160	900	260	67600
	$\Sigma X = 15055$	$\Sigma X = 12705$	$\Sigma D = 2130$	$\Sigma D^2 = 1075250$
	$\bar{X} = 885.58$	$\bar{X} = 747.35$		

The Significance of the Difference
between Means from Paired Observations

Test: Leg Strength (Test #1)

$n = \underline{\quad 17 \quad}$ $\qquad$ $\Sigma D = \underline{\quad 2,130 \quad}$ $\qquad$ $\Sigma D^2 = \underline{\quad 1,075,250 \quad}$

$\Sigma d^2 = \Sigma D^2 - \dfrac{(\Sigma D)^2}{n}$ $\qquad$ $\Sigma d^2 = \underline{\quad 808,373.53 \quad}$

$S_d = \sqrt{\dfrac{\Sigma d^2}{n-1}}$ $\qquad$ $S_d = \sqrt{\dfrac{808,373.53}{16}}$ $\qquad$ $S_d = \underline{\quad 224.772 \quad}$

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $\qquad$ $s\bar{x} - \bar{x} = \dfrac{224.772}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \underline{\quad \dfrac{224.772}{4.123} \quad}$ $\qquad$ $S\bar{x} - \bar{x} = \underline{\quad 54.51 \quad}$

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $\qquad$ $t = \dfrac{885.58 - 767.35}{54.51}$

$t = \underline{\quad 2.53 \quad}$

t at .05 level $= 2.13$

df = n-1

df = 16

Significance of Difference: $\underline{\text{Significant beyond .05 level}}$

Area of Comparison: __Leg Strength__

__Test # 2__

Subjects	Group I	Group II	D	D^2
1	960	1000	-40	1600
2	960	760	200	40000
3	910	1150	-240	57600
4	1140	610	530	280900
5	720	1290	-570	324900
6	1040	990	50	2500
7	680	670	10	100
8	760	830	-70	4900
9	1230	750	480	230400
10	790	1280	-490	240100
11	790	810	-20	400
12	860	625	235	55125
13	680	460	220	48400
14	680	925	-245	60025
15	1180	850	330	108900
16	840	660	180	32400
17	970	980	-10	100
	$\Sigma X =$ 15190	$\Sigma X =$ 14640	$\Sigma D =$ 550	$\Sigma D^2 =$ 1488350

$$\bar{X} = 893.52 \qquad \bar{X} = 861.17$$

The Significance of the Difference
between Means from Paired Observations

Test: Leg Strength (Test #2)

n = _____17_____ ΣD = ____550____ ΣD^2 = __1,488,350__

$\Sigma d^2 = \Sigma D^2 - \dfrac{(\Sigma D)^2}{n}$ Σd^2 = __1,470,555.89__

$S_d = \sqrt{\dfrac{\Sigma d^2}{n-1}}$ $S_d = \sqrt{\dfrac{1,470,555.89}{16}}$ S_d = __303.165__

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{303.165}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{303.165}{4.123}$ $S\bar{x} - \bar{x}$ = __73.54__

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{893.52 - 861.17}{73.54}$

t = _____.439_____

t at .05 level = 2.19

df = n-1

df = 16

Significance of Difference: __Not Significant at .05 level__

Area of Comparison: ___Leg Strength___

Test # 3

Subjects	Group I	Group II	D	D^2
1	860	940	-80	6400
2	920	740	180	32400
3	1120	1080	40	1600
4	1080	660	420	176400
5	880	1120	-240	57600
6	990	1190	-200	40000
7	680	570	110	12100
8	810	950	-140	19600
9	1220	840	380	133400
10	700	1540	-840	369600
11	760	620	140	19600
12	910	570	340	115600
13	810	560	250	12500
14	720	920	-200	40000
15	980	1190	-210	44100
16	940	910	30	900
17	950	870	80	6400

$\Sigma X = 15330$ $\Sigma X = 15270$ $\Sigma D = 60$ $\Sigma D^2 = 1143200$

$\bar{X} = 901.76$ $\bar{X} = 892.22$

The Significance of the Difference
between Means from Paired Observations

Test: Leg Strength (Test #3)

$n = \underline{\hspace{1em} 17 \hspace{1em}}$ $\Sigma D = \underline{\hspace{1em} 60 \hspace{1em}}$ $\Sigma D^2 = \underline{\hspace{1em} 1,143,200 \hspace{1em}}$

$\Sigma d^2 = \Sigma D^2 - \dfrac{(\Sigma D)^2}{n}$ $\Sigma d^2 = \underline{\hspace{1em} 1,142,988.24 \hspace{1em}}$

$S_d = \sqrt{\dfrac{\Sigma d^2}{n-1}}$ $S_d = \sqrt{\dfrac{1,142,988.24}{16}}$ $S_d = \underline{\hspace{1em} 267.525 \hspace{1em}}$

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{267.525}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{267.525}{4.123}$ $S\bar{x} - \bar{x} = \underline{\hspace{1em} 64.88 \hspace{1em}}$

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{901.76 - 892.22}{64.88}$

$t = \underline{\hspace{1em} .147 \hspace{1em}}$

t at .05 level = 2.19

df = n-1

df = 16

Significance of Difference: Not Significant at .05 level

Area of Comparison: ___Back Strength_____

Test # 1

Subjects	Group I	Group II	D	D^2
1	310	305	5	25
2	270	210	60	3600
3	230	290	-60	3600
4	320	200	120	14400
5	310	420	-100	12100
6	375	380	-5	25
7	210	210	0	0
8	360	230	130	16900
9	320	290	30	900
10	340	270	70	4900
11	330	230	100	10000
12	340	250	90	8100
13	290	270	20	400
14	280	250	30	900
15	440	360	80	6400
16	350	230	120	14400
17	340	270	70	4900

$\Sigma X = 5415$ $\Sigma X = 4665$ $\Sigma D = 750$ $\Sigma D^2 = 101550$

$\bar{X} = 318.53$ $\bar{X} = 267.41$

The Significance of the Difference
between Means from Paired Observations

Test: Back Strength (Test #1)

$n =$ ___17___ $\sum D =$ ___750___ $\sum D^2 =$ ___101,550___

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2 =$ ___69,050___

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{69,050}{16}}$ $S_d =$ ___65,697___

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{65,697}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{65,697}{4.123}$ $S\bar{x} - \bar{x} =$ ___15.93___

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{318.53 - 247.41}{15.93}$

$t =$ ___4.46___

t at .05 level $=$ 2.10

df = n-1

df = 16

Significance of Difference: ___Significant beyond .05 level___

Area of Comparison: ___Back Strength___

___Test II___

Subjects	Group I	Group II	D	D^2
1	330	350	-20	400
2	290	235	55	3025
3	275	310	-35	1225
4	340	230	110	12100
5	310	420	-110	12100
6	375	370	5	25
7	225	210	15	225
8	355	240	15	225
9	355	300	55	3025
10	300	315	-15	225
11	310	275	35	1225
12	300	245	55	3025
13	260	280	-20	400
14	260	280	-20	400
15	390	420	-30	900
16	320	260	60	3600
17	320	270	50	2500
$\Sigma X =$	5315	$\Sigma X =$ 5010	$\Sigma D =$ 205	$\Sigma D^2 =$ 44625

$\bar{X} =$ 312.64

$\bar{X} =$ 294.7

The Significance of the Difference
between Means from Paired Observations

Test: Back Strength (Test #2)

$n =$ ___17___ $\sum D =$ ___205___ $\sum D^2 =$ ___44,265___

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2 =$ ___42,152.95___

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{42,152.95}{16}}$ $S_d =$ ___51.327___

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{51.327}{\sqrt{17}}$

$S\bar{x} - \bar{x} =$ ___$\dfrac{51.327}{4.123}$___ $S\bar{x} - \bar{x} =$ ___12.45___

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{312.64 - 294.7}{12.45}$

$t =$ ___1.44___

t at .05 level = 2.13

df = n-1

df = 16

Significance of Difference: ___Not Significant at .05 Level___

Area of Comparison: _____ Back Strength _____

Test # 3

Subjects	Group I	Group II	D	D^2
1	340	360	-20	400
2	300	230	70	4900
3	295	310	-15	225
4	380	230	150	22500
5	290	420	-130	16900
6	380	360	20	400
7	210	240	-30	900
8	370	280	90	8100
9	360	320	40	1600
10	290	340	-50	2500
11	330	280	50	2500
12	320	280	40	1600
13	290	290	0	0
14	250	330	-80	6400
15	370	410	-40	1600
16	375	290	85	7225
17	340	270	70	4900

$\Sigma X = 5490$ $\Sigma X = 5240$ $\Sigma D = 250$ $\Sigma D^2 = 82650$

$\bar{X} = 322.94$ $\bar{X} = 308.23$

The Significance of the Difference
between Means from Paired Observations

Test: Back Strength (Test #3)

$n =$ ___17___ $\sum D =$ ___250___ $\sum D^2 =$ ___82,650___

$$\sum d^2 = \sum D^2 - \frac{(\sum D)^2}{n} \qquad\qquad \sum d^2 = \underline{\hspace{0.3em}78,973.53\hspace{0.3em}}$$

$$S_d = \sqrt{\frac{\sum d^2}{n-1}} \qquad\qquad S_d = \sqrt{\frac{78,973.53}{16}} \qquad S_d = \underline{\hspace{0.3em}70.255\hspace{0.3em}}$$

$$S\bar{x} - \bar{x} = \frac{S_d}{\sqrt{n}} \qquad\qquad s\bar{x} - \bar{x} = \frac{70.255}{\sqrt{17}}$$

$$S\bar{x} - \bar{x} = \frac{70.255}{4.123} \qquad\qquad S\bar{x} - \bar{x} = \underline{\hspace{0.3em}17.03\hspace{0.3em}}$$

$$t = \frac{\bar{X} - \bar{X}}{S\bar{x} - \bar{x}} \qquad\qquad t = \frac{322.94 - 308.25}{17.03}$$

$$t = \underline{\hspace{0.5em}.863\hspace{0.5em}}$$

t at .05 level = 2.19

df = n-1

df = 16

Significance of Difference: ___Not Significant at .05 Level___

Area of Comparison: Arm Strength (Bent Arm Hang)

Test # 1

Subjects	Group I	Group II	D	D^2
1	57	48	9	81
2	24	52	-28	784
3	27	30	-3	9
4	43	48	-5	25
5	33	40	-7	49
6	65	36	29	841
7	25	41	-16	256
8	51	41	10	100
9	61	44	17	189
10	56	26	30	900
11	57	24	33	1089
12	34	16	18	324
13	27	50	-23	529
14	49	60	-11	121
15	53	37	16	256
16	71	26	45	2025
17	42	36	6	36

$\Sigma X = 776$ $\Sigma X = 655$ $\Sigma D = 120$ $\Sigma D^2 = 7614$

$\bar{X} = 45.64$ $\bar{X} = 38.52$

The Significance of the Difference
between Means from Paired Observations

Test: Bent Arm Hang (Test #1)

$n =$ ___17___ $\sum D =$ ___120___ $\sum D^2 =$ ___7,614___

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2 =$ ___6,766.95___

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{6,766.95}{16}}$ $S_d =$ ___20.565___

$S_{\bar{x}-\bar{x}} = \dfrac{S_d}{\sqrt{n}}$ $S_{\bar{x}-\bar{x}} = \dfrac{20.565}{\sqrt{17}}$

$S_{\bar{x}-\bar{x}} = \dfrac{20.565}{4.123}$ $S_{\bar{x}-\bar{x}} =$ ___4.98___

$t = \dfrac{\bar{X}-\bar{X}}{S_{x-x}}$ $t = \dfrac{45.64 - 38.52}{4.98}$

$t =$ ___1.43___

t at .05 level =   2.19

df = n-1

df = 16

Significance of Difference: Not Significant at .05 Level

Area of Comparison: <u>Arm Strength (Bent Arm Hang)</u>

<u>Test # 2</u>

Subjects	Group I	Group II	D	D^2
1	53	55	-2	4
2	40	49	-9	81
3	25	45	-20	400
4	41	49	-8	64
5	32	54	-22	484
6	69	54	15	225
7	27	53	-26	676
8	43	45	-2	4
9	59	66	-7	49
10	58	46	12	144
11	31	18	13	169
12	58	36	22	484
13	39	59	-20	400
14	37	44	-7	49
15	53	23	30	900
16	61	31	30	900
17	44	53	-9	81
	$\Sigma X = 770$	$\Sigma X = 780$	$\Sigma D = -10$	$\Sigma D^2 = 5114$

$\bar{X} = 45.29$ $\bar{X} = 45.88$

The Significance of the Difference
between Means from Paired Observations

Test: Bent Arm Hang (Test #2)

n = _____17_____ ΣD = ___+10___ ΣD^2 = ___5,114___

$\Sigma d^2 = \Sigma D^2 - \dfrac{(\Sigma D)^2}{n}$ Σd^2 = ___5,108.12___

$S_d = \sqrt{\dfrac{\Sigma d^2}{n-1}}$ $S_d = \sqrt{\dfrac{5,108.12}{16}}$ S_d = ___17.867___

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{17.867}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{17.867}{4.123}$ $S\bar{x} - \bar{x}$ = ___4.33___

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{45.29 - 45.86}{4.33}$

t = ___.1306___

t at .05 level = 2.19

df = n-1

df = 16

Significance of Difference: ___Not Significant at .05 Level___

Area of Comparison: ___Arm Strength (Bent Arm Hang)___

___Test # 3___

Subjects	Group I	Group II	D	D^2
1	70	51	19	361
2	45	47	-2	4
3	42	49	-7	49
4	43	39	4	16
5	34	56	-22	484
6	60	36	24	576
7	26	44	18	324
8	41	44	-3	9
9	62	54	8	64
10	55	39	16	256
11	65	26	39	1521
12	48	17	31	961
13	50	51	-1	1
14	40	33	7	49
15	53	22	31	961
16	74	36	38	1384
17	50	39	11	121

$\Sigma X = 858$ $\Sigma X = 683$ $\Sigma D = 211$ $\Sigma D^2 = 7141$

$\bar{X} = 50.47$ $\bar{X} = 40.17$

The Significance of the Difference
between Means from Paired Observations

Test: Bent Arm Hang (Test #2)

$n = $ _____17_____ $\sum D = $ ___211___ $\sum D^2 = $ ___7,141___

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2 = $ ___4,522,12___

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{4,522,12}{16}}$ $S_d = $ ___16.81___

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{16.81}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{16.81}{4.123}$ $S\bar{x} - \bar{x} = $ ___4.07___

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{50.47 - 40.17}{4.07}$

$t = $ ___2.53___

t at .05 level =   2.19

df = n-1

df =   16

Significance of Difference: Significant beyond .05 level

Area of Comparison: __Arm Strength (Bar Dips)__

Test # 1

Subjects	Group I	Group II	D	D^2
1	10	10	0	0
2	10	10	0	0
3	4	8	-4	16
4	11	13	-2	4
5	1	6	-5	25
6	22	11	11	121
7	8	2	6	36
8	10	7	3	9
9	9	10	-1	1
10	9	5	4	16
11	15	7	8	64
12	7	1	6	36
13	7	7	0	0
14	14	10	4	16
15	10	7	3	9
16	13	4	9	81
17	11	15	-4	16

$\Sigma X = 171$ $\Sigma X = 133$ $\Sigma D = 38$ $\Sigma D^2 = 450$

$\bar{X} = 10.05$ $\bar{X} = 7.82$

The Significance of the Difference
between Means from Paired Observations

Test: Bar Dips (Test #1)

n = _____17_____ Σ D = ___38___ Σ D^2 = ___450___

$\Sigma d^2 = \Sigma D^2 - \dfrac{(\Sigma D)^2}{n}$ $\Sigma d^2 = $ ___365.06___

$S_d = \sqrt{\dfrac{\Sigma d^2}{n-1}}$ $S_d = \sqrt{\dfrac{365.06}{16}}$ $S_d = $ ___4.776___

$S_{\bar{x} - \bar{x}} = \dfrac{S_d}{\sqrt{n}}$ $S_{\bar{x} - \bar{x}} = \dfrac{4.776}{\sqrt{17}}$

$S_{\bar{x} - \bar{x}} = \dfrac{4.776}{4.123}$ $S_{\bar{x} - \bar{x}} = $ ___1.15___

$t = \dfrac{\bar{X} - \hat{X}}{S_{\bar{x} - x}}$ $t = \dfrac{10.05 - 7.82}{1.15}$

$t = $ _____1.85_____

t at .05 level = 2.19

df = n-1

df = 16

Significance of Difference: ___Not Significant at .05 level___

Area of Comparison: __Arm Strength (Bar Dips)__

__Test #2__

Subjects	Group I	Group II	D	D^2
1	13	12	1	1
2	7	14	-7	49
3	4	8	-4	16
4	10	15	-5	25
5	1	8	-7	49
6	27	12	15	225
7	9	7	2	4
8	12	7	5	25
9	6	11	-5	25
10	9	10	-1	1
11	15	13	2	4
12	6	1	5	25
13	8	10	-2	4
14	9	13	-4	14
15	11	13	-2	4
16	14	12	2	4
17	9	17	-8	64
	$\Sigma X = 170$	$\Sigma X = 183$	$\Sigma D = -13$	$\Sigma D^2 = 541$

$\bar{X} = 10$ 　　　　　　　　$\bar{X} = 10.76$

The Significance of the Difference
between Means from Paired Observations

Test: Bar Dips (Test #2)

$n =$ _____17_____ $\qquad$ $\Sigma D =$ _____11_____ $\qquad$ $\Sigma D^2 =$ _____561_____

$\Sigma d^2 = \Sigma D^2 - \dfrac{(\Sigma D)^2}{n}$ $\qquad\qquad$ $\Sigma d^2 =$ _____531.06_____

$S_d = \sqrt{\dfrac{\Sigma d^2}{n-1}}$ $\qquad\qquad$ $S_d = \sqrt{\dfrac{531.06}{16}}$ $\qquad$ $S_d =$ _____5.76_____

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $\qquad\qquad$ $s\bar{x} - \bar{x} = \dfrac{5.76}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{5.76}{4.123}$ $\qquad\qquad$ $S\bar{x} - \bar{x} =$ _____1.39_____

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $\qquad\qquad$ $t = \dfrac{10 - 10.76}{1.39}$

$t =$ _____.547_____

t at .05 level = 2.19

df = n-1

df = 16

Significance of Difference: Not Significant at .05 Level _____

Area of Comparison: ___Arm Strength (Bar Dips)___

___Test #2___

Subjects	Group I	Group II	D	D^2
1	13	14	-1	1
2	12	17	-5	25
3	5	9	-4	16
4	13	19	-6	36
5	2	8	-6	36
6	25	13	12	144
7	8	9	-1	1
8	16	9	7	49
9	11	12	-1	1
10	14	11	3	9
11	22	13	9	81
12	5	3	2	4
13	5	9	-4	16
14	17	12	5	25
15	11	8	3	9
16	21	14	7	49
17	12	17	-5	25

$\Sigma X = 212$ $\Sigma X = 197$ $\Sigma D = 15$ $\Sigma D^2 = 527$

$\bar{X} = 12.47$ $\bar{X} = 11.58$

The Significance of the Difference
between Means from Paired Observations

Test: Bar Dips (Test #3)

$n = \underline{\hspace{1cm} 17 \hspace{1cm}}$ $\sum D = \underline{\hspace{1cm} 16 \hspace{1cm}}$ $\sum D^2 = \underline{\hspace{1cm} 527 \hspace{1cm}}$

$\sum d^2 = \sum D^2 - \dfrac{(\sum D)^2}{n}$ $\sum d^2 = \underline{\hspace{1cm} 513.77 \hspace{1cm}}$

$S_d = \sqrt{\dfrac{\sum d^2}{n-1}}$ $S_d = \sqrt{\dfrac{513.77}{16}}$ $S_d = \underline{\hspace{1cm} 5.667 \hspace{1cm}}$

$S\bar{x} - \bar{x} = \dfrac{S_d}{\sqrt{n}}$ $s\bar{x} - \bar{x} = \dfrac{5.667}{\sqrt{17}}$

$S\bar{x} - \bar{x} = \dfrac{5.667}{4.123}$ $S\bar{x} - \bar{x} = \underline{\hspace{1cm} 1.35 \hspace{1cm}}$

$t = \dfrac{\bar{X} - \bar{X}}{Sx - x}$ $t = \dfrac{12.47 - 11.58}{1.35}$

$t = \underline{\hspace{1cm} 1.37 \hspace{1cm}}$

t at .05 level = $\quad$ 2.19

df = n-1

df = 16

Significance of Difference: $\underline{\hspace{0.5cm}}$ Not Significant at .05 Level $\underline{\hspace{1cm}}$