8-1-1967

A Comparison of the Effects of Weight Control and Reduction of High School Wrestlers on Selected Measurements of Strength

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A COMPARISON OF THE EFFECTS OF WEIGHT CONTROL

AND REDUCTION OF HIGH SCHOOL WRESTLERS

ON SELECTED MEASUREMENTS OF STRENGTH

by

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B. S. in Physical Education

Dickinson State College

1963

A Thesis

Submitted to the Faculty

of the

Graduate School

of the

University of North Dakota

in partial fulfillment of the requirements

for the Degree of

Master of Science

Grand Forks, North Dakota

August
1967

This thesis, submitted by John R. Oxton 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 has been done.

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ACKNOWLEDGEMENTS

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ABSTRACT

The purpose of this study was to determine the changes, if any, of selected strength factors of typical North Dakota high school wrestlers, as these might be affected by programs of weight reduction or weight control.

Right grip, left grip, push, pull, leg and back strength data of the subjects were recorded using a dynamometer. The subjects were tested five times during and after the season.

Inter-group and intra-group comparisons of results were made between the control group consisting of seven high school wrestlers and the experimental group of seven high school wrestlers who experienced a weight loss of more than 3 per cent.

A comparison of mean differences found no significance for five of the areas tested. Push strength experienced a significant difference in favor of the experimental group in between group comparisons of Test 1 to Test 5, Test 2 to Test 3, Test 2 to Test 4.

The average weight loss for the experimental group from Test 1 to Test 2 was 4.6 per cent of normal body weight taken at the time of pre-season weigh-in. The average weight gain for all wrestlers from Test 2 to Test 5 was 7.4 per cent of the post season weight.

CHAPTER I

INTRODUCTION

North Dakota, not unlike other states, has experienced many growing pains in the sport of wrestling. With the completion of the first decade of wrestling and the development of keen competition, the problem of weight control and weight reduction has become critical.

Although many research studies on the college level have indicated that weight losses within certain limits appear to have no harmful effect, the same type of weight control at the high school level has had little study.

Weight reduction, as practiced by wrestlers, is a temporary weight loss brought about by means of dehydration, withholding of food, and strenuous exercise. Weight control, as defined in this study, is the maintaining of a certified weight throughout the wrestling season in an attempt to compete at a certain weight classification. Whether present methods of weight control or weight reduction, as practiced by high school wrestlers, are harmful to the growing adolescent remains questionable.

Concern about the problems of weight control and weight reduction at the high school level and their effects

on the growing adolescent led to this study. It is the belief
of this writer that weight reduction beyond certain limits
and the continued weight control over long periods of time
decrease the normal strength patterns which are so important
in high school wrestling. This study, through the use of
selected strength measurements, sought to appraise the
effects of weight reduction and weight control on the strength
of the high school wrestler.

If the strength factors concerned with wrestling are
significantly affected by weight control or weight loss, it
would appear that over emphasis on this particular aspect
of high school wrestling might be realized.

Statement of the Problem

The purpose of this study was to determine the
changes, if any, with respect to selected strength factors
of typical North Dakota high school wrestlers, as these
might be affected by programs of weight reduction or weight
control.

Right and left grip strength, arm and shoulder strength
and leg and back strength were tested at the beginning
of the season, on certification date, mid-season, end of
season, and six weeks after the season. By comparing the
various strength test results with the amount of weight
gained or lost during the same testing periods, the writer
hoped to find an optimal weight plan which would not be
harmful to the growing youngster and yet place him at his

most desirable weight classification.

An attempt was also made to prove that the typical high school wrestler competing during the 1966-67 wrestling season in North Dakota did lose more than the recommended 10 per cent of normal body weight.

Need for the Study

High school wrestling in the state of North Dakota has made great advances in the past few years. As is the case with anything new, many problems have arisen. Parents, administrators, students, and even coaches themselves have criticized the practices of weight reduction and weight control that have developed along with this fast growing sport.

Many problems stem from the lack of understanding of weight problems. Safe limits of weight control actually do exist although many times parents or others involved are not aware of their presence.

As a coach, this writer hoped to develop a better understanding of the problem and to attempt a solution that would aid in the promotion of high school wrestling in North Dakota.

Limitations of the Study

This study was limited to the members of the 1966-67 Mandan High School wrestling team. The physical factors of body strength in relationship to weight gained or lost were the only aspects considered. Interpretations were confined

to the data collected through the various tests administered.

Definitions of Terms

Actual weight loss: Number of pounds that a wrestler lost from his normal weight.

Certified weight: A wrestler's official weight as recorded at the time of the state weigh-in.

Initial weigh-in: The first weigh-in of the season which was conducted on the 23rd of November on the school's certified scale.

Normal weight: The weight of the individual in good physical condition at the first weigh-in or throughout the season if he does not experience weight loss.

Official weigh-in: Another term for the state weigh-in and the one that has been used throughout this study.

Reclassification: The moving of a wrestler from his certified weight upward one or more weight classes.

Weight control: Maintaining a weight classification throughout a season.

Weight division: The weight at which the wrestler actually competes. In North Dakota there are twelve weight divisions starting with the ninety-five pound class and continuing upward through the heavy-weight division.

Weight reduction: The temporary weight loss brought about by means of dehydration, withholding of food, and strenuous exercise.

Weight reduction chart: A chart prepared for this study in which the per cent of weight loss from normal body weight has been calculated.

Review of Related Literature

The problem of weight reduction and weight control has become critical. However, very little literature exists today on the proper methods of weight control for the growing high school wrestler. Strength, and its relationship to athletics, has been critically analyzed during the past decade. Weight reduction on the college level has also been critically studied and results published.

The purpose of this study was to determine whether strength, be it important to wrestling or not, was affected by weight reduction or weight control. If an optimum weight exists beyond which the loss of weight in regard to body strength is of little value, then a just cause for this research seems evident.

Dr. F. W. Reichardt, [1]Wisconsin Interscholastic Athletic Association's Medical Advisor, wrote the following concerning weight reduction:

> "Weight reduction is definitely an intricate part of successful athletic training and probably should be better stressed at all levels of competition. In other words, there seems to be an optimum weight for all individuals considering their height and body build and the character of competition that they participate in. Any boy

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[1]Dr. F. W. Reichardt, Excerpt From a Letter Concerning Weight Reduction, Wisconsin Interscholastic Athletic Association.

or man competing in athletics either in an underweight or overweight situation is at a disadvantage."

Dr. Reichardt discussed the "crash diet," noting that it is not medically sound or competitively right. Loss of body fluid, drying out of the body tissues and disruption of body balance are not desirable. In closing Dr. Reichardt listed several considerations for weight control:

1. Gradual loss of weight with regard to body balance and nutrition and, with an optimum body weight as a goal, is not harmful.

2. Rapid weight loss is not good.

3. Each individual varies in the amount of body weight he can lose. Ten per cent of what could be considered normal body weight is not harmful.

Bedard,[2] in surveying the percentage of weight loss of selected North Dakota high school wrestlers during the 1966-67 season found that at least one out of every ten of the subjects in the study exceeded the ten per cent recommended maximum amount of weight loss. He also noted that the mean percentage of weight loss from normal body weight of high school wrestlers involved in the survey during the 1966-67 wrestling season was 5.91 per cent of body weight.

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[2]Emil R. Bedard, "A Survey of Percentage of Weight Loss in the Weight Classes and Chronological Age Groups of Selected North Dakota High School Wrestlers," (unpublished Master's Thesis, Department of Physical Education, University of North Dakota, 1967).

Weight Loss and Strength

Hassman,[3] in his study of physical change after a six week cessation of practice in varsity wrestlers found that there was a significant increase in elbow flexor strength. He also found a significant change in body weight but became concerned when no change in arm girth occurred. Although Hassman's study was rather vague as to the actual weight of the wrestler at the time of the first test, it was assumed that he was still in competition and therefore probably quite close to his wrestling weight. His study also showed that there was a correlation between body weight and elbow flexor strength in both initial and final tests. However, the correlation between increase in body weight and elbow flexor strength was not significant. On the basis of these findings, he concluded that an increase in body weight was not a factor in the increase of elbow flexor strength.

A doctoral study was conducted by Harold Nichols,[4] Ph.D., currently head wrestling coach at the University of Iowa. Through his study it was shown that a collegiate

[3]Ralph P. Hassman, "Changes in the Physical Status of Varsity and Freshman Wrestlers at the University of Oregon Following a Six Week Cessation of Organized Team Practices and Competition." Thesis (Ed.D.) University of Oregon (1961).

[4]Harold Nichols, "Weight Reduction in College Wrestlers" (unpublished Ph.D dissertation, Dept. of Physical Education, University of Iowa), p. 37, cited by Bedard, loc. cit.

wrestler may safely reduce his weight rapidly up to 10 per cent of his body weight without adversely affecting his physiological responses. It was concluded that weight loss, within the limits of the study, did not materially affect the wrestler's strength, his reaction time, his ability to maintain balance while in motion, his endurance, or his ability to develop power.

The effect of rapid weight reduction on endurance was studied by Schuster.[5] Wrestlers losing up to ten pounds in a seven day period were compared to a control group not losing weight. Rapid weight loss was found to have no significant effect on the difference in performance of the subjects or their wrestling ability.

Johnson,[6] in a study of selected strength test results as related to weight change in high school varsity wrestlers, found that significant unit strength increases were evident for each muscle group tested during the competitive season. He stated that:

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[5]Abraham Z. Schuster, "The Effects of Rapid Weight Reduction on the Endurance Performance of Wrestlers" (unpublished Master's dissertation, Pennsylvania State University, 1954), cited by Philip J. Rasch and Walter Kroll, What Research Tells the Coach About Wrestling, (Washington, D.C.: American Association for Health, Physical Education and Recreation, 1964), pp. 42-43.

[6]Clayton A. Johnson, "An Investigation of Selected Strength Test Results as Related to Weight Changes in High School Varsity Wrestlers," (unpublished Master's Thesis, Department of Physical Education, University of North Dakota, 1966).

"A high school wrestler can increase strength pound for pound when allowed to maintain actual normal weight, or if allowed to gain moderately within limits imposed by Minnesota High School regulations."

Polo[7] studied the strength changes of eleven members of the 1964 Montana State University wrestling team by means of a cable tensiometer. Eight muscle groups were tested five times during and after the season. Significant changes occurred in each of the eight muscle groups at some time during the competitive season. He also found that there was a general decrease in strength throughout the first eight weeks of the season but that all muscle groups showed a significant increase in strength six weeks after the season.

Morrison,[8] in a study of the effect of pre-season conditioning on selected strength factors of collegiate wrestlers at the University of North Dakota, found that the mean scores of the post season test in leg strength and back strength were higher than the mean scores of the pre-season tests. However, arm strength showed an increase one month after pre-season conditioning and then declined for the remainder of the season. The post season mean

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[7] John Francis Polo, Jr., "Strength Changes of Collegiate Wrestlers During and Following Their Competitive Season" (unpublished Master's dissertation, Montana State University, 1964).

[8] Percy R. Morrison, "A Comparison of the Changes Observed in Relation to Various Forms of Conditioning on Wrestlers and Non-Wrestlers at Various Intervals," (unpublished Master's Thesis, Department of Physical Education, University of North Dakota, 1966).

score was lower than the pre-season mean score in arm

strength. Although leg strength test scores were low at

mid-season, a gradual increase in leg strength was noted

until six weeks after the season when the highest mean

score was recorded. The reverse appeared in regard to back

strength where peak strength was reached at mid-season.

Strength Tests

Are muscular strength tests valid means of classifying

wrestlers?

Larson and Yocum[9] in evaluating measurements stated

that:

> "In those instances where successful peformance
> is in proportion to the amount of muscular strength,
> then muscular strength tests are valid means of
> classification for that activity (i.e., wrestling)."

However, Gross,[10] in studying motor educability,

found that a strength test was of little value in predicting

individual learning ability in wrestling.

Kroll,[11] in studying selected factors associated

with wrestling success, found strength and response time to

be of no value in predicting success in wrestling.

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[9]Leonard Larson and Rachel Yocum, Measurement and
Evaluation in Physical Education, Health, and Recreation
(St. Louis) C. V. Mosby Co., 1951.

[10]Elmer Gross, Donald Griesel and Alan Stull,
"Relationship Between Two Motor Educability Tests, A Strength
Test and Wrestling Ability After Eight Weeks Instruction."
Research Quarterly, 27 (Dec. 1956).

[11]Walter Kroll, "Selected Factors Associated With
Wrestling Success, "Research Quarterly, 29 (Dec. 1958).

Kroll[12] had also noted in a previous study that wrestlers were low in fat measurements, below average in right and left grip strength, average in leg lift strength and above average in back strength. Kroll used Big Ten Varsity wrestlers as his sample group. Strength tests were administered immediately after weigh-in for a varsity meet.

In summary of the literature reviewed, it was found that most of the studies conducted were of collegiate wrestlers and that little study had been made of weight reduction or weight control in high school wrestling.

Those studies conducted on the high school level have found that excessive weight loss is a typical coaching problem. North Dakota wrestlers are no exception.

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[12]Walter Kroll, "An Anthropometrical Study of Some Big Ten Wrestlers, "Research Quarterly, 25 (Oct. 1954).

CHAPTER II

METHODOLOGY

The writer, as former coach of the Mandan High School Wrestling Team, used his knowledge of weight reduction and weight control to study the effects of each on body strength as associated with wrestling. In carrying out the experiment, the writer employed the method of controlled observation as used in experimental design.

Description of Data:

The subjects used in the following study were members of the varsity wrestling team at Mandan High School, Mandan, North Dakota. They were selected on the basis of their active participation in the varsity wrestling program throughout the 1966-1967 wrestling season.

Number Tested: Twenty wrestlers who participated during the 1966-1967 wrestling season were tested. Upon completion of the five test periods, the wrestlers who were unable to take one or more of the scheduled tests because of injury or illness were eliminated. The final group of fourteen then provided the statistical information for this study.

Age: The ages of the wrestlers varied from fourteen years of age to seventeen years of age. In Mandan High School only tenth, eleventh and twelfth grade students are permitted to

participate in varsity athletics.

Weight: Weight classification was based on the weight classes used in North Dakota high school competition. These classes include the 95, 103, 112, 120, 127, 133, 138, 145, 154, 165, 180, and heavyweight divisions. Individual wrestling weights were recorded on the record card kept for each of the wrestlers during the testing period.

Height: Height was also recorded for each of the participants with the range being recorded.

Test Groups:

Upon completion of the testing, the wrestlers were divided into one of the following two groups.

Group I - This group was composed of subjects that wrestled in weight divisions in which was experienced less than a 3 per cent weight loss from normal weight.

Group II - This group was composed of subjects that wrestled in weight divisions in which was experienced more than a 3 per cent weight loss from normal weight.

As a convenience factor, Group I has been referred to as the control group and Group II as the experimental group for the remainder of the study. Also, it is important to note that, while the 3 per cent level of weight loss was chosen arbitrarily, the result was two groups with seven wrestlers in each group.

The following examples will help to illustrate the procedure that was followed in classifying the wrestlers according to their particular groupings.

Wrestler C weighed in at the initial weigh-in on November 23rd at 130 pounds. This was his normal body weight after one month of conditioning. He then decided that for the official weigh-in on December 16th, he would wrestle at the 120 pound weight division. Upon weighing-in on December 16th it was found that he had lost ten pounds. It was then possible to compare the loss with the per cent of loss calculated on the Weight Reduction Chart and find that he had lost more than 3 per cent of his normal body weight. This would then classify him as a member of Group II, the experimental group. His actual weight loss was 7.7 per cent of his normal body weight.

Wrestler J weighed-in at the first weigh-in on November 23rd at 165 pounds. He then decided to wrestle at the 165 pound weight division and certified his weight at 163 pounds on December 16th. It was then possible to look at the Weight Reduction Chart and find that he had lost less than 3 per cent of his normal body weight (actually 1.2 per cent) and therefore would be placed in Group I, or the control group.

Measuring Strength:

Immediately following weigh-in the wrestlers were given selected strength tests as follows:

Right and left grip strengths were measured in the following manner. Taking the hand dynamometer, with the right hand and the indicator toward the palm, the student was told to grip as vigorously as possible without the aid of any supporting object. The pounds of grip strength were

then recorded. The same procedure was followed with the left hand. Two trials were given and recorded with the average for the two trials calculated for future use.

Back strength was measured by a leg-back dynamometer. The student was placed on the platform directly above the dynamometer with hands at the front of the thighs. The tester then hooked the handle into the chain so that the top of the bar was just below the student's fingers. The student bent the trunk forward at the hips with one palm pronated and the other supinated. He then steadily lifted without jerking, releasing slowly after what was thought to have been maximum lift. The number of pounds of back lift were then recorded. After a brief rest the student was tested again. The second test score was recorded and the average calculated.

Leg strength was measured by use of the same dynamometer as described above. The student was placed in the same position as when starting the back lift. The bar was placed in the angle created by the thighs and the trunk. The bar was adjusted so that the angle of the knees was as near to 120 degrees as possible. The number of pounds of leg lift was then recorded. The student was instructed to lift by straightening the legs only. A second trial was given after a brief rest and the score recorded. The average leg lift for the two tests was then calculated.

Arm and shoulder strength were measured by the push-pull strength indicated on the hand dynamometer. The hand

dynamometer was placed between the jaws of the push-and-pull attachment. With the palms of the hands facing each other and at the height of the chest, the subject was instructed to grasp the handles and to push as vigorously as possible. Pounds of push strength were then recorded. After a brief pause, a second trial was given and the score recorded. The average for the two trials was then calculated.

The positions for pulling strength were the same as for pushing. The subject was instructed to pull on the handles as vigorously as possible. The number of pounds of pull were then recorded. A second trial was given after a brief pause, the score recorded, and the average of the two trials calculated.

All scores were recorded on each wrestler's record card. After the administration of the strength tests on the fifth and final test on March 30th, the results were tabulated for future study.

Statistical Procedure:

In analyzing the differences between the pre-season test (Test 1), the season tests (Test 2, Test 3, and Test 4), and the post-season test (Test 5) the writer assumed the null hypothesis. The null hypothesis states that the mean scores are not different and any difference found would be a result of chance and be unimportant.

The "t" technique for testing the significance of the difference between means derived from uncorrelated groups from

small samples was used in the treatment of data of this study. The ration between the mean difference and the estimate of sampling error of the mean difference is determined by the specific test employed. The ratio was checked for significance in a "t" table with the value of "t" proportional to the degree of freedom (N-1) allowed to determine the relationship between the mean difference and estimate of sampling error of the mean difference. This investigator decided to retain the null hypothesis at the .05 level of significance.[1]

All data are presented in Appendix B, page 52, including raw scores, mean differences and steps of the mathematical process employed in the analysis of each area tested.

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[1]Quinn McNemar, Psychological Statistics, (New York: John Wiley and Sons, Inc., 1949), 225.

CHAPTER III

ANALYSIS OF DATA

Introduction

This study was undertaken to determine the effects of weight reduction and weight control on wrestling strength among selected North Dakota high school wrestlers. The subjects were members of the 1966-1967 Mandan High School wrestling team. They were divided into two groups on the basis of the amount of weight lost from normal body weight. The control group was composed of any wrestler losing less than 3 per cent of normal body weight. The experimental group was composed of any wrestler losing more than 3 per cent of normal body weight.

The data collected and compiled in this study were analyzed in this chapter. The analysis was divided into six separate areas: right grip strength, left grip strength, push strength, pull strength, leg strength and back strength. Analysis of the data statistically to determine the significance of the differences between the means of the two groups was the next step in this study.

Test Results

Table 1, page 19, shows the data computed on the right grip strength for the pre-season test results (Test 1) and

retest scores at official weigh-in (Test 2), mid-season test (Test 3), end of season test (Test 4), and the post season test (Test 5). Mean differences, estimates of sampling error of mean differences and the significance of "t" at .05 level were also included for the other group comparisons of the control and experimental groups. Mean differences between the experimental group and the control group and "t" with 12 degrees of freedom were computed.

TABLE 1

RIGHT GRIP STRENGTH

Group	Test	Retest	$S_{\overline{D}}$	$\overline{D}$	"t" value
Comparison of mean scores (T_1-T_2) With-in groups					
Control	100.429	97.286	2.35	-3.143	- 1.337 Not Sig.
Experi- mental	100.571	93.286	4.702	-7.286	- 1.549 Not Sig.
Significance of the difference between means (T_1-T_2) of uncorrelated groups					-.788 Not Sig.
Comparison of mean scores (T_1-T_5) With-in groups					
Control	100.429	107.571	4.121	7.142	1.733 Not Sig.
Experi- mental	100.751	105.0	4.087	4.429	1.084 Not Sig.
Significance of the difference between means (T_1-T_5) of uncorrelated groups					-.468 Not Sig.

TABLE 1

RIGHT GRIP STRENGTH CONTINUED

Group	Test	Retest	$S_{\overline{D}}$	$\overline{D}$	"t" value
Comparison of mean scores (T_2-T_3) With-in groups					
Control	97.286	102.571	3.491	5.286	1.514 Not Sig.
Experi- mental	93.286	96.571	3.075	3.286	1.069 Not Sig.
Significance of the difference between means (T_2-T_3) of uncorrelated groups					- .430 Not Sig.
Comparison of mean scores (T_2-T_4) With-in groups					
Control	97.286	102.714	4.09	5.429	1.327 Not Sig.
Experi- mental	93.286	94.143	2.90	.857	.296 Not Sig.
Significance of the difference between means (T_2-T_4) of uncorrelated groups					.912 Not Sig.
Comparison of mean scores (T_2-T_5) With-in groups					
Control	97.286	107.571	3.566	10.286	2.884 Significant
Experi- mental	93.286	105.0	3.558	11.714	3.292 Significant
Significance of the difference between means (T_2-T_5) of uncorrelated groups					.283 Not Sig.

The mean difference of the control group in right grip strength between Test 2 and Test 5 was an increase of 10.286 pounds. The "t" value of 2.884 with 6 degrees of freedom was significant at .05 level.

The mean difference of the experimental group in right grip strength between Test 2 and Test 5 was an increase of 11.714 pounds. The "t" value of 3.292 with 6 degrees of freedom was significant at .05 level.

The between group comparisons of mean differences of right grip strength for all tests administered showed no significance at .05 level with 12 degrees of freedom.

Table 2, page 22, shows the data computed on left grip strength for the pre-season test results (Test 1) of the control and experimental groups and retest scores of official weigh-in test (Test 2), mid-season test (Test 3), end of season test (Test 4), and the post season test (Test 5). Mean differences, estimates of sampling error of mean differences and the significance of "t" at .05 level are also included for the with-in-group comparisons of the control and experimental groups. Mean differences between the experimental group and the control group and "t" with 12 degrees of freedom were computed.

TABLE 2

LEFT GRIP STRENGTH

Group	Test	Retest	$S_{\bar{D}}$	$\bar{D}$	"t" value
Comparison of mean scores (T_1-T_2) With-in groups					
Control	98.286	100.286	4.343	2.0	.46 Not Sig.
Experimental	99.429	95.143	3.098	-4.71	-1.52 Not Sig.
Significance of the difference between means (T_1-T_2) of uncorrelated groups					-1.259 Not Sig.
Comparison of mean scores (T_1-T_5) With-in groups					
Control	98.286	108.714	4.177	10.429	2.497 Significant
Experimental	99.429	102.571	3.638	3.143	.864 Not Sig.
Significance of the difference between means (T_1-T_5) of uncorrelated groups					-1.315 Not Sig.
Comparison of mean scores (T_2-T_3) With-in groups					
Control	100.280	102.571	2.351	2.286	.972 Not Sig.
Experimental	95.280	97.429	3.777	2.143	.567 Not Sig.
Significance of the difference between means (T_2-T_3) of uncorrelated groups					-.032 Not Sig.

TABLE 2

LEFT GRIP STRENGTH CONTINUED

Group	Test	Retest	$S_{\overline{D}}$	$\overline{D}$	"t" value
Comparison of mean scores (T_2-T_4) With-in groups					
Control	100.286	109.286	4.34	9.0	2.074 Not Sig.
Experi- mental	95.286	94.714	2.728	-.571	-.209 Not Sig.
Significance of the difference between means (T_2-T_4) of uncorrelated groups					-1.869 Not Sig.
Comparison of mean scores (T_2-T_5) With-in groups					
Control	100.286	108.714	3.981	8.429	2.117 Not Sig.
Experi- mental	95.286	102.571	3.177	7.286	2.293 Not Sig.
Significance of the difference between means (T_2-T_5) of uncorrelated groups					-.225 Not Sig.

The mean differences of the control group in left grip strength between Test 1 and Test 5 was an increase of 10.429 pounds. The "t" value of 2.497 with 6 degrees of freedom was significant at .05 level.

The mean differences of the experimental group in left grip strength between the initial tests and the retests showed no significance at .05 level.

The between group comparisons of mean differences of left grip strength for all tests administered showed no significance at .05 level with 12 degrees of freedom.

Table 3, page 24, shows the data computed on push strength for the pre-season test results (Test 1), of the control and experimental groups and retest scores of official weigh-in test (Test 2), mid-season test (Test 3), end-of season test (Test 4), and the post season test (Test 5). Mean differences, estimates of sampling error of mean differences and the significance of "t" at .05 level are also included for the with-in group comparisons of the control and experimental groups. Mean differences between the experimental group and the control group and "t" with 12 degrees of freedom were computed.

TABLE 3

PUSH STRENGTH

Group	Test	Retest	$S_{\overline{D}}$	$\overline{D}$	"t" value
Comparison of mean scores (T_1-T_2) With-in groups					
Control	140.714	154.143	12.457	13.429	1.078 Not Sig.
Experi- mental	129.143	137.143	6.34	8.0	1.262 Not Sig.
Significance of the difference between means (T_1-T_2) of uncorrelated groups					-.388
Comparison of mean scores (T_1-T_5) With-in groups					
Control	140.714	139.714	7.789	-1.0	-.128 Not Sig.
Experi- mental	139.143	163.429	7.826	34.286	4.381 Significant
Significance of the difference between means (T_1-T_5) of uncorrelated groups					3.196 Significant

TABLE 3

PUSH STRENGTH CONTINUED

Group	Test	Retest	$S_{\overline{D}}$	$D_{\overline{D}}$	"t" value
Comparison of mean scores (T_2-T_3) With-in groups					
Control	154.143	140.571	4.026	-13.571	-3.371 Significant
Experi- mental	137.143	148.571	6.932	11.429	1.649 Not Sig.
Significance of the difference between means (T_2-T_3) of uncorrelated groups					3.117 Significant
Comparison of mean scores (T_2-T_4) With-in groups					
Control	154.143	135.286	5.891	-18.857	-3.201 Significant
Experi- mental	137.143	136.714	5.898	-.429	-.073 Not Sig.
Significance of the difference between means (T_2-T_4) of uncorrelated groups					2.210 Significant
Comparison of mean scores (T_2-T_5) With-in groups					
Control	154.143	139.714	7.808	-14.429	-1.848 Not Sig.
Experi- mental	137.143	163.429	8.291	-26.286	-3.17 Significant
Significance of the difference between means (T_2-T_5) of uncorrelated groups					-1.041 Not Sig.

The mean difference of the control group in push strength between Test 2 and Test 3 was a decrease of 13.571 pounds. The "t" value of 3.371 with 6 degrees of freedom was significant at .05 level.

The mean difference of the control group in push strength between Test 2 and Test 4 was a decrease of 18.857 pounds. The "t" value of 3.201 with 6 degrees of freedom was significant at .05 level.

The mean differences of the experimental group in push strength between Test 1 and Test 5 was an increase of 34.286 pounds. The "t" value of 4.381 with 6 degrees of freedom was significant at .05 level.

The mean difference of the experimental group in push strength between Test 2 and Test 5 was an increase of 26.286 pounds. The "t" value of 3.17 with 6 degrees of freedom was significant at .05 level.

The between group comparisons of mean differences of push strength for Test 1 to Test 5 showed a "t" value of 3.196 which was significant for the experimental group at .05 level with 12 degrees of freedom.

The between group comparisons of mean differences of push strength for Test 2 to Test 3 showed a "t" value of 3.117 which was significant for the experimental group at .05 level with 12 degrees of freedom.

The between group comparisons of mean differences of push strength for Test 2 to Test 4 showed a "t" value of 2.210 which was significant for the experimental group with 12 degrees of freedom.

After the official weigh-in (Test 2), it was noted that the control group had experienced a gain in push strength from the pre-season weigh-in. However, through the remainder

of the season the control group experienced a loss in push strength. Push strength returned to normal after five weeks cessation of wrestling, Test 1 - Test 5.

The experimental group experienced several strength gains from the pre-season test to the post season test. The first gain occurred between Test 1 and Test 2, the second between Test 2 and Test 3, and the third between Test 4 and Test 5.

Table 4, page 28, shows the data computed on pull strength for the pre-season test results (Test 1) of the control and experimental groups and retest scores of official weigh-in test (Test 2), mid-season test (Test 3), end-of-season test (Test 4), and the post season test (Test 5). Mean differences, estimates of sampling error of mean differences, and the significance of "t" at .05 level are also included for the with-in group comparisons of the control groups and experimental groups. Mean differences between the experimental group and the control group and "t" with 12 degrees of freedom were computed.

TABLE 4

PULL STRENGTH

Group	Test	Retest	$S_{\bar{D}}$	$\bar{D}$	"t" value
Comparison of mean scores (T_1-T_2) With-in groups					
Control	134.429	133.857	3.358	-.571	-.17 Not Sig.
Experimental	139.143	134.0	3.675	-5.143	-1.399 Not Sig.
Significance of the difference between means (T_1-T_2) of uncorrelated groups					-.918 Not Sig.
Comparison of mean scores (T_1-T_5) With-in groups					
Control	134.429	145.0	9.008	10.571	1.174 Not Sig.
Experimental	139.143	147.857	6.558	8.714	1.329 Not Sig.
Significance of the difference between means (T_1-T_5) of uncorrelated groups					.167 Not Sig.
Comparison of mean scores (T_2-T_3) With-in groups					
Control	133.857	139.0	5.075	5.143	1.013 Not Sig.
Experimental	134.0	144.286	2.747	10.286	3.744 Significant
Significance of the difference between means (T_2-T_3) of uncorrelated groups					.891 Not Sig.

TABLE 4

PULL STRENGTH CONTINUED

Group	Test	Retest	$S_{\overline{D}}$	$\overline{D}$	"t" value
Comparison of mean scores (T_2-T_4) With-in groups					
Control	133.857	143.143	4.049	9.286	2.293 Not Sig.
Experimental	134.0	136.143	5.834	2.143	.367 Not Sig.
Significance of the difference between means (T_2-T_4) of uncorrelated groups					-1.006 Not Sig.
Comparison of mean scores (T_2-T_5) With-in groups					
Control	133.857	145.0	8.66	11.143	1.287 Not Sig.
Experimental	134.0	147.857	5.389	13.857	2.571 Significant
Significance of the difference between means (T_2-T_5) of uncorrelated groups					.266 Not Sig.

The mean difference of the control group in pull strength between the initial tests and all retests showed no significance at .05 level.

The mean difference of the experimental group in pull strength between Test 2 and Test 3 was an increase of 10.286 pounds. The "t" value of 3.744 with 6 degrees of freedom was significant at .05 level.

The mean difference of the experimental group in pull strength between Test 2 and Test 5 was an increase of 13.857 pounds. The "t" value of 2.571 with 6 degrees of freedom was

significant at .05 level.

The between group comparisons of mean difference of pull strength for all tests administered showed no significance at .05 level with 12 degrees of freedom.

Table 5, page 30, shows the data computed on leg strength for the pre-season test results (Test 1) of the control and experimental groups and retest scores of the official weigh-in test (Test 2), mid-season test (Test 3), end-of-season test (Test 4), and the post season test (Test 5). Mean differences, estimates of sampling error of mean differences and the significance of "t" at .05 level are also included for the with-in group comparisons of the control and experimental groups. Mean differences between the experimental group and the control group and "t" with 12 degrees of freedom were computed.

TABLE 5

LEG STRENGTH

Group	Test	Retest	$S_{\overline{D}}$	$\overline{D}$	"t" value
Comparison of mean scores (T_1-T_2) With-in groups					
Control	368.571	348.929	18.887	-19.643	-1.04 Not Sig.
Experi-mental	470.714	383.929	48.143	-86.786	-1.803 Not Sig.
Significance of the difference between means (T_1-T_2) of uncorrelated groups					-1.299 Not Sig.

TABLE 5

LEG STRENGTH CONTINUED

Group	Test	Retest	$S_{\overline{D}}$	$\overline{D}$	"t" value
Comparison of mean scores (T_1-T_5) With-in groups					
Control	368.571	388.571	28.358	20.0	.705 Not Sig.
Experi- mental	470.714	432.857	34.29	-37.857	-1.104 Not Sig.
Significance of the difference between means (T_1-T_5) of uncorrelated groups					-1.30 Not Sig.
Comparison of mean scores (T_2-T_3) With-in groups					
Control	348.929	378.571	14.426	29.643	2.055 Not Sig.
Experi- mental	383.929	360.714	22.706	-23.214	-1.022 Not Sig.
Significance of the difference between means (T_2-T_3) of uncorrelated groups					-1.965 Not Sig.
Comparison of mean scores (T_2-T_4) With-in groups					
Control	348.929	356.429	16.909	7.50	.444 Not Sig.
Experi- mental	383.929	369.643	17.589	-14.286	-.812 Not Sig.
Significance of the difference between means (T_2-T_4) of uncorrelated groups					-.893 Not Sig.

TABLE 5

LEG STRENGTH CONTINUED

Group	Test	Retest	$S_{\overline{D}}$	$\overline{D}$	"t" value
Comparison of mean scores (T_2-T_5) With-in groups					
Control	348.929	388.571	14.226	39.643	2.787 Significant
Experi- mental	383.929	412.143	36.283	28.214	.778 Not Sig.
Significance of the difference between means (T_2-T_5) of uncorrelated groups					.293 Not Sig.

The mean differences of the control group in leg strength between Test 2 and Test 5 was an increase of 39.643 pounds. The "t" value of 2.787 with 6 degrees of freedom was significant at .05 level.

The mean differences of the experimental group in leg strength between the initial tests and the retests showed no significance at .05 level with 6 degrees of freedom.

The between group comparisons of mean differences of leg strength for all tests administered showed no significance at .05 level with 12 degrees of freedom.

Table 6, page 33, shows the data computed on back strength for the pre-season test results (Test 1) of the control and experimental groups and retest scores of official weigh-in test (Test 2), mid-season test (Test 3), end-of-season test (Test 4), and the post season test (Test 5).

Mean differences, estimates of sampling error of mean differences and the significance of "t" at .05 level are also included for the with-in group comparisons of the control and experimental groups. Mean differences between the experimental group and the control group and "t" with 12 degrees of freedom were computed.

TABLE 6

BACK STRENGTH

Group	Test	Retest	$S_{\overline{D}}$	$\overline{D}$	"t" value
Comparison of mean scores (T_1-T_2) With-in groups					
Control	296.786	264.643	13.057	-32.143	-2.462 Significant
Experi- mental	299.643	273.929	12.189	-25.714	-2.11 Not Sig.
Significance of the difference between means (T_1-T_2) of uncorrelated groups					.36 Not Sig.
Comparison of mean scores (T_1-T_5) With-in) groups					
Control	296.786	284.286	17.042	-12.5	-.733 Not Sig.
Experi- mental	299.643	305.714	13.483	6.071	.45 Not Sig.
Significance of the difference between means (T_1-T_5) of uncorrelated groups					.854 Not Sig.

TABLE 6

BACK STRENGTH CONTINUED

Group	Test	Retest	$S_{\overline{D}}$	$\overline{D}$	"t" value
Comparison of mean scores (T_2-T_3) With-in groups					
Control	264.643	283.929	13.925	19.286	1.385 Not Sig.
Experi- mental	273.929	293.214	9.815	19.286	1.965 Not Sig.
Significance of the difference between means (T_2-T_3) of uncorrelated groups					0 Not Sig.
Comparison of mean scores (T_2-T_4) With-in groups					
Control	264.643	267.857	15.868	3.214	.203 Not Sig.
Experi- mental	273.929	281.429	8.623	7.50	.870 Not Sig.
Significance of the difference between means (T_2-T_4) of uncorrelated groups					.262 Not Sig.
Comparison of mean scores (T_2-T_5) With-in groups					
Control	264.643	284.286	12.547	19.643	1.566 Not Sig.
Experi- mental	273.929	305.714	15.491	31.786	2.052 Not Sig.
Significance of the difference between means (T_2-T_5) of uncorrelated groups					1.336 Not Sig.

The mean differences of the control group in back strength between Test 1 and Test 2 was an increase of 32.143 pounds. The "t" value of 2.462 with 6 degrees of freedom was significant at .05 level.

The mean differences of the experimental group in back strength between the initial tests and the retests showed no significance at .05 level.

The between group comparisons of mean differences of back strength for all tests administered showed no significance at .05 level with 12 degrees of freedom.

In conclusion it is important to recognize that the between groups comparisons on five areas of wrestling strength showed no significance at the .05 level. Only push strength showed a significant difference in the between groups comparisons of Test 1 to Test 2, Test 2 to Test 3, and Test 2 to Test 4.

The mean differences between the experimental group and control group for Test 1 to Test 2 showed a greater mean difference loss for the experimental group in: right grip strenth, left grip strength, pull strength, and leg strength. Only back strength showed a greater mean difference loss for the control group. Push strength showed a greater mean difference gain for the control group.

The mean differences between the experimental group and control group for Test 1 to Test 5 showed a gain in mean differences for the control group in: right grip strength, left grip strength, pull strength, and leg strength. Push

strength and back strength showed mean difference gains for the experimental group and mean difference losses for the control. Leg strength showed a mean difference loss for the experimental group.

The mean differences between the experimental group and control group for Test 2 to Test 3 showed great gains in mean difference for the control group in: right grip strength, left grip strength, and leg strength. Back strength showed the same gain for both groups. Pull strength showed a greater mean difference gain for the experimental group. Push strength showed a mean difference gain for the experimental group. A mean difference loss was noted for the control group in push strength and for the experimental group in leg strength.

The mean differences between the experimental group and control group for Test 2 to Test 4 showed greater gains in mean difference for the control group in: right grip strength, left grip strength, pull strength and leg strength. The experimental group showed a greater mean difference gain for back strength. Push strength showed a greater mean difference loss for the control group. A mean difference loss was noted for the experimental group in leg strength.

The mean differences between the experimental group and control group for Test 2 to Test 5 showed greater gains in mean difference for the control group in: left grip

strength and leg strength. The experimental group showed

a greater mean difference gain for: right grip strength,

pull strength and back strength. The experimental group showed

a greater mean difference loss for push strength.

CHAPTER IV

DISCUSSION

Within the past few years weight control in all
phases of athletics has become very important. For the
athlete to maintain a competitive weight, the many aspects
of body build, nutrition, energy input and output and
physical conditioning must be taken into consideration.

Weight reduction up to the 10 per cent level has
been found not to be harmful to the college wrestler.
Although the research on weight reduction at the high
school level is somewhat limited, the evidence that does
exist shows no harmful effect with regard to weight loss
within minimum levels. The fact remains that weight reduction
and weight control are serious problems not always appreci-
ated by parents, administrators, wrestlers and even many
coaches. If minimum weight levels do exist beyond which
continued weight loss is detrimental to the athlete with regard
to strength or endurance, then these minimum levels should
be established.

This study was designed to allow for observation
and testing periods for the 1966-1967 Mandan High School
wrestling team. Five testing periods were selected: a
pre-season test, scheduled for one month after practice
began; official weigh-in test, scheduled for December 16,

as allowed for state certification; mid-season test,
scheduled for January 26; end-of-season test, scheduled
for February 23, one day before the state tournament;
and a post season test, scheduled for March 30th, five
weeks after the season ended.

The following six strength tests were administered
for each testing period: right grip strength, left grip
strength, push strength, pull strength, leg strength and
back strength.

Certain factors must be mentioned at this time in
the discussion of this study which are pertinent to the results
brought out by the testing program. Of the twenty parti-
cipants in this study selected for testing only fourteen
remained active participants. The others were eliminated
because they either dropped the activity, were injured so
that they could not participate or missed a test period
for some other reason.

Upon completion of the test on the official weigh-in
date (Test 2), the fourteen members were divided into two
groups. The control group was composed of seven wrestlers
who had lost less than 3 per cent of their normal body
weight taken at the time of Test 1. The experimental group
was composed of those wrestlers losing more than 3 per cent
of their normal body weight as determined from Test 1.
See Appendix A page 49 for weight classification chart.

At this point, a clarification should be stressed. Although the wrestler was placed in the experimental group (those losing over 3 per cent of body weight) it was very likely that he may not have exceeded this arbitrary cut-off by more than a fractional amount. For example, wrestler G weighed-in at Test 1 at 151 pounds. When he weighed-in for Test 2 he weighed 146 pounds for a loss of 5 pounds or 3.3 per cent of his normal weight (taken as of Test 1). The mean difference in weight for the control group from Test 1 to Test 2 was .1 per cent gain. The experimental mean difference in weight from Test 1 to Test 2 was 4.6 per cent loss. This figure was slightly less than the 5.91 per cent average weight loss of North Dakota wrestlers as reported by Bedard[1] for 1966-1967.

Therefore, the arbitrary 3 per cent level falls short of the average weight loss of high school wrestlers reported for the same year. With the average weight loss of the experimental group less than the North Dakota high school wrestler's average weight loss, little difference in strength patterns between the control and experimental groups should have been expected.

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[1]Emil R. Bedard, "A Survey of Percentage of Weight Loss in the Weight Classes and Chronological Age Groups of Selected North Dakota High School Wrestlers," (unpublished Master's Thesis, Department of Physical Education, University of North Dakota, 1967).

Muscular Strength Mean Differences, Test 1 to Test 2

The control group registered a mean decrease of 3.143 pounds in right grip strength. The experimental group registered a mean decrease of 7.286 pounds. No significance at the .05 level was shown for either group.

The control group registered a mean increase of 2 pounds in left grip strength. The experimental group registered a mean decrease of 4.71 pounds for the same testing period. Neither of these was significant at the .05 level.

The control group registered a mean increase of 13.429 pounds in push strength. The experimental group registered a mean increase of 8 pounds for the same testing period. Neither of these was significant at the .05 level.

The control group registered a mean decrease of .571 pounds in pull strength. The experimental group registered a mean decrease of 5.143 pounds for the same testing period. Neither of these was significant at the .05 level.

The control group registered a mean decrease of 19.643 pounds in the leg strength. The experimental group registered a mean decrease of 86.786 pounds for the same testing period. No significance at the .05 level was shown for either group.

The control group registered a mean decrease of 32.143 pounds in back strength. This was significant at the .05 level. The experimental group registered a mean decrease of 25.714 pounds for the same testing period. This was not

significant at the .05 level.

Although the between groups comparisons showed no significance at the .05 level from Test 1 to Test 2 for all strength tests administered, a close study of the mean differences reveals noticeable differences in leg strength and back strength. Leg strength of the experimental group may have been affected by weight reduction during the period between tests. Although the mean difference in back strength between the two groups is not great, it would appear that both groups may have been affected by the weight loss or weight control during the period included.

Muscular Strength Mean Differences, Test 1 to Test 5

The control group registered a mean increase of 7.142 pounds for right grip strength. The experimental group registered a mean increase of 4.429 pounds for the same testing period. Neither gain was significant at the .05 level.

The control group registered a mean increase of 10.249 pounds for left grip strength. The experimental group registered a mean increase of 3.143 pounds for the same testing period. The control group gain proved significant at the .05 level while the experimental group gain did not.

The control group registered a mean decrease of 1 pound for push strength. This was not significant at .05

level. The experimental group registered a mean increase
of 34.286 pounds for the same testing period. This was
significant at the .05 level.

The control group registered a mean increase of
10.571 pounds for pull strength. The experimental group
registered a mean increase of 8.714 pounds for the same
testing period. Neither of these was significant at the
.05 level.

The control group registered a mean increase of
20 pounds in leg strength. The experimental group registered
a mean decrease of 37.857 pounds for the same testing period.
Neither of these was significant.

The control group registered a mean decrease of
12.5 pounds in back strength. The experimental group
registered a mean increase of 6.071 pounds for the same
testing period. Neither of these was significant at .05
level.

Although the between groups comparisons showed no
significance at the .05 level from Test 1 to Test 5 for all
strength tests administered, a close study of the mean
differences reveals noticeable differences in leg and back
strength. Weight reduction above the 3 per cent level may
have some effect on the leg strength of the individual
during the growing years. A slight gain in back strength
is apparent with respect to the experimental group. The
control group does not show this normal body gain in strength
for the same period.

Following are some generalizations obtained from the data gathered:

1. The experimental group lost strength in five areas between Test 1 and Test 2.

2. The experimental group had a lower mean difference than the control group in five of the six areas tested between Test 1 and Test 2.

3. The experimental group gained strength in five of the six areas between Test 1 and Test 5.

4. In the area of leg strength, a loss developed on the part of the experimental group between Test 1 and Test 5.

5. Back strength on the part of the control group decreased between Test 1 and Test 5.

6. The control group had greater strength gains in right grip strength, left grip strength and leg strength than the experimental group during the period between Test 2 and Test 3.

7. Both push and pull strength were areas of mean difference gain for the experimental group between Test 2 and Test 3.

8. Both the control and experimental groups experienced the same gain in back strength between Test 2 and Test 3.

9. The control group experienced a greater mean difference gain than the experimental group in four of the areas tested between Test 2 and Test 4.

10. Back strength experienced a greater mean

difference gain for the experimental group between Test 2 and Test 4.

11. The experimental group experienced a slightly greater strength gain in three areas tested between Test 2 and Test 5.

12. The control group experienced a slightly greater strength gain in two areas tested between Test 2 and Test 5.

13. A comparison of the wrestler's weight from Test 2 to Test 5 found an average weight gain for all wrestlers tested of 7.4 per cent of the post season weight.

Minor injuries, sickness, or other factors may have influenced the results that were obtained. However, it is interesting to note the general trend of strength loss as associated with weight loss.

The normal growing high school wrestler should experience a weight gain throughout the wrestling season. Any loss of weight during the season should be calculated from this ascending weight plane and not from the lowest point on the plane (Test 1). In this study all wrestlers lost, on the average, 7.4 per cent of their normal body weight as recorded five weeks after the wrestling season.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of this study was to determine the relationship, if any, of weight reduction or weight control with selected strength factors of typical North Dakota high school wrestlers.

Right and left grip strength, push and pull strength, and leg and back strength were tested five times during and after the wrestling season.

Data were collected from fourteen members of the 1966-1967 Mandan High School wrestling team. By comparing the various strength test results with the amount of weight gained or lost during the same testing periods the writer attempted to develop an optimal weight plan.

Analysis of the data statistically to determine the significance of the difference between the means of the inter-group and intra-group comparisons was made.

The null hypothesis was assumed with respect to the with-in group and between group comparisons of mean difference. This hypothesis was tested with the "t" technique for the difference between means derived from uncorrelated scores and correlated scores from small samples.

Conclusions

On the basis of the findings of this study the following conclusions were drawn:

1. In comparing the mean differences of the control group with the mean differences of the experimental group, no significance at the .05 level was recorded for five of the areas tested.

2. With respect to push strength, a significant "t" value at the .05 level in favor of the experimental group was evident in between group comparisons of Test 1 to Test 5, Test 2 to Test 3, Test 2 to Test 4.

3. The average weight loss for the experimental group from Test 1 to Test 2 was 4.6 per cent of normal body weight taken at the time of pre-season weigh-in.

4. The comparison of Test 2 to Test 5 found an average weight gain for all wrestlers of 7.4 per cent of the post season weight.

5. Weight reduction or weight control beyond the 3 per cent level may affect leg strength.

Recommendations

It is suggested that in any future study of this nature, the following recommendations may be of value:

1. Comparison of wrestlers weight-strength with that of a control group of non-wrestlers in the same age classification would help to determine whether the strength

differences of either group were significant.

2. A similar study encompassing a greater number of wrestlers from several different high schools should be undertaken to give greater significance to the results in terms of weight loss as found in North Dakota high schools.

3. A weight reduction study emphasizing different areas of wrestling ability on the high school level should be undertaken.

4. A long range study of weight reduction or pro-longed weight control should be undertaken to determine whether any latent effects appear after the wrestler has matured and has become established in life.

5. A strength-weight index should be established to aid the wrestler and coach in determining whether the wrestler is at an optimal weight.

APPENDIX A

WEIGHT REDUCTION CHART I

Wrestler	Weigh-In 1	Weigh-In 2	Difference	Per Cent of Weight Gained or Lost
A	91	90	−1	−1.1
B	111	113	+2	+1.8
C	130	120	−10	−7.7
D	126	127	+1	+.8
E	135	127	−8	−5.9
F	144	138	−6	−4.2
G	151	146	−5	−3.3
H	150	145	−5	−3.3
I	160	153	−7	−4.4
J	165	163	−2	−1.2
K	160	162	+2	+1.3
L	172	171	−1	−1.2
M	185	185	−	0
N	221	214	−7	−3.2
Total			−47	−31.6

Average Weight Loss   2.3

WEIGHT REDUCTION CHART II

Wrestler	Weigh-In 2	Weigh-In 5	Difference	Per Cent of Weight Gained or Lost
A	90	96	+6	6.3
B	113	124	+11	8.9
C	120	142	+22	15.5
D	127	130	+3	2.3
E	127	142	+15	10.6
F	138	158	+20	12.6
G	146	162	+16	9.9
H	145	164	+19	11.6
I	153	169	+16	9.5
J	163	162	-1	-.6
K	162	166	+4	2.4
L	171	184	+13	7.2
M	185	189	+4	2.7
N	214	224	+10	4.5
Total			158	103.4
		Average Weight Gained		7.421

APPENDIX B

COMPARISON OF TESTS I AND II FOR

RIGHT GRIP STRENGTH

Control	Test 1	Test 2	Sum of Difference	Difference Squared
A.	59	55	-4	16
B.	90	87	-3	9
D.	101	100	-1	1
J.	115	113	-2	4
K.	118	102	-16	256
L.	127	127	-	-
M.	93	97	4	16
Total	703	681	-22	302

Mean Score of Test 1   100.429
Mean Score of Test 2   97.286
Sum of the Difference   -22
Sum of the Difference Squared   302

Experi-mental	Test 1	Test 2	Sum of Difference	Difference Squared
C.	103	102	-1	1
E.	102	75	-27	729
F.	125	110	-15	225
G.	105	88	-17	289
H.	99	102	3	9
I.	99	106	7	49
N.	71	70	-1	1
Total	704	653	-51	1303

Mean Score of Test 1   100.571
Mean Score of Test 2   93.286
Sum of the Difference   -51
Sum of the Difference Squared   1303

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS
DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Right Grip Strength   Group Control

N = _____ 7 _____

D = _____ -22 _____

D^2 = _____ 302 _____

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\dfrac{\sqrt{\dfrac{\mathcal{E}D^2 - \dfrac{(\mathcal{E}D)^2}{N}}{N-1}}}{\sqrt{N}} = \dfrac{\sqrt{\dfrac{302 - \dfrac{(-22)^2}{7}}{7-1}}}{2.65}$$

$S_{\overline{D}}$ = _____ 2.35 _____

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{-22}{7}$ = _____ -3.143 _____

"t" $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{-3.143}{2.35}$ = _____ -1.337 _____

df = N - 1 = 7 - = 6

"t" at .05 level = 2.447

Not Significant at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Right Grip Strength</u>   Group <u>Experimental</u>

N = _____ 7 _____

D = _____ -51 _____

D^2 = _____ 1303 _____

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\mathcal{E}D^2 - \dfrac{(\mathcal{E}D)^2}{N}}{N-1}} \qquad \sqrt{\dfrac{1303 - \dfrac{(-51)^2}{7}}{7-1}}$$

$$\sqrt{N} \qquad\qquad 2.65$$

$S_{\overline{D}}$ = _____ 4.702 _____

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{-51}{7}$ = $\underline{-7.286}$

t = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{-7.286}{4.702}$ = $\underline{-1.549}$

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test Right Grip Strength

Experimental Group $\overline{D}$ = -7.286   Control Group $\overline{D}$ = -3.143

Experimental Group $S_{\overline{D}}$ = 4.702   Control Group $S_{\overline{D}}$ = 2.350

SDMD   (the estimate of the sampling error for the distribution of the differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2} \qquad \sqrt{(4.702)^2 + (2.350)^2}$$

SDMD +   5.26

$D_{\overline{D}} = \overline{D}_1 - \overline{D}_2 = $ -7.286   -   -3.143   =   -4.143

"t" = $\dfrac{D_{\overline{D}}}{SDMD}$ = $\dfrac{-4.143}{5.26}$ =   -.788

df = $(N_1 - 1) + (N_2 - 1) = 6 + 6 = $ 12

"t" at .05 level = 2.179

Not Significant at .05 level

COMPARISON OF TESTS I AND II FOR

LEFT GRIP STRENGTH

Control	Test 1	Test 2	Sum of Difference	Difference Squared
A.	66	55	-11	121
B.	85	86	1	1
D.	99	99	-	-
J.	112	110	-2	4
K.	89	108	19	361
L.	134	125	-9	81
M.	103	119	16	256
Total	688	702	14	823

Mean Score of Test 1   98.286
Mean Score of Test 2   100.286
Sum of the Difference   14
Sum of the Difference Squared 823

Experimental	Test 1	Test 2	Sum of Difference	Difference Squared
C.	105	89	-16	256
E.	102	90	-12	144
F.	108	99	-9	81
G.	100	106	6	36
H.	103	106	3	9
I.	102	105	3	25
N.	76	71	5	25
Total	696	666	-33	560

Mean Score of Test 1   99.429
Mean Score of Test 2   95.143
Sum of the Difference   -33
Sum of the Difference Squared 560

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Left Grip Strength</u>   Group   <u>Control</u>

$N = $ <u>7</u>

$D = $ <u>14</u>

$D^2 = $ <u>823</u>

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) $= \dfrac{S_{\overline{D}}}{\sqrt{N}} =$

$$\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}$$

$$\sqrt{\dfrac{823 - \dfrac{(14)^2}{7}}{7-1}}$$

2.65

$$\sqrt{N}$$

$S_{\overline{D}} = $ <u>4.343</u>

$\overline{D}$ (Mean Difference) $= \dfrac{D}{N} = \dfrac{14}{7} = $ <u>2</u>

"t" $= \dfrac{\overline{D}}{S_{\overline{D}}} = \dfrac{2}{4.343} = $ <u>.46</u>

df $= N - 1 = 7 - 1 = 6$

"t" at .05 level $= 2.447$

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Left Grip Strength</u>   Group <u>Experimental</u>

$N =$ <u> -7 </u>

$D =$ <u> -33 </u>

$D^2 =$ <u> 560 </u>

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}} \qquad \sqrt{\dfrac{560 - \dfrac{(-33)^2}{7}}{7-1}}$$

$$2.65$$

$$\sqrt{N}$$

$S_{\overline{D}}$ = <u>   3.098   </u>

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{-33}{7}$ = <u> 4.71 </u>

$t = \dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{-4.71}{3.098}$ = <u>-1.52</u>

df = N - 1 = 7 - 1 = 6

"t" at .05 level - 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test <u>Left Grip Strength</u>

Experimental Group $\overline{D}$ = ___-4.71___   Control Group $\overline{D}$ = ___2.0___

Experimental Group $S_{\overline{D}}$ = ___3.098___   Control Group $S_{\overline{D}}$ = ___4.343___

SDMD   (the estimate of the sampling error for the distribution of the differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^{\,2} + S_{\overline{D}_2}^{\,2}} \qquad \sqrt{(3.098)^2 + (4.343)^2}$$

SDMD + ___5.33___

$D_{\overline{D}}$ - $\overline{D}_1$ - $\overline{D}_2$ = ___-4.71___ - ___2___ = ___-6.71___

"t" = $\dfrac{D_{\overline{D}}}{SDMD}$ = $\dfrac{-6.71}{5.33}$ = ___1.259___

df - $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 = ___12___

"t" at .05 level = 2.179

<u>Not Significant</u> at .05 level

COMPARISON OF TESTS I AND II FOR

PUSH STRENGTH

Control	Test 1	Test 2	Sum of Difference	Difference Squared
A.	80	98	18	324
B.	124	142	18	324
D.	137	133	-4	16
J.	152	179	27	729
K.	162	179	17	289
L.	143	158	15	225
M.	187	190	3	9
Total	985	1079	94	1916

Mean Score of Test 1   140.714
Mean Score of Test 2   154.143
Sum of the Difference   94
Sum of the Difference Squared   1916

Experi-mental	Test 1	Test 2	Sum of Difference	Difference Squared
C.	156	161	5	25
E.	138	148	10	100
F.	117	138	21	441
G.	117	141	24	576
H.	131	155	24	576
I.	167	157	-10	100
N.	78	60	-18	324
Total	904	960	56	2142

Mean Score of Test 1   129.143
Mean Score of Test 2   137.143
Sum of the Difference   56
Sum of the Difference Squared   2142

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DRIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test __Push Strength__   Group __Control__

$N = $ __7__

$D = $ __94__

$D^2 = $ __1916__

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}$$

$$\sqrt{\dfrac{1916 - \dfrac{(94)^2}{7}}{7-1}}$$

2.65

$$\sqrt{N}$$

$S_{\overline{D}} = $ __12.457__

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{94}{7}$ = __13.429__

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{13.429}{12.457}$ = __1.087__

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

__Not Significant__ at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS
DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Push Strength   Group Experimental

N = _____7_____

D = ___56_____

D^2 = ___2142____

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}} \qquad \sqrt{\dfrac{2142 - \dfrac{(56)^2}{7}}{7-1}}$$

2.65

$$\sqrt{N}$$

$S_{\overline{D}}$ = ___6.34_____

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{56}{7}$ = _8.0_

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{8.0}{6.34}$ = _1.262_

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS
DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test <u>Push Strength</u>

Experimental Group $\overline{D}$ = <u> 8.0 </u>   Control Group $\overline{D}$ = <u>13.429</u>

Experimental Group $S_{\overline{D}}$ = <u> 6.34 </u>   Control Group $S_{\overline{D}}$ = <u>12.457</u>

SDMD   (the estimate of the sampling error for the distribution of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^{\,2} + S_{\overline{D}_2}^{\,2}} \qquad\qquad \sqrt{(6.34)^2 + (12.457)^2}$$

SDMD + <u> 13.98   </u>

$D_{\overline{D}}$ = $\overline{D}_1$ - $\overline{D}_2$ = <u> 8 </u> - <u> 13.429 </u> = <u> -5.429 </u>

"t" = $\dfrac{D_{\overline{D}}}{\text{SDMD}}$ = $\dfrac{-5.429}{13.98}$ = <u> -.388 </u>

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 = <u> 12 </u>

"t" at .05 level = 2.179

<u>Not Significant</u> at .05 level

COMPARISON OF TESTS I AND II FOR

PULL STRENGTH

Control	Test 1	Test 2	Sum of Difference	Difference Squared
A.	78	78	–	–
B.	141	140	–1	1
D.	110	103	–7	49
J.	138	131	–7	49
K.	144	135	–9	81
L.	168	171	3	9
M.	162	179	17	289
Total	941	937	–4	478

Mean Score of Test 1   134.429
Mean Score of Test 2   133.857
Sum of the Difference   –4
Sum of the Difference Squared   478

Experi-mental	Test 1	Test 2	Sum of Difference	Difference Squared
C.	160	161	1	1
E.	128	114	–14	196
F.	151	131	–20	400
G.	123	115	–8	64
H.	174	176	2	4
I.	151	146	–5	25
N.	87	95	8	64
Total	974	938	–36	754

Mean Score of Test 1   139.143
Mean Score of Test 2   134.00
Sum of the Difference   –36
Sum of the Difference Squared   754

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Pull Strength</u>   Group <u>Control</u>

$N = $ <u>7</u>

$D = $ <u>-4</u>

$D^2 = $ <u>478</u>

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}$$

$$\sqrt{\dfrac{478 - \dfrac{(-4)^2}{7}}{7-1}}$$

2.65

$$\sqrt{N}$$

$S_{\overline{D}} = $ <u>3.358</u>

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{-4}{7}$ = <u>-.571</u>

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{-.571}{3.358}$ = <u>-.17</u>

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Pull Strength   Group Experimental

N = ___7___

D = ___-36___

D^2 = ___754___

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}} \qquad \sqrt{\dfrac{754 - \dfrac{(-36)^2}{7}}{7-1}}$$

2.65

$$\sqrt{N}$$

$S_{\overline{D}}$ = ___3.675___

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{-36}{7}$ = -5.143

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{-5.143}{3.675}$ = -1.399

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

Not Significant at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test <u>Pull Strength</u>

Experimental Group $\overline{D}$ = <u>-5.143</u>   Control Group $\overline{D}$ = <u>-.571</u>

Experimental Group $S_{\overline{D}}$ = <u>3.675</u>   Control Group $S_{\overline{D}}$ = <u>3.358</u>

SDMD (the estimate of the sampling error for the distribution
of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2} \qquad \sqrt{(3.675)^2 = (3.358)^2}$$

SDMD + <u>4.98</u>

$D_{\overline{D}}$ = $\overline{D}_1$ = $\overline{D}_2$ = <u>-5.143</u> = <u>-.571</u> = <u>-4.572</u>

"t" = $\dfrac{D_{\overline{D}}}{SDMD}$ = $\dfrac{-4.572}{4.98}$ = <u>-.918</u>

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 = <u>12</u>

"t" at .05 level = 2.179

<u>Not Significant</u> at .05 level

COMPARISON OF TESTS I AND II FOR

LEG STRENGTH

Control	Test 1	Test 2	Sum of Difference	Difference Squared
A.	180	185	5	25
B.	230	257.5	27.5	756.25
D.	342.5	315	-27.5	756.25
J.	280	265	-15	225
K.	397.5	360	-37.5	1406.25
L.	535	562.5	27.5	756.25
M.	615	497.5	-117.5	13806.25
Total	2580	2442.5	-137.5	17731.25

Mean Score of Test 1   368.571
Mean Score of Test 2   348.929
Sum of Difference   -137.5
Sum of Difference Squared   17731.25

Experi-mental	Test 1	Test 2	Sum of Difference	Difference Squared
C.	670	367.5	-302.5	91506.25
E.	350	267.5	82.5	6806.25
F.	655	455	-200	40000
G.	365	447.5	82.5	6806.25
H.	555	487.5	-67.5	4556.25
I.	400	382.5	-17.5	306.25
N.	300	280	-20	400
Total	3295	2687.5	-607.5	150,381.25

Mean Score of Test 1   470.714
Mean Score of Test 2   383.929
Sum of Difference   -607.5
Sum of Difference Squared   150,381.25

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test $\underline{\text{Leg Strength}}$ Group $\underline{\text{Control}}$

N = $\underline{\quad 7 \quad}$

D = $\underline{-137.5}$

D^2 = $\underline{17,731.25}$

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}} \qquad \sqrt{\dfrac{17,731.25 - \dfrac{(-137.5)^2}{7}}{7-1}}$$

2.65

$$\dfrac{\sqrt{N}}{}$$

$S_{\overline{D}}$ = $\underline{\quad 18.887 \quad}$

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{-137.5}{7}$ = $\underline{-19.643}$

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{-19.643}{18.887}$ = $\underline{\quad -1.04 \quad}$

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

$\underline{\text{Not Significant}}$ at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Leg Strength   Group Experimental

$N = $ 7

$D = $ -607.5

$D^2 = $ 150,381.25

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\frac{\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N - 1}}}{\sqrt{N}} \qquad \frac{\sqrt{\dfrac{150,381.25 - \dfrac{(607.5)^2}{7}}{7 - 1}}}{2.65}$$

$S_{\overline{D}} = $ 48.143

$\overline{D}$ (Mean Difference) $= \dfrac{D}{N} = \dfrac{-607.5}{} = \dfrac{-86.786}{48.143}$

"t" $= \dfrac{\overline{D}}{S_{\overline{D}}} = -86.786 \qquad = -1.803$

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

Not Significant at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test Leg Strength

Experimental Group $\overline{D}$ = -86.786   Control Group $\overline{D}$ = -19.643

Experimental Group $S_{\overline{D}}$ = 48.143   Control Group $S_{\overline{D}}$ = 18.887

SDMD (the estimate of the sampling error for the distribution of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2} \qquad \sqrt{(48.143)^2 + (18.887)^2}$$

SDMD + 51.7

$D_{\overline{D}} = \overline{D}_1 = \overline{D}_2$ = -86.786 - -19.643 = -67.143

"t" = $\dfrac{D_{\overline{D}}}{SDMD}$ = $\dfrac{-67.143}{51.7}$ = -1.299

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 = 12

"t" at .05 level = 2.179

Not Significant at .05 level

COMPARISON OF TESTS I AND II FOR

BACK STRENGTH

Control	Test 1	Test 2	Sum of Difference	Difference Squared
A.	170	165	-5	25
B.	210	205	-5	25
D.	285	235	-50	2500
J.	270	275	5	25
K.	350	330	-20	400
L.	432.5	347.5	-85	7225
M.	360	295	-65	4225
Total	2077.5	1852.5	-225	14425

Mean Score of Test 1   296.786
Mean Score of Test 2   264.643
Sum of the Difference   -225
Sum of the Difference Squared   14,425

Experi- mental	Test 1	Test 2	Sum of Difference	Difference Squared
C.	290	275	-15	225
E.	252.5	245	-7.5	56.25
F.	305	310	5	25
G.	315	285	-30	900
H.	397.5	310	-87.5	7656.25
I.	272.5	227.5	-45	2025
N.	265	265	-	-
Total	2097.5	1917.5	-180	10,887.5

Mean Score of Test 1   299.643
Mean Score of Test 2   273.929
Sum of the Difference   -180
Sum of the Difference Squared   10,887.5

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS
DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Back Strength</u>   Group <u>Control</u>

$N =$ _____7_____

$D =$ _____-225_____

$D^2 =$ _14,425_

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) $= \dfrac{S_{\overline{D}}}{\sqrt{N}} =$

$$\sqrt{\dfrac{\mathcal{E}D^2 - \dfrac{(\mathcal{E}D)^2}{N}}{N - 1}} \qquad \sqrt{\dfrac{14{,}425 - \dfrac{(.225)^2}{7}}{7 - 1}}$$

$$\overline{}\qquad\qquad 2.65$$

$$\sqrt{N}$$

$S_{\overline{D}} =$ _13.057_

$\overline{D}$ (Mean Difference) $= \dfrac{D}{N} = \dfrac{-225}{7} =$ _-32.143_

$"t" = \dfrac{\overline{D}}{S_{\overline{D}}} = \dfrac{-32.143}{13.057} =$ _-2.462_

$df = N - 1 = 7 - 1 = 6$

"t" at .05 level $= 2.447$

<u>Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS
DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Back Strength   Group Experimental

N = _____ 7 _____

D = _____ -180 _____

D^2 = 10,887.5

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}$$

$$\sqrt{\dfrac{10{,}887.5 - \dfrac{(-180)^2}{7}}{7-1}}$$

2.65

$S_{\overline{D}} = \dfrac{2.65}{\sqrt{N}} = $ 12.189

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{-180}{7}$ = -25.714

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{-25.714}{12.189}$ = -2.11

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

Not Significant at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test Back Strength

Experimental Group $\overline{D}$ = -25.714   Control Group $\overline{D}$ = -32.143

Experimental Group $S_{\overline{D}}$ = 12.189   Control Group $S_{\overline{D}}$ = 13.057

SDMD (the estimate of the sampling error for the distribution
of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2} \qquad \sqrt{(12.189)^2 + (13.057)^2}$$

SDMD +   17.86

$$D_{\overline{D}} = \overline{D}_1 = \overline{D}_2 = \underline{-25.714} - \underline{-32.143} = \underline{6.429}$$

$$\text{"t"} = \frac{D_{\overline{D}}}{\text{SMD}} = \frac{6.429}{17.86} = .36$$

df = $(N_1 - 1) + (N_2 - 1) = 6 + 6 = $ 12

"t" at .05 level = 2.179

Not Significant at .05 level

COMPARISON OF TESTS I AND V FOR

RIGHT GRIP STRENGTH

Control	Test 1	Test 5	Sum of Difference	Difference Squared
A.	59	64	5	25
B.	90	88	-2	4
D.	101	96	-5	25
J.	115	134	19	361
K.	118	118	-	-
L.	127	136	9	81
M.	93	117	24	576
Total	703	753	50	1072

Mean Score of Test 1   100.429
Mean Score of Test 5   107.571
Sum of the Difference   50
Sum of the Difference Squared   1072

Experi-mental	Test 1	Test 5	Sum of Difference	Difference Squared
C.	103	107	4	16
E.	102	96	-6	36
F.	125	123	-2	4
G.	105	103	-2	4
H.	99	126	27	729
I.	99	103	4	16
N.	71	77	6	36
Total	704	735	31	841

Mean Score of Test 1   100.571
Mean Score of Test 5   105
Sum of the Difference   31
Sum of the Difference Squared   841

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Right Grip Strength</u>   Group <u>Control</u>

$N = \underline{\hphantom{xx}7\hphantom{xx}}$

$D = \underline{\hphantom{x}50\hphantom{xx}}$

$D^2 = \underline{1072\hphantom{xx}}$

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\dfrac{\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N - 1}}}{\sqrt{N}} \qquad \dfrac{\sqrt{\dfrac{1072 - \dfrac{(50)^2}{7}}{7 - 1}}}{2.65}$$

$S_{\overline{D}} = \underline{\hphantom{xx}4.121\hphantom{xxxxxxx}}$

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{50}{7}$ = $\underline{7.142}$

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{7.142}{4.121}$ = $\underline{1.733}$

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS
DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Right Grip Strength</u>   Group <u>Experimental</u>

$N = $ ___7___

$D = $ ___31___

$D^2 = $ ___841___

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\dfrac{\Sigma D^2 - \dfrac{(\Sigma D)^2}{N}}{N-1}}{N}}$$

$$\sqrt{\dfrac{\dfrac{841 - \dfrac{(31)^2}{7}}{7-1}}{N}}$$

2.65

$S_{\overline{D}} = $ ___4.087___

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{31}{7}$ = 4.429

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{4.429}{4.087}$ = 1.084

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test <u>Right Grip Strength</u>

Experimental Group $\overline{D}$ = <u>4.429</u>　　　Control Group $\overline{D}$ = <u>7.142</u>

Experimental Group $S_{\overline{D}}$ = <u>4.087</u>　　　Control Group $S_{\overline{D}}$ = <u>4.121</u>

SDMD (the estimate of the sampling error for the distribution of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^{2} + S_{\overline{D}_2}^{2}} \qquad \sqrt{(4.087)^2 + (4.121)^2}$$

SDMD + <u>5.8</u>

$D_{\overline{D}}$ = $\overline{D}_1$ = $\overline{D}_2$ = <u>4.429</u> - <u>7.142</u> = <u>-2.713</u>

"t" = $\dfrac{D_{\overline{D}}}{SDMD}$ = $\dfrac{-2.713}{5.8}$ = <u>-.468</u>

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 = <u>12</u>

"t" at .05 level = 2.179

<u>Not Significant</u> at .05 level

COMPARISON OF TESTS I AND V FOR

LEFT GRIP STRENGTH

Control	Test 1	Test 5	Sum of Difference	Difference Squared
A.	66	60	-6	36
B.	85	94	9	81
D.	99	102	3	9
J.	112	127	15	225
K.	89	118	29	841
L.	134	141	7	49
M.	103	119	16	256
Total	688	761	73	1497

Mean Score of Test 1   98.286
Mean Score of Test 5   108.714
Sum of the Difference   73
Sum of the Difference Squared   1497

Experimental	Test 1	Test 5	Sum of Difference	Difference Squared
C.	105	105	-	-
E.	102	99	-3	9
F.	108	102	-6	36
G.	100	114	14	196
H.	103	121	18	324
I.	102	96	-6	36
N.	76	81	5	25
Total	696	718	22	626

Mean Score of Test 1   99.429
Mean Score of Test 5   102.571
Sum of the Difference   22
Sum of the Difference Squared   626

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Left Grip Strength   Group Control

N = ___7___

D = ___73___

D^2 = _1497_

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\dfrac{\sqrt{\dfrac{\mathcal{E}D^2 - \dfrac{(\mathcal{E}D)^2}{N}}{N-1}}}{\sqrt{N}}$$

$$\sqrt{\dfrac{1497 - \dfrac{(73)^2}{7}}{7-1}}$$

2.65

$S_{\overline{D}}$ = ___4.177___

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{73}{7}$ = 10.429

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{10.429}{4.177}$ = 2.497

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

Significant at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS
DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Left Grip Strength</u>   Group <u>Experimental</u>

N = ___7___

D = ___22___

D^2 = ___626___

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\mathcal{E}D^2 = \dfrac{(\mathcal{E}D)^2}{N}}{N-1}} \qquad \sqrt{\dfrac{626 - \dfrac{(22)^2}{7}}{7-1}}$$

2.65

$$\sqrt{N}$$

$S_{\overline{D}}$ = ___3.638___

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{22}{7}$ = 3.143

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{3.143}{3.638}$ = .864

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test Left Grip Strength

Experimental Group $\bar{D}$ = 3.143   Control Group $\bar{D}$ = 10.429

Experimental Group $S_{\bar{D}}$ = 3.638   Control Group $S_{\bar{D}}$ = 4.177

SDMD (the estimate of the sampling error for the distribution
of differences between the mean differences.)

$$\sqrt{S_{\bar{D}_1}^2 + S_{\bar{D}_2}^2} \qquad\qquad \sqrt{(3.638)^2 + (4.177)^2}$$

SDMD + 5.54

$$D_{\bar{D}} = \bar{D}_1 = \bar{D}_2 = 3.143 - -7.286 = -1.315$$

$$\text{"t"} = \frac{D_{\bar{D}}}{SDMD} = \frac{-7.286}{5.54} = -1.315$$

$$df = (N_1 - 1) + (N_2 - 1) = 6 + 6 = 12$$

"t" at .05 level = 2.179

Not Significant at .05 level

COMPARISON OF TESTS I AND V FOR

PUSH STRENGTH

Control	Test 1	Test 5	Sum of Difference	Difference Squared
A.	80	116	36	1296
B.	124	125	1	1
D.	137	110	-27	729
J.	152	136	-16	256
K.	162	148	-14	196
L.	143	150	7	49
M.	187	193	-6	36
Total	985	978	-7	2563

Mean Score of Test 1   140.714
Mean Score of Test 5   139.714
Sum of the Difference   -7
Sum of the Difference Squared   2563

Experi-mental	Test 1	Test 5	Sum of Difference	Difference Squared
C.	156	173	17	289
E.	138	148	10	100
F.	117	142	25	625
G.	117	171	54	2916
H.	131	198	67	4489
I.	167	192	25	625
N.	78	120	42	1764
Total	904	1144	240	10808

Mean Score of Test 1   129.143
Mean Score of Test 5   163.429
Sum of the Difference   240
Sum of the Difference Squared   10808

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Push Strength</u>   Group <u>Control</u>

N = <u>   7   </u>

D = <u>   -7   </u>

D^2= <u> 2563   </u>

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\frac{\sqrt{\dfrac{\epsilon D^2 - \dfrac{(\epsilon D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad \frac{\sqrt{\dfrac{2563 - \dfrac{(-7)^2}{7}}{7-1}}}{2.65}$$

$S_{\overline{D}}$ = <u>   7.789   </u>

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{-7}{7}$ = <u> -1.0   </u>

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{-1}{7.789}$ = <u> -.128   </u>

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Push Strength</u>   Group <u>Experimental</u>

$N = \underline{ 7 }$

$D = \underline{ 240 }$

$D^2 = \underline{10,808}$

$S_{\overline{D}}$ (estimate of sampling error of $_{\overline{D}}$) $= \dfrac{S_{\overline{D}}}{\sqrt{N}} =$

$$\frac{\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad \frac{\sqrt{\dfrac{10,808 - \dfrac{(240)^2}{7}}{7-1}}}{2.65}$$

$S_{\overline{D}} = \underline{ 7.826 }$

$\overline{D}$ (Mean Difference) $= \underline{\dfrac{D}{N}} = \underline{\dfrac{240}{7}} = \underline{ 34.286 }$

"t" $= \underline{\dfrac{\overline{D}}{S_{\overline{D}}}} = \underline{\dfrac{34.286}{7.826}} = \underline{ 4.381 }$

df $= N - 1 = 7 - 1 = 6$

"t" at .05 level $= 2.447$

<u>Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test _Push Strength_

Experimental Group $\overline{D}$ = _34.286_   Control Group $\overline{D}$ = ___-1___

Experimental Group $S_{\overline{D}}$ = _7.826_   Control Group $S_{\overline{D}}$ = _7.789_

SDMD   (the estimate of the sampling error for the distribution of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2} \qquad \sqrt{(7.826)^2 + (7.789)^2}$$

SDMD + _11.04_

$D_{\overline{D}} = \overline{D}_1 = \overline{D}_2$ = _34.286_ - _-1_ = _35.286_

"t" = $\dfrac{D_{\overline{D}}}{SDMD}$ = $\dfrac{35.286}{11.04}$ = _3.196_

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 = ___12___

"t" at .05 level = 2.179

Significant at .05 level

COMPARISON OF TESTS I AND V FOR

PULL STRENGTH

Control	Test 1	Test 5	Sum of Difference	Difference Squared
A.	78	95	17	289
B.	141	164	23	529
D.	110	139	29	841
J.	138	114	-24	576
K.	144	160	16	256
L.	168	146	-22	484
M.	162	197	35	1225
Total	941	1015	74	4200

Mean Score of Test 1   134.429
Mean Score of Test 5   145.0
Sum of the Difference   74
Sum of the Difference Squared   4200

Experi-mental	Test 1	Test 5	Sum of Difference	Difference Squared
C.	160	164	4	16
E.	128	141	13	169
F.	151	127	-24	576
G.	123	148	25	625
H.	174	176	2	4
I.	151	164	13	169
N.	87	115	28	784
Total	974	1035	61	2343

Mean Score of Test 1   139.143
Mean Score of Test 5   147.857
Sum of the Difference   61
Sum of the Difference Squared   2343

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Pull Strength   Group   Control

$N =$ 7

$D =$ 74

$D^2 =$ 4200

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\frac{\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}}{\sqrt{N}}$$

$$\frac{\sqrt{\dfrac{4200 - \dfrac{(74)^2}{7}}{7-1}}}{2.65}$$

$S_{\overline{D}} =$ 9.008

$\overline{D}$ (Mean Difference) $= \dfrac{D}{N} = \dfrac{74}{7} = 10.571$

$"t" = \dfrac{\overline{D}}{S_{\overline{D}}} = \dfrac{10.571}{9.008} = 1.174$

$df = N - 1 = 7 - 1 = 6$

$"t"$ at .05 level = 2.447

Not Significant at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Pull Strength   Group Experimental

$N = \underline{\quad 7 \quad}$

$D = \underline{\quad 61 \quad}$

$D^2 = \underline{\quad 2343 \quad}$

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\frac{\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad \frac{\sqrt{\dfrac{2343 - \dfrac{(61)^2}{7}}{7-1}}}{}$$

2.65

$S_{\overline{D}} = \underline{\quad 6.558 \quad}$

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{61}{7}$ = $\underline{\quad 8.714 \quad}$

$"t" = \dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{8.714}{6.558}$ = $\underline{\quad 1.329 \quad}$

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

Not Significant at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test **Pull Strength**

Experimental Group $\overline{D}$ = **8.714**   Control Group $\overline{D}$ = **10.571**

Experimental Group $S_{\overline{D}}$ = **6.558**   Control Group $S_{\overline{D}}$ = **9.008**

SDMD   (the estimate of the sampling error for the distribution of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2} \qquad \sqrt{(6.558)^2 + (9.008)^2}$$

SDMD +   **11.12**

$$D_{\overline{D}} = \overline{D}_1 = \overline{D}_2 = \underline{\quad 8.714 \quad} - \underline{\quad 10.571 \quad} = \underline{\quad 1.857 \quad}$$

$$"t" = \frac{D_{\overline{D}}}{SDMD} = \frac{1.857}{11.12} = \underline{\quad .167 \quad}$$

$$df = (N_1 - 1) + (N_2 - 1) = 6 + 6 = \underline{\quad 12 \quad}$$

"t" at .05 level = 2.179

Not Significant at .05 level

COMPARISON OF TESTS I AND V FOR

LEG STRENGTH

Control	Test 1	Test 5	Sum of Difference	Difference Squared
A.	180	235	55	3025
B.	230	305	75	5625
D.	342.5	365	22.5	506.25
J.	280	365	85	7225
K.	397.5	340	-57.5	3306.25
L.	535	605	70	4900
M.	615	505	-110	12100
Total	2580	2720	140	36687.5

Mean Score of Test 1   368.571
Mean Score of Test 5   388.571
Sum of the Difference   140
Sum of the Difference Squared 36,687.5

Experimental	Test 1	Test 5	Sum of Difference	Difference Squared
C.	670	550	-120	14400
E.	350	325	-25	6.250
F.	655	482.5	-172.5	29,756.25
G.	365	432.5	67.5	4556.25
H.	555	505	-50	2500
I.	400	390	-10	100
N.	300	345	45	2025
Total	3295	3030	-265	59587.5

Mean Score of Test 1   470.714
Mean Score of Test 5   432.857
Sum of the Difference   -265
Sum of the Difference Squared 59587.5

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Leg Strength   Group Control

N = _____ 7 _____

D = _____ 140 _____

D^2 = _____ 36,687.5 _____

$S_{\overline{D}}$ (estimate of sampling error or $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\epsilon D^2 - \dfrac{(\epsilon D)^2}{N}}{N-1}}$$
$$\div \sqrt{N}$$

$$\sqrt{\dfrac{36,687.5 - \dfrac{(140)^2}{7}}{7-1}}$$

2.65

$S_{\overline{D}}$ = _____ 28.358 _____

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{140}{7}$ = _____ 20.0 _____

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{20.0}{28.358}$ = _____ .705 _____

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Leg Strength   Group Experimental

N = _____ 7 _____

D = _____ -265 _____

D^2 = 59,587.5 _____

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\frac{\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad \frac{\sqrt{\dfrac{59,587.5 - \dfrac{(-265)^2}{7}}{7-1}}}{2.65}$$

$S_{\overline{D}}$ = _____ 34.29 _____

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{-265}{7}$ = -37.857

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{-37.857}{34.29}$ = -1.104

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test Leg Strength

Experimental Group $\overline{D}$ = -37.857   Control Group $\overline{D}$ = 20.0

Experimental Group $S_{\overline{D}}$ = 34.29   Control Group $S_{\overline{D}}$ = 28.358

SDMD   (the estimate of the sampling error for the distribution of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2} \qquad \sqrt{(34.29)^2 + (28.358)^2}$$

SDMD +   44.49

$D_{\overline{D}}$ = $\overline{D}_1$ = $\overline{D}_2$ =   -37.857   - 20.0   = -57.857

"t" = $\dfrac{D_{\overline{D}}}{SDMD}$ = $\dfrac{-57.857}{44.49}$ = -1.30

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 =   12

"t" at .05 level = 2.179

<u>Not Significant</u> at .05 level

COMPARISON OF TESTS I AND V FOR

BACK STRENGTH

Control	Test 1	Test 5	Sum of Difference	Difference Squared
A.	170	220	50	2500
B.	210	255	45	2025
D.	285	250	-35	1225
J.	270	270	-	-
K.	350	290	-60	3600
L.	432.5	380	-52.5	2756.25
M.	360	325	-35	1225
Total	2077.5	1990	-87.5	13,331.25

Mean Score of Test 1   296.786
Mean Score of Test 5   284.286
Sum of the Difference   -87.5
Sum of the Difference Squared 13,331.25

Experi-mental	Test 1	Test 5	Sum of Difference	Difference Squared
C.	290	372.5	82.5	6806.25
E.	252.5	252.5	-	-
F.	305	320	15	225
G.	315	305	-10	100
H.	397.5	390	7.5	56.25
I.	272.5	250	-22.5	506.25
N.	265	250	-15	225
Total	2097.5	2140	42.5	7918.75

Mean Score of Test 1   299.643
Mean Score of Test 5   305.714
Sum of the Difference   42.5
Sum of the Difference Squared 7918.75

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Back Strength   Group Control

N = _____ 7 _____

D = _____ -87.5 _____

D^2 = 13,331.25

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\frac{\sqrt{\dfrac{\mathfrak{E}D^2 - \dfrac{(\mathfrak{E}D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad \frac{\sqrt{\dfrac{13,331.25 - \dfrac{(-87.5)^2}{7}}{7-1}}}{} $$

2.65

$S_{\overline{D}}$ = _____ 17.042 _____

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{-87.5}{7}$ = _____ -12.5 _____

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{-12.5}{17.042}$ = _____ -.733 _____

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Back Strength</u>   Group <u>Experimental</u>

$N =$ <u>   7   </u>

$D =$ <u>42.5</u>

$D^2 =$ <u>7918.75</u>

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\dfrac{\sqrt{\dfrac{\mathbf{S}D^2 - \dfrac{(\mathbf{S}D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad \dfrac{\sqrt{\dfrac{7918.75 - \dfrac{(42.5)^2}{7}}{7-1}}}{2.65}$$

$S_{\overline{D}}$ = <u>13.483</u>

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{42.5}{7}$ = <u>6.071</u>

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{6.071}{13.483}$ = <u>.45</u>

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test <u>Back Strength</u>

Experimental Group $\overline{D}$ = ___6.071___   Control Group $\overline{D}$ = _-12.5___

Experimental Group $S_{\overline{D}}$ = ___13.483___   Control Group $S_{\overline{D}}$ = __17.042__

SDMD   (the estimate of the sampling error for the distribution of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2} \qquad\qquad \sqrt{(13.483)^2 + (17.042)^2}$$

SDMD   +   ____21.74____

$$D_{\overline{D}} = \overline{D}_1 = \overline{D}_2 = \underline{\quad 6.071 \quad} - \underline{\quad -12.5 \quad} = \underline{\quad 18.571 \quad}$$

$$\text{"t"} = \frac{D_{\overline{D}}}{\text{SDMD}} = \frac{18.571}{21.74} = \underline{\quad .854 \quad}$$

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 = ____12____

"t" at .05 level = 2.179

<u>Not Significant</u> at .05 level

COMPARISON OF TESTS II AND III FOR

RIGHT GRIP STRENGTH

Control	Test 2	Test 3	Sum of Difference	Difference Squared
A.	55	58	3	9
B.	87	79	-8	64
D.	100	98	-2	4
J.	113	119	6	36
K.	102	120	18	324
L.	127	131	4	16
M.	97	113	16	256
Total	681	718	37	709

Mean Score of Test 2   97.286
Mean Score of Test 3   102.571
Sum of the Difference   37
Sum of the Difference Squared   709

Experimental	Test 2	Test 3	Sum of Difference	Difference Squared
C.	102	107	5	25
E.	75	78	3	9
F.	110	113	3	9
G.	88	95	7	49
H.	102	113	11	121
I.	106	92	-14	196
N.	70	78	8	64
Total	653	676	23	473

Mean Score of Test 2   93.286
Mean Score of Test 3   96.571
Sum of the Difference   23
Sum of the Difference Squared   473

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Right Grip Strength</u>   Group <u>Control</u>

$N =$ _____ 7 _____

$D =$ _____ 37 _____

$D^2 =$ _____ 709 _____

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$S_{\overline{D}} = \sqrt{\dfrac{\sqrt{\dfrac{\epsilon D^2 - \dfrac{(\epsilon D)^2}{N}}{N-1}}}{N}} \qquad = \sqrt{\dfrac{\sqrt{\dfrac{709 - \dfrac{(37)^2}{7}}{7-1}}}{N}}$$

2.65

$S_{\overline{D}} =$ _____ 3.491 _____

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{37}{7}$ = _____ 5.286 _____

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{5.286}{3.491}$ = _____ 1.514 _____

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS
DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Right Grip Strength</u>   Group <u>Experimental</u>

N = _____7_____

D = _____23_____

D^2 = _____473_____

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\dfrac{\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad \dfrac{\sqrt{\dfrac{473 - \dfrac{(23)^2}{7}}{7-1}}}{2.65}$$

$S_{\overline{D}}$ = _____3.075_____

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{23}{7}$ = _____3.286_____

"t" = $\dfrac{D}{N}$ = $\dfrac{3.286}{3.075}$ = _____1.069_____

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test <u>Right Grip Strength</u>

Experimental Group $\overline{D}$ = <u>3.286</u>   Control Group $\overline{D}$ = <u>5.286</u>

Experimental Group $S_{\overline{D}}$ = <u>3.075</u>   Control Group $S_{\overline{D}}$ = <u>3.491</u>

SDMD   (the estimate of the sampling error for the distribution of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2} \qquad \sqrt{(3.075)^2 + (3.491)^2}$$

SDMD + <u>4.65</u>

$D_{\overline{D}} = \overline{D}_1 = \overline{D}_2 = $ <u>3.286</u> - <u>5.286</u> = <u>-2</u>

"t" = $\dfrac{D_{\overline{D}}}{SDMD}$ = $\dfrac{-2}{4.65}$ = <u>-.430</u>

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 = <u>12</u>

"t" at .05 level = 2.179

<u>Not Significant</u> at .05 level

COMPARISON OF TESTS II AND III FOR

LEFT GRIP STRENGTH

Control	Test 2	Test 3	Sum of Difference	Difference Squared
A.	55	55	–	–
B.	86	88	2	4
D.	99	97	-2	4
J.	110	122	12	144
K.	108	118	10	100
L.	125	122	-3	9
M.	119	116	-3	9
Total	702	718	16	270

Mean Score of Test 2   100.286
Mean Score of Test 3   102.571
Sum of the Difference   16
Sum of the Difference Squared   270

Experi- mental	Test 2	Test 3	Sum of Difference	Difference Squared
C.	89	104	15	225
E.	90	98	8	64
F.	99	89	-10	100
G.	106	106	–	–
H.	106	118	12	144
I.	105	95	-10	100
N.	72	72	–	–
Total	667	682	15	633

Mean Score of Test 2   95.286
Mean Score of Test 3   97.429
Sum of the Difference   15
Sum of the Difference Squared   633

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Left Grip Strength</u>   Group <u>Control</u>

N = _____7_____

D = _____16_____

D^2 = _____270_____

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\xi D^2 - \dfrac{(\xi D)^2}{N}}{N-1}} \qquad \sqrt{\dfrac{270 - \dfrac{(16)^2}{7}}{7-1}}$$

2.65

$$\sqrt{N}$$

$S_{\overline{D}}$ = _____2.351_____

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{16}{7}$ = _____2.286_____

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{2.286}{2.351}$ = _____.972_____

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS
DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Left Grip Strength</u>　　　　Group <u>Experimental</u>

$N = $ ___7___

$D = $ ___15___

$D^2 = $ ___633___

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\sqrt{\dfrac{\mathbf{\Sigma} D^2 - \dfrac{(\mathbf{\Sigma} D)^2}{N}}{N-1}}}{\sqrt{N}}}$$

$$\sqrt{\dfrac{633 - \dfrac{(15)^2}{7}}{7-1}} \quad 2.65$$

$S_{\overline{D}} = $ ___3.777___

$\overline{D}$ (Mean Difference) $= \dfrac{D}{N} = \dfrac{15}{7} = $ ___2.143___

$"t" = \dfrac{\overline{D}}{S_{\overline{D}}} = \dfrac{2.143}{3.777} = $ ___.567___

$df = N - 1 = 7 - 1 = 6$

$"t"$ at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test <u>Left Grip Strength</u>

Experimental Group $\overline{D}$ = <u>2.143</u>   Control Group $\overline{D}$ = <u>2.286</u>

Experimental Group $S_{\overline{D}}$ = <u>3.777</u>   Control Group $S_{\overline{D}}$ = <u>2.351</u>

SDMD (the estimate of the sampling error for the distribution of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2} \qquad \sqrt{(3.777)^2 + (2.351)^2}$$

SDMD + <u>4.45</u>

$D_{\overline{D}} = \overline{D}_1 = \overline{D}_2 =$ <u>2.143</u> $-$ <u>2.286</u> $=$ <u>-.143</u>

"t" = $\dfrac{D_{\overline{D}}}{SDMD}$ = $\dfrac{-.143}{4.45}$ = <u>-.032</u>

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 = <u>12</u>

"t" at .05 level = 2.179

<u>Not Significant</u> at .05 level

COMPARISON OF TESTS II AND III FOR

PUSH STRENGTH

Control	Test 2	Test 3	Sum of Difference	Difference Squared
A.	98	89	-9	81
B.	142	134	-8	64
D.	133	122	-11	121
J.	179	146	-33	1089
K.	179	180	1	1
L.	158	142	-16	256
M.	190	171	-19	361
Total	1079	984	-95	1973

Mean Score of Test 2   154.143
Mean Score of Test 3   140.571
Sum of the Difference   -95
Sum of the Difference Squared   1973

Experi-mental	Test 2	Test 3	Sum of Difference	Difference Squared
C.	161	145	-16	256
E.	148	157	9	81
F.	138	153	15	225
G.	141	150	9	81
H.	155	153	-2	4
I.	157	180	23	529
N.	60	102	42	1764
Total	960	1040	80	2940

Mean Score of Test 2   137.143
Mean Score of Test 3   148.571
Sum of the Difference   80
Sum of the Difference Squared   2940

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Push Strength</u>　　　　　　　　Group　<u>Control</u>

N = _____7_____

D = ___-95___

D^2= ___1973___

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\frac{\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}}{\sqrt{N}}$$

$$\sqrt{\frac{1973 - \dfrac{(-95)^2}{7}}{7-1}}$$

2.65

$S_{\overline{D}}$ = ___4.026___

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{-95}{7}$ = ___-13.571___

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{-13.571}{4.026}$ = ___-3.371___

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Push Strength</u>   Group <u>Experimental</u>

N = _____7_____

D = _____80_____

D^2 = _____2940_____

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\epsilon D^2 - \dfrac{(\epsilon D)^2}{N}}{N-1}} \qquad \sqrt{\dfrac{2940 - \dfrac{(80)^2}{7}}{7-1}}$$

$$\sqrt{N} \qquad\qquad\qquad 2.65$$

$S_{\overline{D}}$ = _____6.932_____

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{80}{7}$ = _____11.429_____

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{11.429}{6.932}$ = _____1.649_____

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test Push Strength

Experimental Group $\overline{D}$ = ___11.429___   Control Group $\overline{D}$ = ___-13.571___

Experimental Group $S_{\overline{D}}$ = ___6.932___   Control Group $S_{\overline{D}}$ = ___4.026___

SDMD   (the estimate of the sampling error for the distribution of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^{\,2} + S_{\overline{D}_2}^{\,2}} \qquad \sqrt{(6.932)^2 + (4.026)^2}$$

SDMD + ___8.02___

$$D_{\overline{D}} = \overline{D}_1 = \overline{D}_2 = \underline{\quad 11.429 \quad} - \underline{\quad -13.571 \quad} = \underline{\quad 25.00 \quad}$$

$$"t" = \frac{D_{\overline{D}}}{SDMD} = \frac{25.0}{8.02} = \underline{\quad 3.117 \quad}$$

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 = ___12___

"t" at .05 level = 2.179

Significant at .05 level

COMPARISON OF TESTS II AND III FOR

PULL STRENGTH

Control	Test 2	Test 3	Sum of Difference	Difference Squared
A.	78	96	18	324
B.	140	147	7	49
D.	103	114	11	121
J.	131	143	12	144
K.	135	115	-20	400
L.	171	165	-6	36
M.	179	193	14	196
Total	937	973	36	1270

Mean Score of Test 2   133.857
Mean Score of Test 3   139.0
Sum of the Difference   36
Sum of the Difference Squared 1270

Experi-mental	Test 2	Test 3	Sum of Difference	Difference Squared
C.	161	163	2	4
E.	114	132	18	324
F.	131	138	7	49
G.	115	125	10	100
H.	176	194	18	324
I.	146	147	1	1
N.	95	111	16	256
Total	938	1010	72	1058

Mean Score of Test 2   134.0
Mean Score of Test 3   144.286
Sum of the Difference   72
Sum of the Difference Squared 1058

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS
DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test __Pull Strength__   Group __Control__

N = ___7___

D = ___36___

D^2 = ___1270___

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\dfrac{\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N-1}}{N-1}}}{\sqrt{N}}$$

$$\sqrt{\dfrac{1270 - \dfrac{(36)^2}{7}}{7 - 1}}$$

2.65

$S_{\overline{D}}$ = ___5.075___

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{36}{7}$ = ___5.143___

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{5.143}{5.075}$ = ___1.013___

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Pull Strength</u>   Group <u>Experimental</u>

N = _____7_____

D = _____72_____

D^2 = _____1058_____

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\sqrt{\dfrac{\Sigma D^2 - \dfrac{(\Sigma D)^2}{N}}{N-1}}}{N}} \qquad \sqrt{\dfrac{\sqrt{\dfrac{1058 - \dfrac{(72)^2}{7}}{7-1}}}{2.65}}$$

$S_{\overline{D}}$ = _____2.747_____

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{72}{7}$ = _____10.286_____

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{10.286}{2.747}$ = _____3.744_____

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test <u>Pull Strength</u>

Experimental Group $\overline{D}$ = <u>10.286</u>   Control Group $\overline{D}$ = <u>5.143</u>

Experimental Group $S_{\overline{D}}$ = <u>2.747</u>   Control Group $S_{\overline{D}}$ = <u>5.075</u>

SDMD   (the estimate of the sampling error for the distribution of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2} \qquad \sqrt{(2.747)^2 + (5.075)^2}$$

SDMD + <u>   5.77   </u>

$D_{\overline{D}}$ = $\overline{D}_1$ = $\overline{D}_2$ = <u>10.286</u> - <u>5.153</u> = <u>5.143</u>

"t" = $\dfrac{D_{\overline{D}}}{SDMD}$ = $\dfrac{5.143}{5.77}$ = <u>.891</u>

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 = <u> 12 </u>

"t" at .05 level = 2.179

<u>Not Significant</u> at .05 level

COMPARISON OF TESTS II AND III FOR

LEG STRENGTH

Control	Test 2	Test 3	Sum of Difference	Difference Squared
A.	185	162.5	-22.5	506.25
B.	257.5	287.5	30	900
D.	315	370	55	3025
J.	265	360	95	9025
K.	360	380	20	400
L.	562.5	560	-2.5	6.25
M.	497.5	530	32.5	1056.25
Total	2442.5	2650	207.5	14918.75

Mean Score of Test 2   348.929
Mean Score of Test 3   378.571
Sum of the Difference   207.5
Sum of the Difference Squared   14918.75

Experi-mental	Test 2	Test 3	Sum of Difference	Difference Squared
C.	367.5	410	42.5	1806.25
E.	267.5	295	27.5	756.25
F.	455	460	5	25
G.	447.5	415	-32.5	1056.25
H.	487.5	435	-52.5	2756.25
I.	382.5	245	-137.5	18906.25
N.	280	265	-15	225
Total	2687.5	2525	-162.5	25531.25

Mean Score of Test 2   383.929
Mean Score of Test 3   360.714
Sum of the Difference   -162.5
Sum of the Difference Squared   25531.25

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Leg Strength</u>   Group <u>Control</u>

$N = $ <u>   7   </u>

$D = $ <u>   207.5   </u>

$D^2 = $ <u>14918.75</u>

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}\Bigg/\sqrt{N} \qquad \sqrt{\dfrac{14918.75 - \dfrac{(207.5)^2}{7}}{7-1}}\ \ 2.65$$

$S_{\overline{D}}$ = <u>14.426</u>

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{207.5}{7}$ = <u>29.643</u>

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{29.643}{14.426}$ = <u>2.055</u>

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Leg Strength   Group Experimental

$N = 7$

$D = -162.5$

$D^2 = 25531.25$

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\dfrac{\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad \dfrac{\sqrt{\dfrac{25531.25 - \dfrac{(-162.5)^2}{7}}{7-1}}}{2.65}$$

$S_{\overline{D}} = 22.706$

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{-162.5}{7}$ = -23.214

$"t" = \dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{-23.214}{22.706}$ = 1.022

$df = N - 1 = 7 - 1 = 6$

"t" at .05 level = 2.447

Not Significant at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test Leg Strength

Experimental Group $\overline{D}$ = -23.214   Control Group $\overline{D}$ = 29.643

Experimental Group $S_{\overline{D}}$ = 22.706   Control Group $S_{\overline{D}}$ = 14.426

SDMD   (the estimate of the sampling error for the distribution
of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2}$$ $$\sqrt{(22.706)^2 + (14.426)^2}$$

SDMD +   26.9

$D_{\overline{D}}$ = $\overline{D}_1$ = $\overline{D}_2$ = -23.214   = 29.643   = -52.857

"t" = $\dfrac{D_{\overline{D}}}{SDMD}$ = $\dfrac{-52.857}{26.9}$ = -1.965

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 +   12

"t" at .05 level = 2.179

Not Significant at .05 level

COMPARISON OF TESTS II AND III FOR

BACK STRENGTH

Control	Test 2	Test 3	Sum of Difference	Difference Squared
A.	165	197.5	32.5	1056.25
B.	205	257.5	52.5	2756.25
D.	235	275	40	1600
J.	275	270	-5	25
K.	330	285	-45	2025
L.	347.5	405	57.5	3306.25
M.	295	297.5	2.5	6.25
Total	1852.5	1987.5	135	10775

Mean Score of Test 2   264.643
Mean Score of Test 3   283.929
Sum of the Difference   135
Sum of the Difference Squared   10775

Experi- mental	Test 2	Test 3	Sum of Difference	Difference Squared
C.	275	285	10	100
E.	245	280	35	1225
F.	310	310	-	-
G.	285	317.5	32.5	1056.25
H.	310	375	65	4225
I.	227.5	220	-7.5	56.25
N.	265	265	-	-
Total	1917.5	2052.5	135	6662.5

Mean Score of Test 2   273.929
Mean Score of Test 3   293.214
Sum of the Difference   135
Sum of the Difference Squared   6662.5

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS
DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Back Strength</u>   Group <u>Control</u>

N = _____7_____

D = ___135___

D^2 = ___1077.5___

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\sqrt{\mathcal{E}D^2 - \dfrac{(\mathcal{E}D)^2}{N}}}{N-1}} \qquad \sqrt{\dfrac{\sqrt{10775 - \dfrac{(135)^2}{7}}}{7-1}}$$

2.65

$S_{\overline{D}}$ = ___13.925___

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{135}{7}$ = ___19.286___

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{19.286}{13.925}$ = ___1.385___

df = N − 1 = 7 − 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test   Back Strength   Group   Experimental

N =   7

D =   135

D^2 =   6662.5

$S_{\overline{D}}$ (estimate of the sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\sqrt{\Sigma D^2 - \dfrac{(\Sigma D)^2}{N}}}{N-1}} \qquad \sqrt{\dfrac{\sqrt{6662.5 - \dfrac{(135)^2}{7}}}{7-1}}$$

2.65

$S_{\overline{D}}$ =   9.815

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{135}{7}$ = 19.286

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{19.286}{9.815}$ = 1.965

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

Not Significant at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test <u>Back Strength</u>

Experimental Group $\overline{D}$ = ___19.286___   Control Group $\overline{D}$ = ___19.286___

Experimental Group $S_{\overline{D}}$ = ___9.815___   Control Group $S_{\overline{D}}$ = ___13.925___

SDMD   (the estimate of the sampling error for the distribution of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2} \qquad \sqrt{(9.815)^2 + (13.925)^2}$$

SDMD + ___17.04___

$D_{\overline{D}} = \overline{D}_1 = \overline{D}_2$ = ___19.286___ - ___19.286___ = ___0___

$"t" = \dfrac{D_{\overline{D}}}{SDMD}$ = $\dfrac{0}{17.04}$ = ___0___

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 = ___12___

"t" at .05 level = 2.179

<u>Not Significant</u> at .05 level

COMPARISON OF TESTS II AND IV FOR

RIGHT GRIP STRENGTH

Control	Test 2	Test 4	Sum of Difference	Difference Squared
A.	55	57	2	4
B.	87	85	-2	4
D.	100	95	-5	25
J.	113	118	5	25
K.	102	117	15	225
L.	127	125	-2	4
M.	97	122	25	625
Total	681	719	38	912

Mean Score of Test 2   97.286
Mean Score of Test 4   102.714
Sum of the Difference   38
Sum of the Difference Squared   912

Experi- mental	Test 2	Test 4	Sum of Difference	Difference Squared
C.	102	90	-12	144
E.	75	84	9	81
F.	110	107	-3	9
G.	88	97	9	81
H.	102	104	2	4
I.	106	111	5	25
N.	70	66	-4	16
Total	653	659	6	360

Mean Score of Test 2   93.286
Mean Score of Test 4   94.143
Sum of the Difference   6
Sum of the Difference Squared   360

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Right Grip Strength</u>　　　　Group　<u>Control</u>

N = <u>　7　</u>

D = <u>　38　</u>

D^2 = <u>　912　</u>

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\frac{\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad \frac{\sqrt{\dfrac{912 - \dfrac{(38)^2}{7}}{7-1}}}{} $$

2.65

$S_{\overline{D}}$ = <u>　409　</u>

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{38}{7}$ = <u>5.429</u>

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{5.429}{4.09}$ = <u>1.327</u>

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Right Grip Strength</u>   Group <u>Experimental</u>

N =   <u>7</u>

D =   <u>6</u>

D^2 =   <u>360</u>

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{}$ =

$$\dfrac{\sqrt{\dfrac{\mathbf{\varepsilon}D^2 - \dfrac{(\mathbf{\varepsilon}D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad \dfrac{\sqrt{\dfrac{360 - \dfrac{(6)^2}{7}}{7-1}}}{2.65}$$

$$S_{\overline{D}} = \dfrac{290}{\sqrt{N}}$$

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{6}{7}$ = <u>.857</u>

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{.857}{2.90}$ = <u>.296</u>

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test Right Grip Strength

Experimental Group $\overline{D}$ = .857   Control Group $\overline{D}$ = 5.429

Experimental Group $S_{\overline{D}}$ = 2.90   Control Group $S_{\overline{D}}$ = 4.09

SDMD   (the estimate of the sampling error for the distribution
         of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2} \qquad\qquad \sqrt{(2.90)^2 + (4.09)^2}$$

SDMD +   5.01

$D_{\overline{D}} = \overline{D}_1 = \overline{D}_2 =$ .857   - 5.429   = 4.57

$"t" = \dfrac{D_{\overline{D}}}{SDMD} = \dfrac{4.57}{5.01} =$ .912

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 = 12

"t" at .05 level = 2.179

Not Significant at .05 level

COMPARISON OF TESTS II AND IV FOR

LEFT GRIP STRENGTH

Control	Test 2	Test 4	Sum of Difference	Difference Squared
A.	55	66	11	121
B.	86	90	4	16
D.	99	98	-1	1
J.	110	130	20	400
K.	108	118	10	100
L.	125	151	26	676
M.	119	112	-7	49
Total	702	765	63	1363

Mean Score of Test 2   100.286
Mean Score of Test 4   109.286
Sum of the Difference   63
Sum of the Difference Squared   1363

Experi-mental	Test 2	Test 4	Sum of Difference	Difference Squared
C.	89	95	6	36
E.	90	98	8	64
F.	99	98	-1	1
G.	106	103	-3	9
H.	106	111	5	25
I.	105	95	-10	100
N.	72	63	-9	81
Total	667	663	-4	316

Mean Score of Test 2   95.286
Mean Score of Test 4   94.714
Sum of the Difference   -4
Sum of the Difference Squared   316

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Left Grip Strength</u>   Group <u>Control</u>

N = _____7_____

D = ___63___

D^2 = ___1363___

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\dfrac{\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad \dfrac{\sqrt{\dfrac{1363 - \dfrac{(63)^2}{7}}{7-1}}}{2.65}$$

$S_{\overline{D}}$ = ___4.34___

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{63}{7}$ = ___9.0___

"t" - $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{9.0}{4.34}$ = ___2.074___

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS
DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Left Grip Strength</u>   Group <u>Experimental</u>

N = _____7_____

D = _____-4_____

D^2 = _____316_____

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\epsilon D^2 - \dfrac{(\epsilon D)^2}{N}}{N - 1}} \qquad \sqrt{\dfrac{316 - \dfrac{(-4)^2}{7}}{7 - 1}}$$

2.65

$$\sqrt{N}$$

$S_{\overline{D}}$ = _____2.728_____

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{-4}{7}$ = _____-.571_____

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{-.571}{2.728}$ = _____-.209_____

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test <u>Left Grip Strength</u>

Experimental Group $\overline{D}$ = <u>-.571</u>   Control Group $\overline{D}$ = <u>9.0</u>

Experimental Group $S_{\overline{D}}$ = <u>2.728</u>   Control Group $S_{\overline{D}}$ = <u>4.34</u>

SDMD   (the estimate of the sampling error for the distribution of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2} \qquad \sqrt{(2.728)^2 + (4.34)^2}$$

SDMD + <u>5.12</u>

$D_{\overline{D}}$ = $\overline{D}_1$ = $\overline{D}_2$ = <u>-.571</u> - <u>9</u> = <u>-9.571</u>

"t" = $\dfrac{D_{\overline{D}}}{SDMD}$ = $\dfrac{-9.571}{5.12}$ = <u>-1.869</u>

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 = <u>12</u>

"t" at .05 level = 2.179

<u>Not Significant</u> at .05 level

COMPARISON OF TESTS II AND IV FOR

PUSH STRENGTH

Control	Test 2	Test 4	Sum of Difference	Difference Squared
A.	98	94	-4	16
B.	142	103	-39	1521
D.	133	119	-14	196
J.	179	159	-20	400
K.	179	144	-35	1225
L.	158	162	4	16
M.	190	166	-24	576
Total	1079	947	-132	3950

Mean Score of Test 2   154.143
Mean Score of Test 4   135.286
Sum of the Difference   -132
Sum of the Difference Squared 3950

Experi-mental	Test 2	Test 4	Sum of Difference	Difference Squared
C.	161	128	-33	1089
E.	148	152	4	16
F.	138	150	12	144
G.	141	139	-2	4
H.	155	166	11	121
I.	157	153	-4	16
N.	60	69	9	81
Total	960	957	-3	1471

Mean Score of Test 2   137.143
Mean Score of Test 4   136.714
Sum of the Difference   -3
Sum of the Difference Squared 1471

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Push Strength</u>   Group <u>Control</u>

$N = $ <u> 7 </u>

$D = $ <u> -132 </u>

$D^2 = $ <u> 3950 </u>

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\frac{\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad\qquad \sqrt{\dfrac{3950 - \dfrac{(-132)^2}{7}}{7-1}}$$

$$2.65$$

$S_{\overline{D}} = $ <u> 5.891 </u>

$\overline{D}$ (Mean Difference) $= \dfrac{D}{N} = \dfrac{-132}{7} = $ <u> -18.857 </u>

"t" $= \dfrac{\overline{D}}{S_{\overline{D}}} = \dfrac{-18.857}{5.891} = $ <u> -3.201 </u>

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Push Strength   Group Experimental

$N = $ 7

$D = $ -3

$D^2 = $ 1471

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\dfrac{\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}}{\sqrt{N}}$$

$$\dfrac{\sqrt{\dfrac{1471 - \dfrac{(-31)^2}{7}}{7-1}}}{2.65}$$

$S_{\overline{D}} = \dfrac{5.898}{}$

$\overline{D}$ (Mean Difference) $= \dfrac{D}{N} = \dfrac{-3}{7} = -.429$

$"t" = \dfrac{\overline{D}}{S_{\overline{D}}} = \dfrac{-.429}{5.898} = .073$

$df = N - 1 = 7 - 1 = 6$

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test <u>Push Strength</u>

Experimental Group $\overline{D}$ = <u> -.429 </u>   Control Group $\overline{D}$ = <u>-18.857</u>

Experimental Group $S_{\overline{D}}$ = <u> 5.898 </u>   Control Group $S_{\overline{D}}$ = <u> 5.891 </u>

SDMD   (the estimate of the sampling error for the distribution
of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2} \qquad \sqrt{(5.898)^2 + (5.891)^2}$$

SDMD + <u> 8.34 </u>

$D_{\overline{D}}$ = $\overline{D}_1$ = $\overline{D}_2$ = <u> -.429 </u> - <u> -18.857 </u> = <u> 18.428 </u>

"t" = $\dfrac{D_{\overline{D}}}{SDMD}$ = $\dfrac{18.428}{8.34}$ = <u> 2.210 </u>

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 = <u> 12 </u>

"t" at .05 level = 2.179

<u>Significant</u> at .05 level

COMPARISON OF TESTS II AND IV FOR

PULL STRENGTH

Control	Test 2	Test 4	Sum of Difference	Difference Squared
A.	78	88	10	100
B.	140	136	-4	16
D.	103	105	2	4
J.	131	140	9	81
K.	135	165	30	900
L.	171	176	5	25
M.	179	192	13	169
Total	937	1002	65	1295

Mean Score of Test 2   133.857
Mean Score of Test 4   143.143
Sum of the Difference   65
Sum of the Difference Squared   1295

Experi-mental	Test 2	Test 4	Sum of Difference	Difference Squared
C.	161	146	-15	225
E.	114	138	24	576
F.	131	135	4	16
G.	115	106	-9	81
H.	176	194	18	324
I.	146	153	7	49
N.	95	81	-14	196
Total	938	953	15	1467

Mean Score of Test 2   134.0
Mean Score of Test 4   136.143
Sum of the Difference   15
Sum of the Difference Squared   1467

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS
DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Pull Strength</u>   Group <u>Control</u>

$N = $ _____7_____

$D = $ _____65_____

$D^2 = $ _____1295_____

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{} = $

$$\dfrac{\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}}{\sqrt{N}}$$

$$\dfrac{\sqrt{\dfrac{1295 - \dfrac{(65)^2}{7}}{7-1}}}{}$$

2.65

$S_{\overline{D}} = $ _____4.049_____

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{65}{7}$ = ___9.286___

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{9.286}{4.049}$ = ___2.293___

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Pull Strength   Group   Experimental

$N = $ _____ 7 _____

$D = $ _____ 15 _____

$D^2 = $ _____ 1467 _____

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\frac{\sqrt{\dfrac{\epsilon D^2 - \dfrac{(\epsilon D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad \frac{\sqrt{\dfrac{1467 - \dfrac{(15)^2}{7}}{7-1}}}{2.65}$$

$S_{\overline{D}} = $ _____ 5.834 _____

$\overline{D}$ (Mean Difference) $= \dfrac{D}{N} = \dfrac{15}{7} = 2.143$

"t" $= \dfrac{\overline{D}}{S_{\overline{D}}} = \dfrac{2.143}{5.834} = .367$

df $= N - 1 = 7 - 1 = 6$

"t" at .05 level = 2.447

Not Significant at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test Pull Strength

Experimental Group $\overline{D}$ = 2.143   Control Group $\overline{D}$ = 9.286

Experimental Group $S_{\overline{D}}$ = 5.834   Control Group $S_{\overline{D}}$ = 4.049

SDMD   (the estimate of the sampling error for the distribution of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2} \qquad \sqrt{(5.834)^2 + (4.049)^2}$$

SDMD ÷ ___7.1___

$D_{\overline{D}} = \overline{D}_1 = \overline{D}_2 = $ ___2.143___ - ___9.286___ = ___-7.143___

$"t" = \dfrac{D_{\overline{D}}}{\text{SDMD}} = \dfrac{-7.143}{7.1} = $ ___-1.006___

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 = ___12___

"t" at .05 level = 2.179

Not Significant at .05 level

COMPARISON OF TESTS II AND IV FOR

LEG STRENGTH

Control	Test 2	Test 4	Sum of Difference	Difference Squared
A.	185	175	-10	100
B.	257.5	277.5	20	400
D.	315	335	20	400
J.	265	350	85	7225
K.	360	327.5	-32.5	1056.25
L.	562.5	585	22.5	506.25
M.	497.5	445	-52.5	2756.25
Total	2442.5	2495	52.5	12443.75

Mean Score of Test 2   348.929
Mean Score of Test 4   356.429
Sum of the Difference   52.5
Sum of the Difference Squared   12443.75

Experi-mental	Test 2	Test 4	Sum of Difference	Difference Squared
C.	367.5	375	7.5	56.25
E.	267.5	310	42.5	1806.25
F.	455	460	5	25
G.	447.5	365	-82.5	6806.25
H.	487.5	435	-52.5	2756.25
I.	382.5	335	-47.5	2256.25
N.	280	307.5	27.5	756.25
Total	2687.5	2587.5	-100	14462.5

Mean Score of Test 2   383.929
Mean Score of Test 4   369.643
Sum of the Difference   -100
Sum of the Difference Squared   14462.5

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Leg Strength   Group Control

N =   7

D =   52.5

D^2 = 12443.75

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}$$

$$\sqrt{\dfrac{12443.75 - \dfrac{(52.5)^2}{7}}{7-1}}$$

2.65

$\sqrt{N}$

$S_{\overline{D}}$ =   16.909

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{52.5}{7}$ = 7.50

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{7.50}{16.909}$ = .444

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS
DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Leg Strength   Group Experimental

N = ___7___

D = _-100_

D^2 = _14462.5_

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\dfrac{\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad \dfrac{\sqrt{\dfrac{14462.5 - \dfrac{(-100)^2}{7}}{7-1}}}{}$$

2.65

$S_{\overline{D}}$ = _17.589_

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{-100}{7}$ = _-14.286_

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{-14.286}{17.589}$ = _-.812_

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test <u>Leg Strength</u>

Experimental Group $\overline{D}$ = <u>-14.286</u>   Control Group $\overline{D}$ = <u>7.50</u>

Experimental Group $S_{\overline{D}}$ = <u>17.589</u>   Control Group $S_{\overline{D}}$ = <u>16.909</u>

SDMD   (the estimate of the sampling error for the distribution of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + D_{\overline{D}_2}^2} \qquad \sqrt{(17.589)^2 + (16.909)^2}$$

SDMD ÷ <u>24.4</u>

$D_{\overline{D}} = \overline{D}_1 = \overline{D}_2$ = <u>-14.286</u> − <u>7.50</u> = <u>-21.786</u>

"t" = $\dfrac{D_{\overline{D}}}{\text{SDMD}}$ = $\dfrac{-21.786}{24.4}$ = <u>-.893</u>

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 = <u>12</u>

"t" at .05 level = 2.179

<u>Not Significant</u> at .05 level

COMPARISON OF TESTS II AND IV FOR

BACK STRENGTH

Control	Test 2	Test 4	Sum of Difference	Difference Squared
A.	165	170	5	25
B.	205	222.5	17.5	306.25
D.	235	257.5	22.5	506.25
J.	275	250	-25	625
K.	330	267.5	-62.5	3906.25
L.	347.5	420	72.5	5256.25
M.	295	287.5	-7.5	56.25
Total	1852.5	1875	22.5	10681.25

Mean Score of Test 2   264.643
Mean Score of Test 4   267.857
Sum of the Difference   22.5
Sum of the Difference Squared   10681.25

Experi- mental	Test 2	Test 4	Sum of Difference	Difference Squared
C.	275	290	15	225
E.	245	270	25	625
F.	310	320	10	100
G.	285	245	-40	1600
H.	310	315	5	25
I.	227.5	257.5	30	900
N.	265	272.5	7.5	56.25
Total	1917.5	1970	52.5	3531.25

Mean Score of Test 2   273.929
Mean Score of Test 4   281.429
Sum of the Difference   52.5
Sum of the Difference Squared   3531.25

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Back Strength</u>   Group <u>Control</u>

N = ___7___

D = ___22.5___

D^2 = <u>10681.25</u>

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\sum D^2 - \dfrac{(\sum D)^2}{N}}{N-1}} \bigg/ \sqrt{N} \qquad\qquad \sqrt{\dfrac{10681.25 - \dfrac{(22.5)^2}{7}}{7-1}} \bigg/ 2.65$$

$S_{\overline{D}}$ = <u>15.868</u>

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{22.5}{7}$ = <u>3.214</u>

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{3.214}{15.868}$ = <u>.203</u>

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Back Strength   Group Experimental

$N = \underline{\quad 7 \quad}$

$D = \underline{\quad 52.5 \quad}$

$D^2 = \underline{\quad 3531.25 \quad}$

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\dfrac{\sqrt{\dfrac{\mathcal{E}D^2 - \dfrac{(\mathcal{E}D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad \dfrac{\sqrt{\dfrac{3531.25 - \dfrac{(52.5)^2}{7}}{7-1}}}{2.65}$$

$S_{\overline{D}} = \underline{\quad 8.623 \quad}$

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{52.5}{7}$ = $\underline{\quad 7.50 \quad}$

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{7.50}{8.623}$ = $\underline{\quad .870 \quad}$

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test <u>Back Strength</u>

Experimental Group $\overline{D}$ = __7.50__   Control Group $\overline{D}$ = __3.214__

Experimental Group $S_{\overline{D}}$ = __8.623__   Control Group $S_{\overline{D}}$ = __15.868__

SDMD   (the estimate of the sampling error for the distribution of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2} \qquad \sqrt{(8.623)^2 = (15.868)^2}$$

SDMD + __16.35__

$D_{\overline{D}} = \overline{D}_1 = \overline{D}_2 = $ __7.50__ - __3.214__ = __4.286__

"t" = $\dfrac{D_{\overline{D}}}{SDMD}$ = $\dfrac{4.286}{16.35}$ = __.262__

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 = __12__

"t" at .05 level = 2.179

<u>Not Significant</u> at .05 level

COMPARISON OF TESTS II AND V FOR

RIGHT GRIP STRENGTH

Control	Test 2	Test 5	Sum of Difference	Difference Squared
A.	55	64	9	81
B.	87	88	1	1
D.	100	96	-4	16
J.	113	134	21	441
K.	102	118	16	256
L.	127	136	9	81
M.	97	117	20	400
Total	681	753	72	1276

Mean Score of Test 2   97.286
Mean Score of Test 5   107.571
Sum of the Difference   72
Sum of the Difference Squared   1276

Experi-mental	Test 2	Test 5	Sum of Difference	Difference Squared
C.	102	107	5	25
E.	75	96	21	441
F.	110	123	13	169
G.	88	103	15	225
H.	102	126	24	576
I.	106	103	-3	9
N.	70	77	7	49
Total	653	735	82	1494

Mean Score of Test 2   93.286
Mean Score of Test 5   105
Sum of the Difference   82
Sum of the Difference Squared   1494

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Right Grip Strength   Group Control

N = _____7_____

D = _____72_____

D^2 = _1276_

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\dfrac{\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad = \qquad \dfrac{\sqrt{\dfrac{1276 - \dfrac{(72)^2}{7}}{7-1}}}{} \; = \; 2.65$$

$S_{\overline{D}}$ = _3.566_

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{72}{7}$ = _10.286_

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{10.286}{3.566}$ = _2.884_

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS
DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Right Grip Strength</u>   Group <u>Experimental</u>

$N = $ <u> 7 </u>

$D = $ <u> 82 </u>

$D^2 = $ <u>1494</u>

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) $= \dfrac{S_{\overline{D}}}{\sqrt{N}} =$

$$= \dfrac{\sqrt{\dfrac{\mathcal{E}D^2 - \dfrac{(\mathcal{E}D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad = \dfrac{\sqrt{\dfrac{1494 - \dfrac{(82)^2}{7}}{7-1}}}{2.65}$$

$S_{\overline{D}} = $ <u>3.558</u>

$\overline{D}$ (Mean Difference) $= \dfrac{D}{N} = \dfrac{82}{7} = $ <u>11.714</u>

"t" $= \dfrac{\overline{D}}{S_{\overline{D}}} = \dfrac{11.714}{3.558} = $ <u>3.292</u>

df $= N - 1 = 7 - 1 = 6$

"t" at .05 level $= 2.447$

<u>Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test <u>Right Grip Strength</u>

Experimental Group $\overline{D}$ = <u>11.714</u>   Control Group $\overline{D}$ = <u>10.286</u>

Experimental Group $S_{\overline{D}}$ = <u>3.558</u>   Control Group $S_{\overline{D}}$ = <u>3.566</u>

SDMD   (the estimate of the sampling error for the distribution of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^{\;2} + S_{\overline{D}_2}^{\;2}} \qquad \sqrt{(3.558)^2 + (3.566)^2}$$

SDMD + <u>5.04</u>

$D_{\overline{D}} = \overline{D}_1 = \overline{D}_2$ = <u>11.714</u> - <u>10.286</u> = <u>1.428</u>

"t" = $\dfrac{D_{\overline{D}}}{\text{SDMD}}$ = $\dfrac{1.428}{5.04}$ = <u>.283</u>

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 = <u>12</u>

"t" at .05 level = 2.179

<u>Not Significant</u> at .05 level

COMPARISON OF TESTS II AND V FOR

LEFT GRIP STRENGTH

Control	Test 2	Test 5	Sum of Difference	Difference Squared
A.	55	60	5	25
B.	86	94	8	64
D.	99	102	3	9
J.	110	127	17	289
K.	108	118	10	100
L.	125	141	16	256
M.	119	119	-	-
Total	702	761	59	743

Mean Score of Test 2   100.286
Mean Score of Test 5   108.714
Sum of the Difference   59
Sum of the Difference Squared 743

Experi-mental	Test 2	Test 5	Sum of Difference	Difference Squared
C.	89	105	16	256
E.	90	99	9	81
F.	99	102	3	9
G.	106	114	8	64
H.	106	121	15	225
I.	105	96	-9	81
N.	72	81	9	81
Total	667	718	51	797

Mean Score of Test 2   95.286
Mean Score of Test 5   102.571
Sum of the Difference   51
Sum of the Difference Squared 797

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Left Grip Strength</u>   Group <u>Control</u>

N = <u>   7   </u>

D = <u>   59   </u>

D^2 = <u>   743   </u>

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\frac{\sqrt{\dfrac{\Sigma D^2 - \dfrac{(\Sigma D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad \frac{\sqrt{\dfrac{743 - \dfrac{(59)^2}{7}}{7-1}}}{}$$

2.65

$S_{\overline{D}}$ = <u>3.981</u>

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{59}{7}$ = <u>8.429</u>

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{8.429}{3.981}$ = <u>2.117</u>

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Left Grip Strength</u>   Group <u>Experimental</u>

N = _____7_____

D = ____51_____

D^2= ____797____

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\frac{\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad \sqrt{\frac{797 - \dfrac{(51)^2}{7}}{7-1}}$$

2.65

$S_{\overline{D}}$ = ____3.177____

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{51}{7}$ = 7.286

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{7.286}{3.177}$ = 2.293

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test <u>Left Grip Strength</u>

Experimental Group $\overline{D}$ = <u>7.286</u>   Control Group $\overline{D}$ = <u>8.429</u>

Experimental Group $S_{\overline{D}}$ = <u>3.177</u>   Control Group $S_{\overline{D}}$ = <u>3.981</u>

SDMD   (the estimate of the sampling error for the distribution of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^{\,2} + S_{\overline{D}_2}^{\,2}} \qquad\qquad \sqrt{(3.177)^2 + (3.981)^2}$$

SDMD +   <u>5.09</u>

$$D_{\overline{D}} = \overline{D}_1 = \overline{D}_2 = \underline{\quad 7.286 \quad} - \underline{\quad 8.429 \quad} = \underline{\quad -1.143 \quad}$$

$$\text{"t"} = \frac{D_{\overline{D}}}{SDMD} = \frac{-1.143}{5.09} = \underline{\quad -.225 \quad}$$

$$df = (N_1 - 1) + (N_2 - 1) = 6 + 6 = \underline{\quad 12 \quad}$$

"t" at .05 level =   2.179

<u>Not Significant at .05 level</u>

COMPARISON OF TESTS II AND V FOR

PUSH STRENGTH

Control	Test 2	Test 5	Sum of Difference	Difference Squared
A.	98	116	18	324
B.	142	125	-17	289
D.	133	110	-23	529
J.	179	136	-43	1849
K.	179	148	-31	961
L.	158	150	-8	64
M.	190	193	3	9
Total	1079	978	-101	4025

Mean Score of Test 2   154.143
Mean Score of Test 5   139.714
Sum of the Difference   -101
Sum of the Difference Squared   4025

Experi-mental	Test 2	Test 5	Sum of Difference	Difference Squared
C.	161	173	12	144
E.	148	148	-	-
F.	138	142	4	16
G.	141	171	30	900
H.	155	198	43	1849
I.	157	192	35	1225
N.	60	120	60	3600
Total	960	1144	-184	7734

Mean Score of Test 2   137.143
Mean Score of Test 5   163.429
Sum of the Difference   -184
Sum of the Difference Squared   7734

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Push Strength</u>   Group <u>Control</u>

N = <u>   7   </u>

D = <u> -101   </u>

D^2= <u> 4025   </u>

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}$$

$$\sqrt{\dfrac{4025 - \dfrac{(-101)^2}{7}}{7-1}}$$

$$\sqrt{N}$$

2.65

$S_{\overline{D}}$ = <u> 7.808   </u>

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{-101}{7}$ = <u> -14.429 </u>

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{-14.429}{7.808}$ = <u> 1.848   </u>

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS
DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Push Strength</u>   Group <u>Experimental</u>

N = _____7_____

D = _____-184_____

D^2 = _____7734_____

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}$$

$$\sqrt{N}$$

$$\dfrac{7734 - \dfrac{(-184)^2}{7}}{7-1}$$

2.65

$S_{\overline{D}}$ = ____8.291____

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{-184}{7}$ = -26.286

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{-26.286}{8.291}$ = -3.17

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test Push Strength

Experimental Group $\overline{D}$ = _-26.286_   Control Group $\overline{D}$ = _-14.429_

Experimental Group $S_{\overline{D}}$ = _8.291_   Control Group $S_{\overline{D}}$ = _7.808_

SDMD   (the estimate of the sampling error for the distribution
of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2} \qquad \sqrt{(8.291)^2 + (7.808)^2}$$

SDMD + _11.39_

$D_{\overline{D}}$ = $\overline{D}_1$ = $\overline{D}_2$ = _-26.286_ - _-14.429_ = _-11.857_

"t" = $\dfrac{D_{\overline{D}}}{SDMD}$ = $\dfrac{-11.857}{11.39}$ = _-1.041_

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 = _12_

"t" at .05 level = 2.179

Not Significant at .05 level

COMPARISON OF TESTS II AND V FOR

PULL STRENGTH

Control	Test 2	Test 5	Sum of Difference	Difference Squared
A.	78	95	17	289
B.	140	164	24	576
D.	103	139	36	1296
J.	131	114	-17	289
K.	135	160	25	625
L.	171	146	-25	625
M.	179	197	18	324
Total	937	1015	78	4024

Mean Score of Test 2   133.857
Mean Score of Test 5   145.0
Sum of the Difference   78
Sum of the Difference Squared   4024

Experimental	Test 2	Test 5	Sum of Difference	Difference Squared
C.	161	164	3	9
E.	114	141	27	429
F.	131	127	-4	16
G.	115	148	33	1089
H.	176	176	-	-
I.	146	164	18	324
N.	95	115	20	400
Total	938	1035	97	2567

Mean Score of Test 2   134.0
Mean Score of Test 5   147.857
Sum of the Difference   97
Sum of the Difference Squared   2567

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Pull Strength   Group Control

N = _____ 7 _____

D = _____ 78 _____

D^2 = _____ 4028 _____

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\frac{\sqrt{\dfrac{\epsilon D^2 - \dfrac{(\epsilon D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad \frac{\sqrt{\dfrac{4028 - \dfrac{(78)^2}{7}}{7-1}}}{}$$

2.65

$S_{\overline{D}}$ = _____ 8.66 _____

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{78}{7}$ = 11.143

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{11.143}{8.66}$ = 1.287

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

Not Significant at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Pull Strength</u>   Group <u>Experimental</u>

N = _____ 7 _____

D = _____ 97 _____

D^2 = _____ 2567 _____

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\mathbf{\epsilon} D^2 - \dfrac{(\mathbf{\epsilon}D)^2}{N}}{N-1}}$$

$$\sqrt{N}$$

$$\sqrt{\dfrac{2567 - \dfrac{(97)^2}{7}}{7-1}}$$

$$2.65$$

$S_{\overline{D}}$ = _____ 5.389 _____

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{97}{7}$ = _____ 13.857 _____

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{13.857}{5.389}$ = _____ 2.571 _____

df = N - 1 = 7 - 1 = 6

"t" at .05 level ≐ 2.447

<u>Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test Pull Strength

Experimental Group $\overline{D}$ = 13.857   Control Group $\overline{D}$ = 11.143

Experimental Group $S_{\overline{D}}$ = 5.389   Control Group $S_{\overline{D}}$ = 8.66

SDMD (the estimate of the sampling error for the distribution of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2} \qquad \sqrt{(5.389)^2 + (8.66)^2}$$

SDMD + 10.2

$D_{\overline{D}} = \overline{D}_1 = \overline{D}_2 =$ 13.857 - 11.143 = 2.714

$$\text{"t"} = \frac{D_{\overline{D}}}{SDMD} = \frac{2.714}{10.2} = .266$$

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 = 12

"t" at .05 level = 2.179

Not Significant at .05 level

COMPARISON OF TESTS II AND V FOR

LEG STRENGTH

Control	Test 2	Test 5	Sum of Difference	Difference Squared
A.	185	235	50	2500
B.	257.5	305	47.5	2256.25
D.	315	365	50	2500
J.	265	365	100	10,000
K.	360	340	-20	400
L.	562.5	605	42.5	1806.25
M.	497.5	505	7.5	56.25
Total	2442.5	2720	277.5	19518.75

Mean Score of Test 2   348.929
Mean Score of Test 5   388.571
Sum of the Difference   277.5
Sum of the Difference Squared   19518.75

Experimental	Test 2	Test 5	Sum of Difference	Difference Squared
C.	367.5	550	182.5	33306.25
E.	267.5	325	57.5	3306.25
F.	455	482.5	27.5	756.25
G.	447.5	432.5	-15	225
H.	487.5	505	17.5	306.25
I.	382.5	245	-137.5	18906.25
N.	280	345	65	4225
Total	2687.5	2885	197.5	61031.25

Mean Score of Test 2   383.929
Mean Score of Test 5   412.143
Sum of the Difference   197.5
Sum of the Difference Squared   61031.25

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Leg Strength</u> Group <u>Control</u>

N = <u>7</u>

D = <u>277.5</u>

D^2 = <u>19,518.75</u>

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\frac{\sqrt{\dfrac{\mathcal{E} D^2 - \dfrac{(\mathcal{E}D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad \frac{\sqrt{\dfrac{19518.75 - \dfrac{(277.5)^2}{7}}{7-1}}}{2.65}$$

$S_{\overline{D}}$ = <u>14.226</u>

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{277.5}{7}$ = <u>39.643</u>

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{39.643}{14.226}$ = <u>2.787</u>

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Leg Strength   Group Experimental

N =   7

D =   197.5

D^2 =   61031.25

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\sqrt{\dfrac{\Sigma D^2 - \dfrac{(\Sigma D)^2}{N}}{N-1}} \Bigg/ \sqrt{N}$$

$$\sqrt{\dfrac{61{,}031.25 - \dfrac{(197.5)^2}{7}}{7-1}}$$

2.65

$S_{\overline{D}}$ = 36.283

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{197.5}{7}$ = 28.214

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{28.214}{36.283}$ = .778

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

Not Significant at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test   Leg Strength

Experimental Group $\overline{D}$ = ___28.214___   Control Group $\overline{D}$ = ___39.643___

Experimental Group $S_{\overline{D}}$ = ___36.283___   Control Group $S_{\overline{D}}$ = ___14.226___

SDMD   (the estimate of the sampling error for the distribution
of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2} \qquad\qquad \sqrt{(36.283)^2 + (14.226)^2}$$

SDMD +   ___38.97___

$D_{\overline{D}} = \overline{D}_1 = \overline{D}_2 =$ ___28.214___   - 39.643 ___   =   ___11.429___

$"t" = \dfrac{D_{\overline{D}}}{SDMD}$ $= \dfrac{11.429}{38.97}$ =   ___.293___

$df = (N_1 - 1) + (N_2 - 1) = 6 + 6 = $ ___12___

"t" at .05 level = 2.179

<u>Not Significant</u> at .05 level

COMPARISON OF TESTS II AND V FOR

BACK STRENGTH

Control	Test 2	Test 5	Sum of Difference	Difference Squared
A.	165	220	55	3025
B.	205	255	50	2500
D.	235	250	15	225
J.	275	270	-5	25
K.	330	290	40	1600
L.	347.5	380	32.5	1056.25
M.	295	325	30	900
Total	1852.5	1990	137.5	9331.25

Mean Score of Test 2　　　　　264.643
Mean Score of Test 5　　　　　284.286
Sum of the Difference　　　　137.5
Sum of the Difference Squared　9331.25

Experimental	Test 2	Test 5	Sum of Difference	Difference Squared
C.	275	372.5	97.5	9506.25
E.	245	252.5	7.5	56.25
F.	310	320	10	100
G.	285	305	20	400
H.	310	390	80	6400
I.	227.5	250	22.5	506.25
N.	265	250	-15	225
Total	1917.5	2140	222.5	17193.75

Mean Score of Test 2　　　　　273.929
Mean Score of Test 5　　　　　305.714
Sum of the Difference　　　　222.5
Sum of the Difference Squared　17193.75

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Back Strength</u>   Group <u>Control</u>

N = _____ 7 _____

D = _____ 137.5 _____

D^2 = _____ 9331.25 _____

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\dfrac{\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N-1}}}{\sqrt{N}} \qquad \dfrac{\sqrt{\dfrac{9331.25 - \dfrac{(137.5)^2}{7}}{7-1}}}{2.65}$$

$S_{\overline{D}}$ = _____ 12.547 _____

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{137.5}{7}$ = 19.643 _____

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{19.643}{12.547}$ = 1.566 _____

df = N - 1 = 7 - 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test <u>Back Strength</u>   Group <u>Experimental</u>

N = ___7___

D = ___222.5___

D^2 = ___17193.75___

$S_{\overline{D}}$ (estimate of sampling error of $\overline{D}$) = $\dfrac{S_{\overline{D}}}{\sqrt{N}}$ =

$$\frac{\sqrt{\dfrac{\varepsilon D^2 - \dfrac{(\varepsilon D)^2}{N}}{N - 1}}}{\sqrt{N}} \qquad \frac{\sqrt{\dfrac{17193.75 - \dfrac{(222.5)^2}{7}}{7 - 1}}}{2.65}$$

$S_{\overline{D}}$ = ___15.491___

$\overline{D}$ (Mean Difference) = $\dfrac{D}{N}$ = $\dfrac{222.5}{7}$ = ___31.786___

"t" = $\dfrac{\overline{D}}{S_{\overline{D}}}$ = $\dfrac{31.786}{15.491}$ = ___2.052___

df = N – 1 = 7 – 1 = 6

"t" at .05 level = 2.447

<u>Not Significant</u> at .05 level

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS

DERIVED FROM UNCORRELATED GROUPS FROM SMALL SAMPLES

Test Back Strength

Experimental Group $\overline{D}$ = 31.786   Control Group $\overline{D}$ = 19.643

Experimental Group $S_{\overline{D}}$ = 15.491   Control Group $S_{\overline{D}}$ = 12.547

SDMD   (the estimate of the sampling error for the distribution of differences between the mean differences.)

$$\sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2} \qquad \sqrt{(15.491)^2 + (12.547)^2}$$

SDMD + ___9.09___

$D_{\overline{D}} = \overline{D}_1 = \overline{D}_2 = $ ___31.786___ − ___19.643___ = ___12.143___

"t" = $\dfrac{D_{\overline{D}}}{SDMD}$ = $\dfrac{12.143}{9.09}$ = ___1.336___

df = $(N_1 - 1) + (N_2 - 1)$ = 6 + 6 = __12__

"t" at .05 level = 2.179

Not Significant at .05 level

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